

PROJECT MANUAL

NURSING PROGRAM EXPANSION

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VERMONT STATE COLLEGES SYSTEM
d/b/a VERMONT STATE UNIVERSITY
JOHNSON, VERMONT



DECEMBER 9, 2025

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PROJECT DIRECTORY

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DOCUMENT 001116 - INVITATION TO BID

1.1 PROJECT INFORMATION

- A. Notice to Bidders: Invited bidders are invited to submit bids for Project as described in this Document according to the Instructions to Bidders.
- B. Project Identification: Nursing Program Expansion - Johnson - Phase 3.
- C. Project Locations:
 - 1. Willey Library, Vermont State University, Johnson Campus, Johnson, Vermont.
- D. Owner: Vermont State Colleges System d/b/a Vermont State University.
 - 1. Owner's Representative: Steven Brauns, Vermont State Colleges System d/b/a Vermont State University, 575 Stone Cutters Way, Montpelier, VT 05602, (802) 461-6654, Steven.brauns@vermontstate.edu.
- E. Architect: SAS Architects.
 - 1. Architect: Tricia Roy, 117 St. Paul Street, 3rd Floor, Burlington, Vermont 05401, (802) 863-2227, tricia@sasarchitects.com.
- F. Project Description:
 - 1. Johnson Campus, Willey Library: Construction of the Nursing Space Expansion at the second floor of the Willey Library. The renovation and fit-up within the Phase 2 perimeter walls include approximately 4700 SF, including a Skills Lab, Simulation Lab with Control Room, Immersive Lab, Debrief Rooms, Offices and Storage. The project will include replacement of air handling units within the existing penthouse and adjacent rooftop. The roofing system at the roof adjacent to the penthouse will be replaced as part of this scope of work.
- G. Construction Contract: Bids will be received for the following Work:
 - 1. Interior renovation.

1.2 BID SUBMITTAL AND OPENING

- A. Owner will receive sealed bids until the bid time and date at the location indicated below. Owner will consider bids prepared in compliance with the Instructions to Bidders issued by Owner, and delivered by mail or in person. Email bids are accepted. Bids received after the bid time and date will not be considered.
 - 1. Bid Date: Friday, January 30, 2026.
 - 2. Bid Time: 1:00 p.m., local time.
 - 3. Email bids to Steven Brauns: Steven.brauns@vermontstate.edu and Tricia Roy: tricia@sasarchitects.com.
 - 4. Bids will be thereafter privately opened.

1.3 BID SECURITY

- A. Bid security is not required. No bids may be withdrawn for a period of 60 days after opening of bids. Owner reserves the right to reject any and all bids and to waive informalities and irregularities.

1.4 PRE-BID CONFERENCE

- A. A Pre-Bid Conference for all bidders will be held as follows. Prospective bidders are required to attend.
 - 1. Vermont State University, Willey Library, Johnson Campus: Thursday, December 18, 2025 at 1:00 p.m.
- B. Questions regarding the Project must be submitted by Tuesday, January 6, 2026, at 4:00 p.m. ET to Tricia Roy, tricia@sasarchitects.com and Steven Brauns, steven.brauns@vermontstate.edu.
- C. Request for Proposals can be found on the following VTSU website: <https://www.vsc.edu/employee-resources/rfps/>

1.5 TIME OF COMPLETION

- A. Bidders shall begin the Work on receipt of the Notice to Proceed, with construction starting May 26, 2026, and shall complete the Work no later than August 7, 2026.

1.6 BIDDER'S QUALIFICATIONS

- A. Bidders must be invited and prequalified by Owner and Architect.
- B. Insurance: The Construction firm must be able to provide the following insurance coverage:
 - 1. General Liability and Property Damage: With respect to all operations performed under the contract, the Construction firm shall carry general liability insurance having all major divisions of coverage including, but not limited to:
 - a. Premises – Operations.
 - b. Products and Completed Operations.
 - c. Personal Injury Liability.
 - d. Contractual Liability.
 - 2. This policy shall be on an occurrence form and limits shall not be less than:
 - a. \$1,000,000 per Occurrence.
 - b. \$1,000,000 General Aggregate.
 - c. \$1,000,000 Products/Completed Operations Aggregate.
 - d. \$50,000 Fire/Legal/Liability
 - 3. Automotive Liability: The Construction firm shall carry automotive liability insurance covering all motor vehicles, including hired and non-owned coverage, used in connection

with the Agreement. Limits of coverage shall not be less than: \$1,000,000 combined single limit.

END OF DOCUMENT 001116

DOCUMENT 002113 - INSTRUCTIONS TO BIDDERS

- A. AIA Document A701, "Instructions to Bidders," is hereby incorporated into the Procurement and Contracting Requirements by reference.
 - 1. A copy of AIA Document A701, "Instructions to Bidders," is bound in this Project Manual.

END OF DOCUMENT 002113

DRAFT AIA® Document A701™ – 2018

Instructions to Bidders

for the following Project:

(Name, location, and detailed description)

«Nursing Program Expansion - Phase 3»
Willey Library
«Vermont State University - Johnson Campus»

THE OWNER:

(Name, legal status, address, and other information)

Vermont State Colleges System d/b/a Vermont State University
«575 Stone Cutters Way»
«Montpelier, VT 051602»
« »

THE ARCHITECT:

(Name, legal status, address, and other information)

«SAS Architects »« »
«117 St. Paul Street, 3rd Floor»
«Burlington, VT 05401»
« »

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ADDITIONS AND DELETIONS:

The author of this document has added information needed for its completion. The author may also have revised the text of the original AIA standard form. An *Additions and Deletions Report* that notes added information as well as revisions to the standard form text is available from the author and should be reviewed.

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

FEDERAL, STATE, AND LOCAL LAWS MAY IMPOSE REQUIREMENTS ON PUBLIC PROCUREMENT CONTRACTS. CONSULT LOCAL AUTHORITIES OR AN ATTORNEY TO VERIFY REQUIREMENTS APPLICABLE TO THIS PROCUREMENT BEFORE COMPLETING THIS FORM.

It is intended that AIA Document G612™-2017, Owner's Instructions to the Architect, Parts A and B will be completed prior to using this document.

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ARTICLE 1 DEFINITIONS

§ 1.1 Bidding Documents include the Bidding Requirements and the Proposed Contract Documents. The Bidding Requirements consist of the advertisement or invitation to bid, Instructions to Bidders, supplementary instructions to bidders, the bid form, and any other bidding forms. The Proposed Contract Documents consist of the unexecuted form of Agreement between the Owner and Contractor and that Agreement's Exhibits, Conditions of the Contract (General, Supplementary and other Conditions), Drawings, Specifications, all Addenda, and all other documents enumerated in Article 8 of these Instructions.

§ 1.2 Definitions set forth in the General Conditions of the Contract for Construction, or in other Proposed Contract Documents apply to the Bidding Documents.

§ 1.3 Addenda are written or graphic instruments issued by the Architect, which, by additions, deletions, clarifications, or corrections, modify or interpret the Bidding Documents.

§ 1.4 A Bid is a complete and properly executed proposal to do the Work for the sums stipulated therein, submitted in accordance with the Bidding Documents.

§ 1.5 The Base Bid is the sum stated in the Bid for which the Bidder offers to perform the Work described in the Bidding Documents, to which Work may be added or deleted by sums stated in Alternate Bids.

§ 1.6 An Alternate Bid (or Alternate) is an amount stated in the Bid to be added to or deducted from, or that does not change, the Base Bid if the corresponding change in the Work, as described in the Bidding Documents, is accepted.

§ 1.7 A Unit Price is an amount stated in the Bid as a price per unit of measurement for materials, equipment, or services, or a portion of the Work, as described in the Bidding Documents.

§ 1.8 A Bidder is a person or entity who submits a Bid and who meets the requirements set forth in the Bidding Documents.

§ 1.9 A Sub-bidder is a person or entity who submits a bid to a Bidder for materials, equipment, or labor for a portion of the Work.

ARTICLE 2 BIDDER'S REPRESENTATIONS

§ 2.1 By submitting a Bid, the Bidder represents that:

- .1 the Bidder has read and understands the Bidding Documents;
- .2 the Bidder understands how the Bidding Documents relate to other portions of the Project, if any, being bid concurrently or presently under construction;
- .3 the Bid complies with the Bidding Documents;
- .4 the Bidder has visited the site, become familiar with local conditions under which the Work is to be performed, and has correlated the Bidder's observations with the requirements of the Proposed Contract Documents;
- .5 the Bid is based upon the materials, equipment, and systems required by the Bidding Documents without exception; and
- .6 the Bidder has read and understands the provisions for liquidated damages, if any, set forth in the form of Agreement between the Owner and Contractor.

ARTICLE 3 BIDDING DOCUMENTS

§ 3.1 Distribution

§ 3.1.1 Bidders shall obtain complete Bidding Documents, as indicated below, from the issuing office designated in the advertisement or invitation to bid, for the deposit sum, if any, stated therein.

(Indicate how, such as by email, website, host site/platform, paper copy, or other method Bidders shall obtain Bidding Documents.)

«Bid documents are available for purchase at Blueprints, Etc. Only complete sets will be issued. »

§ 3.1.2 Any required deposit shall be refunded to Bidders who submit a bona fide Bid and return the paper Bidding Documents in good condition within ten days after receipt of Bids. The cost to replace missing or damaged paper

documents will be deducted from the deposit. A Bidder receiving a Contract award may retain the paper Bidding Documents, and the Bidder's deposit will be refunded.

§ 3.1.3 Bidding Documents will not be issued directly to Sub-bidders unless specifically offered in the advertisement or invitation to bid, or in supplementary instructions to bidders.

§ 3.1.4 Bidders shall use complete Bidding Documents in preparing Bids. Neither the Owner nor Architect assumes responsibility for errors or misinterpretations resulting from the use of incomplete Bidding Documents.

§ 3.1.5 The Bidding Documents will be available for the sole purpose of obtaining Bids on the Work. No license or grant of use is conferred by distribution of the Bidding Documents.

§ 3.2 Modification or Interpretation of Bidding Documents

§ 3.2.1 The Bidder shall carefully study the Bidding Documents, shall examine the site and local conditions, and shall notify the Architect of errors, inconsistencies, or ambiguities discovered and request clarification or interpretation pursuant to Section 3.2.2.

§ 3.2.2 Requests for clarification or interpretation of the Bidding Documents shall be submitted by the Bidder in writing and shall be received by the Architect at least seven days prior to the date for receipt of Bids.
(Indicate how, such as by email, website, host site/platform, paper copy, or other method Bidders shall submit requests for clarification and interpretation.)

«Submit questions by email to Tricia Roy at tricia@sasarchitects.com & Steven Brauns at Steven.brauns@vermontstate.edu.

§ 3.2.3 Modifications and interpretations of the Bidding Documents shall be made by Addendum. Modifications and interpretations of the Bidding Documents made in any other manner shall not be binding, and Bidders shall not rely upon them.

§ 3.3 Substitutions

§ 3.3.1 The materials, products, and equipment described in the Bidding Documents establish a standard of required function, dimension, appearance, and quality to be met by any proposed substitution.

§ 3.3.2 Substitution Process

§ 3.3.2.1 Written requests for substitutions shall be received by the Architect at least ten days prior to the date for receipt of Bids. Requests shall be submitted in the same manner as that established for submitting clarifications and interpretations in Section 3.2.2.

§ 3.3.2.2 Bidders shall submit substitution requests on a Substitution Request Form if one is provided in the Bidding Documents.

§ 3.3.2.3 If a Substitution Request Form is not provided, requests shall include (1) the name of the material or equipment specified in the Bidding Documents; (2) the reason for the requested substitution; (3) a complete description of the proposed substitution including the name of the material or equipment proposed as the substitute, performance and test data, and relevant drawings; and (4) any other information necessary for an evaluation. The request shall include a statement setting forth changes in other materials, equipment, or other portions of the Work, including changes in the work of other contracts or the impact on any Project Certifications (such as LEED), that will result from incorporation of the proposed substitution.

§ 3.3.3 The burden of proof of the merit of the proposed substitution is upon the proposer. The Architect's decision of approval or disapproval of a proposed substitution shall be final.

§ 3.3.4 If the Architect approves a proposed substitution prior to receipt of Bids, such approval shall be set forth in an Addendum. Approvals made in any other manner shall not be binding, and Bidders shall not rely upon them.

§ 3.3.5 No substitutions will be considered after the Contract award unless specifically provided for in the Contract Documents.

§ 3.4 Addenda

§ 3.4.1 Addenda will be transmitted to Bidders known by the issuing office to have received complete Bidding Documents.

(Indicate how, such as by email, website, host site/platform, paper copy, or other method Addenda will be transmitted.)

«Addenda will be issued by email.»

§ 3.4.2 Addenda will be available where Bidding Documents are on file.

§ 3.4.3 Addenda will be issued no later than four days prior to the date for receipt of Bids, except an Addendum withdrawing the request for Bids or one which includes postponement of the date for receipt of Bids.

§ 3.4.4 Prior to submitting a Bid, each Bidder shall ascertain that the Bidder has received all Addenda issued, and the Bidder shall acknowledge their receipt in the Bid.

ARTICLE 4 BIDDING PROCEDURES

§ 4.1 Preparation of Bids

§ 4.1.1 Bids shall be submitted on the forms included with or identified in the Bidding Documents.

§ 4.1.2 All blanks on the bid form shall be legibly executed. Paper bid forms shall be executed in a non-erasable medium.

§ 4.1.3 Sums shall be expressed in both words and numbers, unless noted otherwise on the bid form. In case of discrepancy, the amount entered in words shall govern.

§ 4.1.4 Edits to entries made on paper bid forms must be initialed by the signer of the Bid.

§ 4.1.5 All requested Alternates shall be bid. If no change in the Base Bid is required, enter "No Change" or as required by the bid form.

§ 4.1.6 Where two or more Bids for designated portions of the Work have been requested, the Bidder may, without forfeiture of the bid security, state the Bidder's refusal to accept award of less than the combination of Bids stipulated by the Bidder. The Bidder shall neither make additional stipulations on the bid form nor qualify the Bid in any other manner.

§ 4.1.7 Each copy of the Bid shall state the legal name and legal status of the Bidder. As part of the documentation submitted with the Bid, the Bidder shall provide evidence of its legal authority to perform the Work in the jurisdiction where the Project is located. Each copy of the Bid shall be signed by the person or persons legally authorized to bind the Bidder to a contract. A Bid by a corporation shall further name the state of incorporation and have the corporate seal affixed. A Bid submitted by an agent shall have a current power of attorney attached, certifying the agent's authority to bind the Bidder.

§ 4.1.8 A Bidder shall incur all costs associated with the preparation of its Bid.

§ 4.2 Bid Security

§ 4.2.1 Each Bid shall be accompanied by the following bid security:

(Insert the form and amount of bid security.)

«Not required.»

§ 4.2.2 The Bidder pledges to enter into a Contract with the Owner on the terms stated in the Bid and shall, if required, furnish bonds covering the faithful performance of the Contract and payment of all obligations arising thereunder. Should the Bidder refuse to enter into such Contract or fail to furnish such bonds if required, the amount of the bid security shall be forfeited to the Owner as liquidated damages, not as a penalty. In the event the Owner fails to comply with Section 6.2, the amount of the bid security shall not be forfeited to the Owner.

§ 4.2.3 If a surety bond is required as bid security, it shall be written on AIA Document A310™, Bid Bond, unless otherwise provided in the Bidding Documents. The attorney-in-fact who executes the bond on behalf of the surety shall

affix to the bond a certified and current copy of an acceptable power of attorney. The Bidder shall provide surety bonds from a company or companies lawfully authorized to issue surety bonds in the jurisdiction where the Project is located.

§ 4.2.4 The Owner will have the right to retain the bid security of Bidders to whom an award is being considered until (a) the Contract has been executed and bonds, if required, have been furnished; (b) the specified time has elapsed so that Bids may be withdrawn; or (c) all Bids have been rejected. However, if no Contract has been awarded or a Bidder has not been notified of the acceptance of its Bid, a Bidder may, beginning «60» days after the opening of Bids, withdraw its Bid and request the return of its bid security.

§ 4.3 Submission of Bids

§ 4.3.1 A Bidder shall submit its Bid as indicated below:

(Indicate how, such as by website, host site/platform, paper copy, or other method Bidders shall submit their Bid.)

«By mail or by email.»

§ 4.3.2 Paper copies of the Bid, the bid security, and any other documents required to be submitted with the Bid shall be enclosed in a sealed opaque envelope. The envelope shall be addressed to the party receiving the Bids and shall be identified with the Project name, the Bidder's name and address, and, if applicable, the designated portion of the Work for which the Bid is submitted. If the Bid is sent by mail, the sealed envelope shall be enclosed in a separate mailing envelope with the notation "SEALED BID ENCLOSED" on the face thereof.

§ 4.3.3 Bids shall be submitted by the date and time and at the place indicated in the invitation to bid. Bids submitted after the date and time for receipt of Bids, or at an incorrect place, will not be accepted.

§ 4.3.4 The Bidder shall assume full responsibility for timely delivery at the location designated for receipt of Bids.

§ 4.3.5 A Bid submitted by any method other than as provided in this Section 4.3 will not be accepted.

§ 4.4 Modification or Withdrawal of Bid

§ 4.4.1 Prior to the date and time designated for receipt of Bids, a Bidder may submit a new Bid to replace a Bid previously submitted, or withdraw its Bid entirely, by notice to the party designated to receive the Bids. Such notice shall be received and duly recorded by the receiving party on or before the date and time set for receipt of Bids. The receiving party shall verify that replaced or withdrawn Bids are removed from the other submitted Bids and not considered. Notice of submission of a replacement Bid or withdrawal of a Bid shall be worded so as not to reveal the amount of the original Bid.

§ 4.4.2 Withdrawn Bids may be resubmitted up to the date and time designated for the receipt of Bids in the same format as that established in Section 4.3, provided they fully conform with these Instructions to Bidders. Bid security shall be in an amount sufficient for the Bid as resubmitted.

§ 4.4.3 After the date and time designated for receipt of Bids, a Bidder who discovers that it made a clerical error in its Bid shall notify the Architect of such error within two days, or pursuant to a timeframe specified by the law of the jurisdiction where the Project is located, requesting withdrawal of its Bid. Upon providing evidence of such error to the reasonable satisfaction of the Architect, the Bid shall be withdrawn and not resubmitted. If a Bid is withdrawn pursuant to this Section 4.4.3, the bid security will be attended to as follows:

(State the terms and conditions, such as Bid rank, for returning or retaining the bid security.)

«Bid security is not required.»

ARTICLE 5 CONSIDERATION OF BIDS

§ 5.1 Opening of Bids

If stipulated in an advertisement or invitation to bid, or when otherwise required by law, Bids properly identified and received within the specified time limits will be publicly opened and read aloud. A summary of the Bids may be made available to Bidders.

§ 5.2 Rejection of Bids

Unless otherwise prohibited by law, the Owner shall have the right to reject any or all Bids.

§ 5.3 Acceptance of Bid (Award)

§ 5.3.1 It is the intent of the Owner to award a Contract to the lowest responsive and responsible Bidder, provided the Bid has been submitted in accordance with the requirements of the Bidding Documents. Unless otherwise prohibited by law, the Owner shall have the right to waive informalities and irregularities in a Bid received and to accept the Bid which, in the Owner's judgment, is in the Owner's best interests.

§ 5.3.2 Unless otherwise prohibited by law, the Owner shall have the right to accept Alternates in any order or combination, unless otherwise specifically provided in the Bidding Documents, and to determine the lowest responsive and responsible Bidder on the basis of the sum of the Base Bid and Alternates accepted.

ARTICLE 6 POST-BID INFORMATION

§ 6.1 Contractor's Qualification Statement

Bidders to whom award of a Contract is under consideration shall submit to the Architect, upon request and within the timeframe specified by the Architect, a properly executed AIA Document A305™, Contractor's Qualification Statement, unless such a Statement has been previously required and submitted for this Bid.

§ 6.2 Owner's Financial Capability

A Bidder to whom award of a Contract is under consideration may request in writing, fourteen days prior to the expiration of the time for withdrawal of Bids, that the Owner furnish to the Bidder reasonable evidence that financial arrangements have been made to fulfill the Owner's obligations under the Contract. The Owner shall then furnish such reasonable evidence to the Bidder no later than seven days prior to the expiration of the time for withdrawal of Bids. Unless such reasonable evidence is furnished within the allotted time, the Bidder will not be required to execute the Agreement between the Owner and Contractor.

§ 6.3 Submittals

§ 6.3.1 After notification of selection for the award of the Contract, the Bidder shall, as soon as practicable or as stipulated in the Bidding Documents, submit in writing to the Owner through the Architect:

- .1 a designation of the Work to be performed with the Bidder's own forces;
- .2 names of the principal products and systems proposed for the Work and the manufacturers and suppliers of each; and
- .3 names of persons or entities (including those who are to furnish materials or equipment fabricated to a special design) proposed for the principal portions of the Work.

§ 6.3.2 The Bidder will be required to establish to the satisfaction of the Architect and Owner the reliability and responsibility of the persons or entities proposed to furnish and perform the Work described in the Bidding Documents.

§ 6.3.3 Prior to the execution of the Contract, the Architect will notify the Bidder if either the Owner or Architect, after due investigation, has reasonable objection to a person or entity proposed by the Bidder. If the Owner or Architect has reasonable objection to a proposed person or entity, the Bidder may, at the Bidder's option, withdraw the Bid or submit an acceptable substitute person or entity. The Bidder may also submit any required adjustment in the Base Bid or Alternate Bid to account for the difference in cost occasioned by such substitution. The Owner may accept the adjusted bid price or disqualify the Bidder. In the event of either withdrawal or disqualification, bid security will not be forfeited.

§ 6.3.4 Persons and entities proposed by the Bidder and to whom the Owner and Architect have made no reasonable objection must be used on the Work for which they were proposed and shall not be changed except with the written consent of the Owner and Architect.

ARTICLE 7 PERFORMANCE BOND AND PAYMENT BOND

§ 7.1 Bond Requirements

§ 7.1.1 If stipulated in the Bidding Documents, the Bidder shall furnish bonds covering the faithful performance of the Contract and payment of all obligations arising thereunder.

§ 7.1.2 If the furnishing of such bonds is stipulated in the Bidding Documents, the cost shall be included in the Bid. If the furnishing of such bonds is required after receipt of bids and before execution of the Contract, the cost of such bonds shall be added to the Bid in determining the Contract Sum.

§ 7.1.3 The Bidder shall provide surety bonds from a company or companies lawfully authorized to issue surety bonds in the jurisdiction where the Project is located.

§ 7.1.4 Unless otherwise indicated below, the Penal Sum of the Payment and Performance Bonds shall be the amount of the Contract Sum.

(If Payment or Performance Bonds are to be in an amount other than 100% of the Contract Sum, indicate the dollar amount or percentage of the Contract Sum.)

«Performance and Payment Bonds are not required.»

§ 7.2 Time of Delivery and Form of Bonds

§ 7.2.1 The Bidder shall deliver the required bonds to the Owner not later than three days following the date of execution of the Contract. If the Work is to commence sooner in response to a letter of intent, the Bidder shall, prior to commencement of the Work, submit evidence satisfactory to the Owner that such bonds will be furnished and delivered in accordance with this Section 7.2.1.

§ 7.2.2 Unless otherwise provided, the bonds shall be written on AIA Document A312, Performance Bond and Payment Bond.

§ 7.2.3 The bonds shall be dated on or after the date of the Contract.

§ 7.2.4 The Bidder shall require the attorney-in-fact who executes the required bonds on behalf of the surety to affix to the bond a certified and current copy of the power of attorney.

ARTICLE 8 ENUMERATION OF THE PROPOSED CONTRACT DOCUMENTS

§ 8.1 Copies of the proposed Contract Documents have been made available to the Bidder and consist of the following documents:

- .1 AIA Document A101™–2017, Standard Form of Agreement Between Owner and Contractor, unless otherwise stated below.

(Insert the complete AIA Document number, including year, and Document title.)

« »

- .2 AIA Document A101™–2017, Exhibit A, Insurance and Bonds, unless otherwise stated below.

(Insert the complete AIA Document number, including year, and Document title.)

« »

- .3 AIA Document A201™–2017, General Conditions of the Contract for Construction, unless otherwise stated below.

(Insert the complete AIA Document number, including year, and Document title.)

« »

- .4 AIA Document E203™–2013, Building Information Modeling and Digital Data Exhibit, dated as indicated below:

(Insert the date of the E203-2013.)

«

»

- .5 Drawings

Number

Title

Date

.6 Specifications

Section	Title	Date	Pages

.7 Addenda:

Number	Date	Pages

.8 Other Exhibits:

(Check all boxes that apply and include appropriate information identifying the exhibit where required.)

[☐] AIA Document E204™–2017, Sustainable Projects Exhibit, dated as indicated below:
(Insert the date of the E204-2017.)

☐ ☐

[☐] The Sustainability Plan:

Title	Date	Pages

[☐] Supplementary and other Conditions of the Contract:

Document	Title	Date	Pages

.9 Other documents listed below:

(List here any additional documents that are intended to form part of the Proposed Contract Documents.)

☐ ☐

DOCUMENT 002213 - SUPPLEMENTARY INSTRUCTIONS TO BIDDERS

1.1 INSTRUCTIONS TO BIDDERS

A. Instructions to Bidders for Project consist of the following:

1. AIA Document A701, "Instructions to Bidders."
2. The following Supplementary Instructions to Bidders that modify and add to the requirements of the Instructions to Bidders.
3. Vermont State Colleges System d/b/a Vermont State University requirements as follows:
 - a. The Vermont State Colleges System complies with the Vermont Public Records Act, 1 VSA § 315 *et seq.* which requires public agencies to allow any person to inspect or copy any public record upon request. Accordingly, bidders for this RFP are hereby advised that any communications, data or other information received by the Vermont State Colleges System during the RFP process could be subject to a public records request. However, certain records are exempt from public inspection and copying, as set forth in 1 VSA § 317(c), including, for example, those portions of a record which meet the statutory definition of a trade secret. Accordingly, bidders must submit a second copy of their proposal, from which any portion of the proposal that the bidder reasonably believes to be exempt from disclosure under the Public Records Act has been redacted, if the bidder's proposal may not be publicly inspected in its entirety. **By submitting a proposal, you indicate that you understand your sole responsibility to provide a redacted version of any confidential materials and the potential applicability of Vermont's Public Records Act to your proposal.**
 - b. Any contract awarded will be governed by the laws of the State of Vermont and adjudicated in the exclusive jurisdiction of the court of the State of Vermont.

1.2 SUPPLEMENTARY INSTRUCTIONS TO BIDDERS, GENERAL

- A. The following supplements modify AIA Document A701, "Instructions to Bidders." Where a portion of the Instructions to Bidders is modified or deleted by these Supplementary Instructions to Bidders, unaltered portions of the Instructions to Bidders shall remain in effect.

1.3 ARTICLE 2 - BIDDER'S REPRESENTATIONS

A. Add Section 2.1.3.1:

1. 2.1.3.1 - The Bidder has investigated all required construction-related fees, permits, and regulatory requirements of authorities having jurisdiction and has properly included in the submitted bid the cost of such fees, permits, and requirements not otherwise indicated as provided by Owner. No Act 250 Permit is required. The Owner will obtain local permits, if any, and a Construction Permit from the Division of Fire Safety.

B. Add Section 2.1.5:

1. 2.1.5 - The Bidder meets qualifications indicated in the Procurement and Contracting Documents.

C. Add Section 2.1.6:

1. 2.1.6 - The Bidder has incorporated into the Bid adequate sums for work performed by installers whose qualifications meet those indicated in the Procurement and Contracting Documents.

1.4 ARTICLE 3 - BIDDING DOCUMENTS

A. 3.4 - Addenda:

1. Delete Section 3.4.3 and replace with the following:
 - a. 3.4.3 - Addenda may be issued at any time prior to the receipt of bids.

1.5 ARTICLE 4 - BIDDING PROCEDURES

A. 4.1 - Preparation of Bids:

1. Add Section 4.1.1.1:
 - a. 4.1.1.1 - Printable electronic Bid Forms and related documents are available from Architect.
2. Add Section 4.1.9:
 - a. 4.1.9 - Owner may elect to disqualify a bid due to failure to submit a bid in the form requested, failure to bid requested alternates, failure to complete entries in all blanks in the Bid Form, or inclusion by the Bidder of any alternates, conditions, limitations or provisions not called for.
3. Add Section 4.1.10:
 - a. 4.1.10 - The Owner is exempt from sales tax.

B. 4.4 - Modification or Withdrawal of Bids:

1. Add the following sections to 4.4.2:
 - a. 4.4.2.1 - Such modifications to or withdrawal of a bid may only be made by persons authorized to act on behalf of the Bidder. Authorized persons are those so identified in the Bidder's corporate bylaws, specifically empowered by the Bidder's charter or similar legally binding document acceptable to Owner, or by a power of attorney, signed and dated, describing the scope and limitations of the power of attorney. Make such documentation available to Owner at the time of seeking modifications or withdrawal of the Bid.

- b. 4.4.2.2 - Owner will consider modifications to a bid written on the sealed bid envelope by authorized persons when such modifications comply with the following: the modification is indicated by a percent or stated amount to be added to or deducted from the Bid; the amount of the Bid itself is not made known by the modification; a signature of the authorized person, along with the time and date of the modification, accompanies the modification. Completion of an unsealed bid form, awaiting final figures from the Bidder, does not require power of attorney due to the evidenced authorization of the Bidder implied by the circumstance of the completion and delivery of the Bid.
 - C. 4.6 - Subcontractors, Suppliers, and Manufacturers List Bid Supplement:
 - 1. Add Section 4.6:
 - a. 4.6 - Provide list of major subcontractors, suppliers, and manufacturers furnishing or installing products no later than two business days following Architect's request. Include those subcontractors, suppliers, and manufacturers providing work totaling 5 percent or more of the Bid amount. Do not change subcontractors, suppliers, and manufacturers from those submitted without approval of Owner.
- 1.6 ARTICLE 5 - CONSIDERATION OF BIDS
- A. 5.2 - Rejection of Bids:
 - 1. Add Section 5.2.1:
 - a. 5.2.1 - Owner reserves the right to reject a bid based on Owner's and Architect's evaluation of qualification information submitted following opening of bids. Owner's evaluation of the Bidder's qualifications will include: status of licensure and record of compliance with licensing requirements, record of quality of completed work, record of Project completion and ability to complete, record of financial management including financial resources available to complete Project and record of timely payment of obligations, record of Project site management including compliance with requirements of authorities having jurisdiction, record of and number of current claims and disputes and the status of their resolution, and qualifications of the Bidder's proposed Project staff and proposed subcontractors.
- 1.7 ARTICLE 8 - FORM OF AGREEMENT BETWEEN OWNER AND CONTRACTOR
- A. AIA Document A101-2007 "Standard Form of Agreement between Owner and Contractor where Basis of Payment is a Stipulated Sum".
- 1.8 ARTICLE 9 - EXECUTION OF THE CONTRACT
- A. Add Article 9:
 - 1. 9.1.1 - Subsequent to the Notice of Intent to Award, and within 10 days after the prescribed Form of Agreement is presented to the Awardee for signature, the Awardee

shall execute and deliver the Agreement to Owner through Architect, in such number of counterparts as Owner may require.

2. 9.1.2 - Owner may deem as a default the failure of the Awardee to execute the Contract and to supply the required bonds when the Agreement is presented for signature within the period of time allowed.
3. 9.1.3 - Unless otherwise indicated in the Procurement and Contracting Documents or the executed Agreement, the date of commencement of the Work shall be the date of the executed Agreement or the date that the Bidder is obligated to deliver the executed Agreement and required bonds to Owner.
4. 9.1.4 - In the event of a default, Owner may declare the amount of the Bid security forfeited and elect to either award the Contract to the next responsible bidder or re-advertise for bids.

1.9 MINIMUM INSURANCE REQUIREMENTS

- A. General Contractor and Subcontractors are expected to maintain the following minimums for the life of the Project:

1. Worker's Compensation - Limits

- a. State: \$500,000
- b. Federal: \$500,000
- c. Employer's Liability: \$500,000

2. General Liability (including comprehensive form, premises, operations, explosions and collapse hazard, underground hazard, products/completed operations, contractual insurance, broad form property damage, independent contractors and personal injury).

- a. Bodily Injury Limits: \$1,000,000 Each Occurrence \$2,000,000 Aggregate
- b. Property Damage Limits: \$1,000,000 Each Occurrence \$2,000,000 Aggregate
- c. Personal Injury Limits: \$1,000,000 Each Occurrence \$2,000,000 Aggregate

Above to be provided on an Occurrence basis.

Above policy to name the Architect as additional insured.

3. Automobile Liability (including comprehensive form, owned, non-owned and hired)

- a. Automobile Liability Limits: \$1,000,000 Each Occurrence

4. Excess Liability (umbrella form)

- a. Excess Liability Limits: \$1,000,000 Limit

5. Provide certificates from the General Contractor and all Subcontractors with an endorsement letter naming the Vermont State Colleges System d/b/a Vermont State University as an additional insured. Coverage is to be primary non-contributory with a minimum 30-day cancellation notice. Work will not commence until copies of these certificates are delivered to the Owner.

6. All policies are to be written by insurance companies licensed to do business in the State of Vermont.

7. The Owner will provide Builder's Risk coverage that will remain in force until Final Acceptance of the Project.

END OF DOCUMENT 002213

DOCUMENT 003126 - EXISTING HAZARDOUS MATERIAL INFORMATION

PART 1 - GENERAL

1.1 EXISTING HAZARDOUS MATERIAL INFORMATION

- A. This Document with its referenced attachments provides Owner's information for Bidders' convenience. The information is made available for Bidders' convenience and information but is not a warranty of existing conditions.
- B. An existing asbestos report for Willey Library at the Johnson Campus, prepared by KD Associates working directly for the Owner, dated February 5, 2024, is attached.
- C. Related Requirements:
 - 1. Section 002113 "Instructions to Bidders" for the Bidder's responsibilities for examination of Project site and existing conditions.
 - 2. Section 011000 "Summary" for Project Schedule.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF DOCUMENT 003126

ASBESTOS INSPECTION REPORT

of

Vermont State Colleges - “Johnson Campus / Wiley Library”
1001 College Road
Lyndonville, VT 05851

Prepared for:

Eric Bregante
VT State Colleges
1001 College Rd.
Lyndonville, VT 05851

February 5, 2024

KDAI Project No: 19114-014



ASSOCIATES, INC.

Environmental Consulting & Contracting

41 IDX Drive, Suite 209, South Burlington, Vermont 05403-7757

(802) 862-7490

INTRODUCTION

At your request a representative from K-D Associates, Inc. inspected and collected select samples of suspect building materials for the presence of asbestos from the Wiley Library and adjacent areas of the Vermont State Colleges Johnson Facility Located on 1001 College Road, Lyndonville, VT. The survey was designed and conducted to satisfy the pre-renovation requirements of EPA 40 CFR 61, Subpart M, National Emission Standards for Hazardous Air Pollutants (NESHAP), Occupational Safety and Health Administration (OSHA), and the Vermont Regulations for Asbestos Control (VRAC) (V.S.A. Title 18, Chapter 26). The site visit and inspection was conducted on January 23, 2024.

Multiple samples of each suspect material were collected per homogeneous area. The number of samples was guided by the sampling requirements of the EPA Asbestos Hazard Emergency Response Act (AHERA). Each sample was sealed in a distinct sampling bag, labeled, and transported under a chain-of-custody to the laboratory for analysis.

All samples were analyzed by Polarized Light Microscopy (PLM) until either a positive sample was found in a material type or all samples were analyzed. Asbestos-Containing Material (ACM) as defined by the EPA and the State of Vermont are materials with an asbestos concentration of greater than one percent ($>1\%$). Laboratory analysis was performed by PLM using EPA Method 600/R-93/116 (point-counted when positive at less than 5%). When one sample in a material type is found to contain asbestos in a concentration greater than one percent ($>1.0\%$), the remaining samples in that group are not analyzed (positive stop). Complete laboratory results are attached.

FINDINGS:

No asbestos was detected in any of the select samples collected during the January 23, 2024 site visit.

The following materials were analyzed and found to be non-asbestos containing materials:

Sample ID	Material Description	Location
24WB023-01, -02	Ceiling Tile	Wiley Library Mezzanine, Suspended in Track, 24" x 48"
24WB023-03, -04	Vinyl Baseboard - Grey	Wiley Library Mezzanine, By Spiral Staircase
24WB023-05, -06	Adhesive	Associated with Samples #03 & #04
24WB023-07, -08	Adhesive	Wiley Library Mezzanine, Associated with Red Carpet
24WB023-09, -10	Gypsum Board	Wiley Library Mezzanine, Wall Behind Book Racks & Staircase
24WB023-11, -12	Joint Compound	Wiley Library Mezzanine, Wall Behind Book Racks & Staircase
24WB023-13, -14	Vinyl Baseboard - Pink	Classroom #217
24WB023-15, -16	Adhesive	Associated with Samples #13 & #14
24WB023-17, -18	Vinyl Baseboard - Pink	Classroom #217

24WB023-19, -20	Adhesive	Associated with Samples #17 & #18
24WB023-21, -22	Gypsum Board	Classroom #216 & #217 Wall
24WB023-23, -24	Joint Compound	Classroom #216 & #217 Wall
24WB023-25, -26	Ceiling Tile	Classroom #217 & #216, Suspended in Track, 24" x 48"
24WB023-27, -28	Adhesive	Classroom #217 & #216, Associated with Multi-Color Carpet
24WB023-29, -30	12" x 12" Floor Tile - Black	Second-Floor Hallway, Outside Classrooms #217 & #214
24WB023-31, -32	Adhesive	Associated with Samples #29 & #30
24WB023-33, -34	Gypsum Board	Classrooms #213 & #214 Wall
24WB023-35, -36	Joint Compound	Classrooms #213 & #214 Wall
24WB023-37, -38	Vinyl Baseboard	Classrooms #213 & #214
24WB023-39, -40	Adhesive	Associated with Samples #37 & #38
24WB023-41, -42	Adhesive	Classrooms #213 & #214, Associated with Carpet

RESULTS / CONCLUSIONS

The results of this select sample pre-renovation asbestos inspection in the Wiley Library and adjacent areas of the Vermont State Colleges Johnson Facility Located on 1001 College Road, Lyndonville, VT, have found no building materials that contain asbestos. It is important to note that the samples listed above are the only materials tested during the January 23, 2024 site visit.

The Vermont Regulations for Asbestos Control (VRAC) and National Emission Standards for Hazardous Air Pollutants (NESHAP) have notification requirements 10 work days prior to abatement and/or demolition activities that may apply.

An effort was made to find materials hidden from casual view, however additional suspect materials may be present in concealed or inaccessible spaces. Any other suspect materials found during renovation/demolition activities, not specifically sampled/identified in this survey should be presumed to be positive for asbestos until they can be sampled and laboratory analysis shows otherwise.

This report is not intended to be used as a bid document or specification for the purpose of abatement estimating. The quantities associated with the above materials are approximated and are not intended to be used for abatement cost estimation.

Please do not hesitate to call if you have any questions or need additional information.

Respectfully,

A handwritten signature in black ink, appearing to read 'Dillon Wells', with a stylized, cursive script.

Dillon Wells
VT Asbestos Inspector #AI8939810

Enclosure  19114-014



EMSL Analytical, Inc.

200 Route 130 North Cinnaminson, NJ 08077

Tel/Fax: (800) 220-3675 / (856) 786-5974

<http://www.EMSL.com/cinnasblab@EMSL.com>

EMSL Order: 042401591

Customer ID: KDAI50

Customer PO:

Project ID:

Attention: K-D Associates, Inc.

K-D Associates

41 IDX Drive

Suite 209

South Burlington, VT 05403

Project: 19114-014 / Wiley Library / 1001 College Rd, Lyndonville VT

Phone: (802) 862-7490

Fax: (802) 660-2462

Received Date: 01/25/2024 9:40 AM

Analysis Date: 01/29/2024

Collected Date: 01/23/2024

Test Report: Asbestos Analysis of Bulk Materials via AHERA Method 40CFR 763 Subpart E Appendix E supplemented with EPA 600/R-93/116 using Polarized Light Microscopy

Sample	Description	Appearance	Non-Asbestos		Asbestos % Type
			% Fibrous	% Non-Fibrous	
24WB023-01 042401591-0001	Wiley Library - Mezzanine - 24"x48" Suspended in Track Ceiling Tile	Gray Fibrous Homogeneous	65% Min. Wool	35% Non-fibrous (Other)	None Detected
24WB023-02 042401591-0002	Wiley Library - Mezzanine - 24"x48" Suspended in Track Ceiling Tile	Gray Fibrous Homogeneous	70% Min. Wool	30% Non-fibrous (Other)	None Detected
24WB023-03 042401591-0003	Library Mezzanine by Spiral Staircase - Gray Vinyl Baseboard	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-04 042401591-0004	Library Mezzanine by Spiral Staircase - Gray Vinyl Baseboard	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-05 042401591-0005	Library Mezzanine by Spiral Staircase - Adhesive a/w 03	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-06 042401591-0006	Library Mezzanine by Spiral Staircase - Adhesive a/w 04	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-07 042401591-0007	Wiley Library - Mezzanine - Adhesive a/w Red Carpet	Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-08 042401591-0008	Wiley Library - Mezzanine - Adhesive a/w Red Carpet	Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-09 042401591-0009	Wiley Library - Mezzanine Wall behind Book Racks - Gypsum Board	Brown/White Fibrous Homogeneous	15% Cellulose 5% Glass	80% Non-fibrous (Other)	None Detected
24WB023-10 042401591-0010	Wiley Library - Mezzanine Wall behind Book Racks - Gypsum Board	Brown/White Fibrous Homogeneous	15% Cellulose 3% Glass	82% Non-fibrous (Other)	None Detected
24WB023-11 042401591-0011	Wiley Library - Mezzanine Wall behind Book Racks - Joint Compound	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-12 042401591-0012	Wiley Library - Mezzanine Wall behind Book Racks - Joint Compound	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-13 042401591-0013	Room 217 - Vinyl Baseboard	Pink Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-14 042401591-0014	Room 217 - Vinyl Baseboard	Pink Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected

Initial report from: 01/29/2024 23:15:37



EMSL Analytical, Inc.

200 Route 130 North Cinnaminson, NJ 08077

Tel/Fax: (800) 220-3675 / (856) 786-5974

<http://www.EMSL.com> / cinnasblab@EMSL.com

EMSL Order: 042401591

Customer ID: KDAI50

Customer PO:

Project ID:

Test Report: Asbestos Analysis of Bulk Materials via AHERA Method 40CFR 763 Subpart E Appendix E supplemented with EPA 600/R-93/116 using Polarized Light Microscopy

Sample	Description	Appearance	Non-Asbestos		Asbestos
			% Fibrous	% Non-Fibrous	% Type
24WB023-15 042401591-0015	Room 217 - Adhesive a/w 13	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-16 042401591-0016	Room 217 - Adhesive a/w 14	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-17 042401591-0017	Room 217 - Gray Vinyl Baseboard	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-18 042401591-0018	Room 216 - Gray Vinyl Baseboard	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-19 042401591-0019	Room 217 - Adhesive a/w 17	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-20 042401591-0020	Room 216 - Adhesive a/w 18	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-21 042401591-0021	Room 217 - Gypsum Board	Brown/Gray Fibrous Homogeneous	15% Cellulose 5% Glass	80% Non-fibrous (Other)	None Detected
24WB023-22 042401591-0022	Room 216 - Gypsum Board	Brown/Gray Fibrous Homogeneous	15% Cellulose 5% Glass	80% Non-fibrous (Other)	None Detected
24WB023-23 042401591-0023	Room 217 - Joint Compound	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-24 042401591-0024	Room 216 - Joint Compound	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-25 042401591-0025	Room 217 - 24"x48" Suspended in Track Ceiling Tile	Gray/White Fibrous Homogeneous	65% Min. Wool	35% Non-fibrous (Other)	None Detected
24WB023-26 042401591-0026	Room 216 - 24"x48" Suspended in Track Ceiling Tile	Gray/White Fibrous Homogeneous	65% Min. Wool	35% Non-fibrous (Other)	None Detected
24WB023-27 042401591-0027	Room 217 - Adhesive a/w Multi-Color Carpet	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-28 042401591-0028	Room 216 - Adhesive a/w Multi-Color Carpet	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-29 042401591-0029	Room 217 - 12"x12" Black Floor Tile	Black Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-30 042401591-0030	Room 214 - 12"x12" Black Floor Tile	Black Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-31 042401591-0031	Room 217 - Adhesive a/w 29	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-32 042401591-0032	Room 214 - Adhesive a/w 30	Yellow/Green Fibrous Heterogeneous	5% Synthetic	95% Non-fibrous (Other)	None Detected

Result includes a small amount of inseparable attached material

Initial report from: 01/29/2024 23:15:37



EMSL Analytical, Inc.

200 Route 130 North Cinnaminson, NJ 08077

Tel/Fax: (800) 220-3675 / (856) 786-5974

<http://www.EMSL.com / cinnasblab@EMSL.com>

EMSL Order: 042401591

Customer ID: KDAI50

Customer PO:

Project ID:

Test Report: Asbestos Analysis of Bulk Materials via AHERA Method 40CFR 763 Subpart E Appendix E supplemented with EPA 600/R-93/116 using Polarized Light Microscopy

Sample	Description	Appearance	Non-Asbestos		Asbestos
			% Fibrous	% Non-Fibrous	% Type
24WB023-33 042401591-0033	Room 213 Wall - Gypsum Board	Brown/White Fibrous Homogeneous	15% Cellulose 5% Glass	80% Non-fibrous (Other)	None Detected
24WB023-34 042401591-0034	Room 214 Wall - Gypsum Board	Brown/White Fibrous Homogeneous	10% Cellulose 3% Glass	87% Non-fibrous (Other)	None Detected
24WB023-35 042401591-0035	Room 213 Wall - Joint Compound	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-36 042401591-0036	Room 214 Wall - Joint Compound	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-37 042401591-0037	Room 213 - Vinyl Baseboard	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-38 042401591-0038	Room 214 - Vinyl Baseboard	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-39 042401591-0039	Room 213 - Adhesive a/w 37	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-40 042401591-0040	Room 214 - Adhesive a/w 38	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-41 042401591-0041	Room 213 - Adhesive a/w Carpet	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
24WB023-42 042401591-0042	Room 214 - Adhesive a/w Carpet	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected

Report Comment: Vermont Cert: ASB-I-PLM-000027(MB); Asb-I-PLM-000033(QV)

Analyst(s)

Michael Bocchicchio (21)

Quynh Vu (21)

Samantha Rundstrom, Laboratory Manager
or Other Approved Signatory

EMSL maintains liability limited to cost of analysis. Interpretation and use of test results are the responsibility of the client. This report relates only to the samples reported above, and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. The report reflects the samples as received. Results are generated from the field sampling data (sampling volumes and areas, locations, etc.) provided by the client on the Chain of Custody. Samples are within quality control criteria and met method specifications unless otherwise noted. The above analyses were performed in general compliance with Appendix E to Subpart E of 40 CFR (previously EPA 600/M4-82-020 "Interim Method") but augmented with procedures outlined in the 1993 ("final") version of the method. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST or any agency of the federal government. Non-friable organically bound materials present a problem matrix and therefore EMSL recommends gravimetric reduction prior to analysis. Unless requested by the client, building materials manufactured with multiple layers (i.e. linoleum, wallboard, etc.) are reported as a single sample. Estimation of uncertainty is available on request.

Samples analyzed by EMSL Analytical, Inc. Cinnaminson, NJ NVLAP Lab Code 101048-0, AIHA LAP, LLC-IHLAP Lab 100194, PA ID# 68-00367, LA #04127

Initial report from: 01/29/2024 23:15:37

DOCUMENT 004113 – BID FORM - STIPULATED SUM (SINGLE-PRIME CONTRACT)

1.1 BID INFORMATION

- A. Bidder: _____.
- B. Project Name: Nursing Program Expansion - Johnson - Phase 3
- C. Project Locations:
1. Willey Library, Vermont State University, Johnson Campus, Johnson, Vermont.
- D. Owner: Vermont State Colleges System d/b/a Vermont State University, Attn: Steven Brauns.
- E. Architect: Smith-Alvarez-Sienkiewicz Architects, Attn: Tricia Roy.
- F. Architect Project Number: 1612.

1.2 CERTIFICATIONS AND BASE BID

- A. Base Bid, Single-Prime (All Trades) Contract: The undersigned Bidder, having carefully examined the Procurement and Contracting Requirements, Conditions of the Contract, Drawings, Specifications, and all subsequent Addenda, as prepared by Smith-Alvarez-Sienkiewicz Architects, P.C. and Architect's consultants, having visited the site, and being familiar with all conditions and requirements of the Work, hereby agrees to furnish all material, labor, equipment and services necessary to complete the construction of the above-named project, according to the requirements of the Procurement and Contracting Documents, for the stipulated sum of:
1. _____ Dollars (\$_____).
 2. The above Base Bid **does not** include the following Additive Alternate, as defined in the Contract Documents, including Section 012300 "Alternates".
 - a. Add Alternate No. 1: \$ _____
(Moisture Vapor Emission Control)
 - b. Add Alternate No. 2: \$ _____
(Replace deteriorated mortar joints @ stone windowsills)
 - c. Add Alternate No. 3: \$ _____
(Replace suspended acoustic ceiling grid and tile in Classrooms 212, 215, 216 & Corridor 205)
 - d. Add Alternate No. 4: \$ _____
(Replace existing 2x4 light fixtures w/ 2x2 fixtures w/ dimmable controls. Existing ceiling to remain. Modify grid & tile as required)

- e. Add Alternate No. 5: \$ _____
(Replace carpet & rubber base in Classroom 215 & 216)
- f. Add Alternate No. 6: \$ _____
(Install solid surface at existing windowsills)
- g. Add Alternate No. 7: \$ _____
(Replace existing EIFS system @ Penthouse)
3. The above Base Bid **does not** include the following Deduct Alternate, as defined in the Contract Documents, including Section 012300 "Alternates".
- a. DEDUCT ALTERNATE #1: \$ _____
(Alternate Mechanical System)

1.3 UNIT PRICES

- A. The undersigned Bidder proposes the amounts below be added to or deducted from the Contract Sum on performance and measurement of the individual items of Work and for adjustment of the quantity given in the Unit-Price Allowance for the actual measurement of individual items of the Work.

Unit-Price No. 1: Provide unit price for work identified in 'Alternate No. 2', Replace Deteriorated Mortar Joints at Stone Sills.

a. _____ dollars (\$ _____) per unit.

Unit-Price No. 2: Provide unit price for work identified in 'Alternate No. 3', Replace suspended Acoustic Tile Ceiling & Grid.

a. _____ dollars (\$ _____) per unit.

Unit-Price No. 3: Provide unit price for work identified in 'Alternate No. 5', Replace existing Carpet and Base.

a. _____ dollars (\$ _____) per unit.

Unit-Price No. 4: Provide unit price for work identified in 'Alternate No. 6', Install Solid Surface at Existing Windowsills.

a. Condition A: _____ dollars (\$ _____) per unit.

b. Condition B: _____ dollars (\$ _____) per unit.

1.3 TIME OF COMPLETION

- A. The undersigned Bidder proposes and agrees hereby to commence the Work of the Contract Documents on a date specified in a written Notice to Proceed to be issued by Owner, and shall fully complete the Work by August 7, 2026.

1.4 ACKNOWLEDGEMENT OF ADDENDA

- A. The undersigned Bidder acknowledges receipt of and use of the following Addenda in the preparation of this Bid:

1. Addendum No. 1, dated _____.
2. Addendum No. 2, dated _____.
3. Addendum No. 3, dated _____.
4. Addendum No. 4, dated _____.

1.5 SUBMISSION OF BID

- A. Respectfully submitted this ____ day of _____, 2026.
- B. Submitted By: _____ (Name of bidding firm or corp.).
- C. Authorized Signature: _____ (Handwritten signature).
- D. Signed By: _____ (Type or print name).
- E. Title: _____ (Owner/Partner/President/Vice President).
- F. Street Address: _____.
- G. City, State, Zip: _____.
- H. Phone: _____.
- I. Federal ID No.: _____ (Affix Corporate Seal Here).

END OF DOCUMENT 004113

SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Project information.
- 2. Work covered by Contract Documents.
- 3. Work by Owner.
- 4. Work under separate contracts.
- 5. Owner-furnished products.
- 6. Access to site.
- 7. Work restrictions.
- 8. Specification and drawing conventions.
- 9. Miscellaneous provisions.

- B. Related Requirements:

- 1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.3 PROJECT INFORMATION

- A. Project Identification: Nursing Program Expansion – Johnson – Phase 3.

- 1. Project Location:

- a. Willey Library, Vermont State University, Johnson Campus, Johnson, Vermont.

- B. Owner: Vermont State Colleges System d/b/a Vermont State University

- 1. Owner's Representative:

Steven Brauns
Phone: 802-461-6654
Email: Steven.brauns@vermontstate.edu

C. Architect:

1. SAS Architects
117 St. Paul Street, 3rd Floor
Burlington, Vermont 05401

Attn: Tricia Roy
Architect
Phone: 802-863-2227
Email: tricia@sasarchitects.com

D. Architect's Consultants: The Architect has retained the following design professionals who have prepared designated portions of the Contract Documents:

1. Mechanical/Electrical/Plumbing:
 - a. L.N. Consulting
208 Flynn Avenue, #2J
Burlington, Vt 05401

Attn: John Magnant
Phone: 802-655-1753
Email: jmagnant@lnconsulting.com

E. LEED:

1. Vermont State Colleges System d/b/a Vermont State University will not seek LEED certification for the Project.

F. The project area will be partially occupied by Vermont State Colleges System d/b/a Vermont State University staff during construction.

G. Project Record Drawings for Willey Library in Johnson are available for review from Vermont State Colleges System d/b/a Vermont State University. It is the Contractor's responsibility to review the Project Record Drawings and existing building before bidding to acquaint themselves with existing conditions.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of the following:

1. The Project at the Johnson Campus, Willey Library, includes the construction of the Nursing Space Expansion at the second floor of the Willey Library. Work includes fit up within Phase 2 perimeter walls, and renovation of classrooms, and support spaces.
2. Replace the EPDM membrane roofing system, insulation, and all associated flashings at the roof at the same elevation as, and west of Mechanical Penthouse 401(approximately 1,500 SF).
3. Mechanical work includes replacement of existing air handling units within the Mechanical Penthouse and adjacent rooftop.

4. Contractor is responsible for moving VTSU purchased nursing beds from stored location in a building adjacent to the library, to the renovated second floor nursing spaces.

B. Type of Contract:

1. Project will be constructed under a single prime contract.

1.5 WORK BY OWNER

- A. General: Cooperate fully with Owner so work may be carried out smoothly, without interfering with or delaying work under this Contract or work by Owner. Coordinate the Work of this Contract with work performed by Owner.
- B. Preceding Work: Owner will perform the following operations at Project site. Those operations are scheduled to be substantially complete before work under this Contract begins.
 1. Remove all equipment and furnishings in spaces involving renovation.
- C. Installation of equipment and furnishings will occur after Final Completion by the Owner, as designated in the Documents.
- D. Owner to supply and install all project signage.

1.6 ACCESS TO SITE

- A. General: Contractor shall have limited use of Project site for construction operations.
- B. Use of Site: Limit use of Project site to areas within the Contract limits established for the building. Do not disturb portions of Project site beyond areas in which the Work is indicated.
 1. Driveways, Walkways and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
- C. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations.

1.7 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
- B. On-Site Work Hours: Limit work to normal business working hours of 7:00 a.m. to 6:00 p.m., Monday through Friday, unless otherwise indicated or approved by Owner.
 1. Weekend Hours: As approved in advance by the Owner.
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:

1. Notify Owner not less than two days in advance of proposed utility interruptions.
 2. Obtain Owner's written permission before proceeding with utility interruptions.
- D. Non-Smoking Building: Smoking is not permitted within the building or on the site except in a designated smoking area approved by the Owner.
- E. All workers must wear shirts at all times they are on the ground on campus.

1.8 SCHEDULE

- A. Construction Start: May 26, 2026.
- B. Final Completion of Construction: August 7, 2026.

1.9 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard and scheduled on Drawings.
 3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 012200 - UNIT PRICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for unit prices.
- B. Related Requirements:
 - 1. Section 012600 "Contract Modification Procedures" for procedures for submitting and handling Change Orders.
 - 2. Section 012300 "Alternates".

1.3 DEFINITIONS

- A. Unit price is a price per unit of measurement for materials, equipment, or services, or a portion of the Work, added to or deducted from the Contract Sum by appropriate modification, if the scope of Work or estimated quantities of Work required by the Contract Documents are increased or decreased.

1.4 PROCEDURES

- A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, overhead, and profit.
- B. Measurement and Payment: See individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.
- C. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.
- D. List of Unit Prices: A schedule of unit prices is included in Part 3. Specification Sections referenced in the Part 3 "Schedule of Unit Prices" Article contain requirements for materials described under each unit price.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF UNIT PRICES

- A. Unit Price No. 1: Provide unit price for work identified in 'Alternate No. 2'; Replace Deteriorated Mortar Joints at Stone Sills. Owner may elect to add or deduct from this scope of work.
1. Description: Replace deteriorated mortar joints at existing stone sills as identified on Drawing A-3.0. Conditions require resetting of existing stone sills.
 2. Unit of Measurement: Cost per linear foot to repoint/reset existing stone sills.
- B. Unit Price No. 2: Provide unit price for work identified in 'Alternate No. 3'; Replace Suspended Acoustic Tile Ceiling & Grid. Owner may elect to add or deduct from this scope of work.
1. Description: Replace existing 2x4 suspended acoustic tile ceiling and grid with new 2x2 acoustic ceiling tile and grid.
 2. Unit of Measurement: Cost per square foot for new ceiling tile and grid.
- C. Unit Price No. 3: Provide unit price for work identified in 'Alternate No. 5', Replace Existing Carpet and Base. Owner may elect to add or deduct from this scope of work.
1. Description: Replace existing carpet and rubber base.
 2. Unit of Measurement: Cost per square foot for new carpet tile and rubber base.
- D. Unit Price No. 4: Provide unit price for work identified in 'Alternate No. 6', Install Solid Surface at Existing Windowsills, and as identified on Drawing A-3.0. Owner may elect to add or deduct from this scope of work.
1. Condition A: Windowsills:
 - a. Description: Remove existing laminate and deteriorated substrate at windowsill. Install plywood substrate, thickness to match existing, and solid surface sill.
 - b. Unit of Measurement: Cost per lineal foot.
 2. Condition B: Sills at Exterior Walls adjacent to Windowsills:
 - c. Description: Remove existing laminate and install solid surface sill. Assume substrate is in fair condition.
 - d. Unit of Measurement: Cost per lineal foot.

END OF SECTION 012200

SECTION 012300 - ALTERNATES

PART 1 - GENERAL

1.1 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.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for Additive and Deduct Alternates.

1.3 DEFINITIONS

- A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to or deducted from the Base Bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
 - 1. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternates into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

- A. Coordination: Modify or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
 - 1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
- B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications to alternates.
- C. Execute accepted alternates under the same conditions as other work of the Contract.
- D. Schedule: A Schedule of Alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

A. ADD ALTERNATE NO. 1: MOISTURE VAPOR EMISSION CONTROL:

1. All labor, materials, equipment and incidentals to install a moisture vapor emission control system over the concrete slab scheduled to receive one of the following finishes:
 - a. Resilient Tile Flooring.
 - b. Carpet.
2. See Specification Section 090561 "Moisture Vapor Emission Control".
3. Moisture testing of the concrete slab is required and defined in the specifications for the finishes listed above. Testing is part of the Base Bid and must be completed within 30 days of the start of construction. Based on the results, the Owner will decide whether to accept this Additive Alternate.

B. ADD ALTERNATE NO. 2: REPLACE DETERIORATED MORTAR JOINTS AT STONE WINDOWSILLS:

1. All labor, materials, equipment and incidentals to replace deteriorated mortar joints at existing stone windowsills. This includes intermediate joints between sill pieces and at joint between brick and stone sill. Assume conditions require removing the existing sill and re-setting.
2. See Specification Section 040140 "Stone Re-pointing".

C. ADD ALTERNATE NO. 3: REPLACE SUSPENDED ACOUSTIC TILE & GRID:

1. All labor, materials, equipment and incidentals to replace existing 2x4 suspended acoustic tile and grid with a 2x2 SAC in Classrooms 212, 215, 216 and Corridor 205.
2. See Specification Section 095120 "Acoustic Tile Ceilings".
3. Base bid is existing SAC to remain in these spaces.

D. ADD ALTERNATE NO. 4: REPLACE LIGHTING AND CONTROLS:

1. All labor, materials, equipment and incidentals to replace existing lighting and controls in Classrooms 212, 215, 216 and Corridor 205.
2. See fixture schedule, control diagrams and plan notes for complete scope of work.
3. Base bid is existing fixtures and controls to remain in these spaces.

E. ADD ALTERNATE NO. 5: REPLACE CARPET & RUBBER BASE:

1. All labor, materials, equipment and incidentals to remove and replace existing carpet and rubber base in Classrooms 215 & 216.
2. See Specification Section 096810 "Carpet Tile".
3. Base bid is existing carpet and base to remain in these spaces.

F. ADD ALTERNATE NO. 6: INSTALL SOLID SURFACE AT EXISTING WINDOWSILLS:

1. All labor, materials, equipment and incidentals to install solid surface at existing windowsills as indicated on Architectural drawings A-1.1 & A-3.0. Existing laminate has warped and delaminated from the existing substrate due to moisture over time. Replace existing substrate at windowsill locations, thickness to match existing. Assume existing substrate at the sill on either side of the windowsill is in fair condition and can remain in place. Install solid surface at windowsill and sills on either side of window.
2. Alternate also includes the installation of a hardwood trim at the existing window valance. The existing laminate at the bottom of the valance has delaminated and should be removed and replaced with a hardwood edge. Stain to match and apply clear finish.
3. See Specification Section 062023 "Interior Finish Carpentry".
3. Base bid is existing laminate windowsills and valance to remain.

G. ADD ALTERNATE NO. 7: REPLACE EIFS AT MECHANICAL PENTHOUSE:

1. All labor, materials, equipment and incidentals to remove and replace the EIFS on the exterior of the Mechanical Penthouse walls (approximately 1,500SF).
2. See Specification Section 072413 "Polymer-Based Exterior Insulation and Finish System (EIFS)".

H. DEDUCT ALTERNATE NO. 1: MECHANICAL SYSTEMS:

1. Provide a difference in project costs to provide and install the "Alternate" mechanical systems in lieu of the base bid systems. See the "Alternate" drawings and schedules. Generally, this system shall consist of modifying and replacing in kind, the indicated Air Handler Units, to provide cooling to the sections of the building served by Air Handling Units #2, 3 & 4. The level 2 fit up area will be served by a separate, local air handler unit. Associated ductwork and equipment will be maintained to the greatest extent feasible. This alternate system shall be constant volume type with no energy recovery.

SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.
- B. Related Requirements:
 - 1. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.3 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
 - 1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - 2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.4 ACTION SUBMITTALS

- A. Substitution Requests: Submit electronic copy of each request for consideration, supplemented by samples as requested or appropriate. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
 - b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.

- e. Samples, where applicable or requested.
 - f. Certificates and qualification data, where applicable or requested.
 - g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
 - h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
 - i. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 - j. Cost information, including a proposal of change, if any, in the Contract Sum.
 - k. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
 - l. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within 7 days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 14 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
 - b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.5 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

- A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 14 days prior to time required for preparation and review of related submittals.

1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - b. Substitution request is fully documented and properly submitted.
 - c. Requested substitution will not adversely affect Contractor's construction schedule.
 - d. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - e. Requested substitution is compatible with other portions of the Work.
 - f. Requested substitution has been coordinated with other portions of the Work.
 - g. Requested substitution provides specified warranty.
 - h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- B. Substitutions for Convenience: Architect will consider requests for substitution if received within 30 days after commencement of the Work. Requests received after that time may be considered or rejected at discretion of Owner.
 1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
 - b. Requested substitution does not require extensive revisions to the Contract Documents.
 - c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - d. Substitution request is fully documented and properly submitted.
 - e. Requested substitution will not adversely affect Contractor's construction schedule.
 - f. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - g. Requested substitution is compatible with other portions of the Work.
 - h. Requested substitution has been coordinated with other portions of the Work.
 - i. Requested substitution provides specified warranty.

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

SECTION 012600 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for handling and processing Contract modifications.
- B. Related Requirements:
 - 1. Section 012500 "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.

1.3 MINOR CHANGES IN THE WORK

- A. Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710, "Architect's Supplemental Instructions".

1.4 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
 - 1. Work Change Proposal Requests issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
 - 2. Within 7 days, when not otherwise specified, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
 - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - c. Include costs of labor and supervision directly attributable to the change.
 - d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and

finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

- e. Quotation Form: Use forms acceptable to Architect and Owner.

- B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Architect.

1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Include costs of labor and supervision directly attributable to the change.
5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Section 012500 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
7. Proposal Request Form: Use form acceptable to Architect and Owner.

1.5 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Work Changes Proposal Request, Architect will issue a Change Order for signatures of Owner and Contractor on AIA Document G701.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012600

SECTION 012900 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Requirements:
 - 1. Section 012600 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
 - 2. Section 013200 "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.

1.3 DEFINITIONS

- A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.4 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.
 - 1. Coordinate line items in the schedule of values with other required administrative forms and schedules, including the following:
 - a. Application for Payment forms with continuation sheets.
 - b. Submittal schedule.
 - c. Items required to be indicated as separate activities in Contractor's construction schedule.
 - 2. Submit the schedule of values to Architect at earliest possible date, but no later than 14 days before the date scheduled for submittal of initial Applications for Payment.
- B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values.
 - 1. Arrange schedule of values consistent with format of AIA Document G703.

2. Arrange the schedule of values in tabular form with separate columns to indicate the following for each item listed:
 - a. Related Specification Section or Division.
 - b. Description of the Work.
 - c. Name of subcontractor.
 - d. Name of manufacturer or fabricator.
 - e. Name of supplier.
 - f. Change Orders (numbers) that affect value.
 - g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
 - 1) Labor.
 - 2) Materials.
 - 3) Equipment.
3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with Project Manual table of contents.
4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
5. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
 - a. Differentiate between items stored on-site and items stored off-site. If required, include evidence of insurance.
6. Each item in the schedule of values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
 - a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the schedule of values or distributed as general overhead expense, at Contractor's option.
7. Schedule Updating: Update and resubmit the schedule of values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.5 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by Owner.
 1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.
- B. Payment Application Times: Submit Application for Payment to Architect by the 7th of the month. The period covered by each Application for Payment is one month, ending on the last day of the month.
 1. Submit draft copy of Application for Payment 7 days prior to due date for review by Architect.

- C. Application for Payment Forms: Use AIA Document G702 and AIA Document G703 as form for Applications for Payment.
- D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.
 - 1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
 - 2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
 - 3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
- E. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.
 - 1. Provide certificate of insurance and evidence of transfer of title to Owner for stored materials.
 - 2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
 - 3. Provide summary documentation for stored materials indicating the following:
 - a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
 - b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
 - c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.
- F. Transmittal: Submit 3 signed and notarized original copies of each Application for Payment to Architect by a method ensuring receipt. One copy shall include waivers of lien and similar attachments if required.
 - 1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.
- G. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from entities lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.
 - 1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
 - 2. When an application shows completion of an item, submit conditional final or full waivers.
 - 3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
 - 4. Waiver Forms: Submit executed waivers of lien on forms acceptable to Owner.

- H. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.
 2. Schedule of values.
 3. Contractor's construction schedule (preliminary if not final).
 4. Submittal schedule (preliminary if not final).
 5. List of Contractor's staff assignments.
 6. Copies of building permits.
 7. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
 8. Certificates of insurance and insurance policies.
- I. Application for Payment at Substantial Completion.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
- J. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of Project closeout requirements.
 2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
 3. Updated final statement, accounting for final changes to the Contract Sum.
 4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
 5. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
 6. Evidence that claims have been settled.
 7. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012900

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. General coordination procedures.
 - 2. Requests for Information (RFIs).
 - 3. Project meetings.
- B. Related Requirements:
 - 1. Section 013200 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
 - 2. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
 - 3. Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.

1.3 DEFINITIONS

- A. RFI: Request from Owner, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
 - 1. Name, address, and telephone number of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.
- B. Key Personnel Names: Before starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and e-mail addresses. Provide names, addresses,

and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1.5 GENERAL COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in 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 ensure maximum performance and accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
 - 1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- C. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
 - 1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

1.6 REQUESTS FOR INFORMATION (RFIs)

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
 - 1. Architect will return RFIs submitted to Architect by other entities controlled by Contractor with no response.
 - 2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
 - 1. Project name.
 - 2. Project number.
 - 3. Date.
 - 4. Name of Contractor.
 - 5. Name of Architect.

6. RFI number, numbered sequentially.
 7. RFI subject.
 8. Specification Section number and title and related paragraphs, as appropriate.
 9. Drawing number and detail references, as appropriate.
 10. Field dimensions and conditions, as appropriate.
 11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 12. Contractor's signature.
 13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. RFI Forms: AIA Document G716 or Software-generated form with substantially the same content as indicated above, acceptable to Architect.
1. Attachments shall be electronic files in Adobe Acrobat PDF format.
- D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow 7 working days for Architect's response for each RFI.
1. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Architect's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
 2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt of additional information.
 3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 3 days of receipt of the RFI response.
- E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log upon request by Owner or Architect.
- F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within 3 days if Contractor disagrees with response.

1. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.

1.7 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.
 1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 3. Minutes: Architect will record significant discussions and agreements achieved and distribute the meeting minutes to everyone concerned, including Owner and Contractor, within 3 days of the meeting.
- B. Progress Meetings: Conduct progress meetings at every other weekly intervals.
 1. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Access.
 - 5) Site utilization.
 - 6) Temporary facilities and controls.
 - 7) Progress cleaning.
 - 8) Quality and work standards.
 - 9) Status of correction of deficient items.
 - 10) Field observations.
 - 11) Status of RFIs.
 - 12) Status of proposal requests.

- 13) Pending changes.
 - 14) Status of Change Orders.
 - 15) Pending claims and disputes.
 - 16) Documentation of information for payment requests.
3. Minutes: Architect will record and distribute the meeting minutes to each party present and to parties requiring information.
- a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 - 1. Contractor's construction schedule.
 - 2. Daily construction reports.
 - 3. Special reports.
- B. Related Requirements:
 - 1. Section 013300 "Submittal Procedures" for submitting schedules and reports.
 - 2. Section 014000 "Quality Requirements" for submitting a schedule of tests and inspections.

1.3 DEFINITIONS

- A. 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.
- B. Event: The starting or ending point of an activity.

1.4 SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
 - 1. PDF electronic file.
 - 2. One paper copy for Owner and one for Architect.
- B. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
- C. Daily Construction Reports: Submit when requested by Architect or Owner.
- D. Special Reports: Submit at time of unusual event.

1.5 COORDINATION

- A. Coordinate Contractor's construction schedule with the schedule of values, submittal schedule, progress reports, payment requests, and other required schedules and reports.
 - 1. Secure time commitments for performing critical elements of the Work from entities involved.

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Time Frame: Extend schedule from date established for the Notice to Proceed to date of final completion.
 - 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- B. Activities: Comply with the following:
 - 1. Procurement Activities: Include procurement process activities for long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 - 2. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
 - 3. Startup and Testing Time: Include adequate time for startup and testing.
 - 4. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
 - 5. Punch List and Final Completion: Include not more than 15 days for completion of punch list items and final completion.
- C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
 - 1. Products Ordered in Advance (if any): Include a separate activity for each product. Include delivery date indicated in Section 011000 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
 - 2. Owner-Furnished Products (if any): Include a separate activity for each product. Include delivery date indicated in Section 011000 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
 - 3. Work Restrictions (if any): Show the effect of the following items on the schedule:
 - a. Coordination with existing construction.
 - b. Limitations of continued occupancies.
 - c. Uninterruptible services.
 - d. Partial occupancy before Substantial Completion.

- e. Use of premises restrictions.
 - f. Provisions for future construction.
 - g. Seasonal variations.
 - h. Environmental control.
- D. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion.
- E. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE (GANTT CHART)

- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's construction schedule within 7 days of date established for the Notice to Proceed.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.
 - 1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in 25 percent increments within time bar.

2.3 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
 - 1. List of subcontractors at Project site.
 - 2. List of separate contractors at Project site.
 - 3. Approximate count of personnel at Project site.
 - 4. Equipment at Project site.
 - 5. Material deliveries.
 - 6. High and low temperatures and general weather conditions, including presence of rain or snow.
 - 7. Accidents.
 - 8. Meetings and significant decisions.
 - 9. Unusual events (see special reports).
 - 10. Orders and requests of authorities having jurisdiction.
 - 11. Services connected and disconnected.
 - 12. Equipment or system tests and startups.

2.4 SPECIAL REPORTS

- A. General: Submit special reports directly to Owner and copy Architect within one day of an occurrence. Distribute copies of report to parties affected by the occurrence.

- B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule at regularly-scheduled progress meeting.
- B. Distribution: Distribute copies of approved schedule to Architect, Owner, and other parties identified by Contractor with a need-to-know schedule responsibility.
 - 1. When revisions are made, distribute updated schedules to the same parties. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 013200

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
- B. Related Requirements:
 - 1. Section 012900 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
 - 2. Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.

1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."
- B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."
- C. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.
- D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.4 ACTION SUBMITTALS

- A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making

corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.

1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
2. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.
 - a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.
3. Format: Arrange the following information in a tabular format:
 - a. Scheduled date for first submittal.
 - b. Specification Section number and title.
 - c. Submittal category: Action; informational.
 - d. Name of subcontractor.
 - e. Description of the Work covered.
 - f. Scheduled date for Architect's final release or approval.
 - g. Scheduled date of fabrication.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Architect's Digital Data Files: Electronic digital data files of the Contract Drawings will be provided by Architect for Contractor's use in preparing submittals, upon request.
 1. Architect will furnish Contractor one set of digital data drawing files of the Contract Drawings for use in preparing Shop Drawings and Project record drawings.
 - a. Architect makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
 - b. Digital Drawing Software Program: The Contract Drawings are available in the various formats in which they were produced.
 - c. Contractor shall execute a data licensing agreement in the form of AIA Document C106, Digital Data Licensing Agreement.
 - d. The following digital data files will be furnished for each appropriate discipline:
 - 1) Floor plans.
 - 2) Reflected ceiling plans.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

- a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
 1. Initial Review: Allow 14 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 3. Resubmittal Review: Allow 10 days for review of each resubmittal.
- D. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:
 1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 2. Name file with submittal number or other unique identifier, including revision identifier.
 3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.
 4. Transmittal Form for Electronic Submittals: Use software-generated form from electronic project management software or electronic form acceptable to Architect and Owner, containing the following information:
 - a. Project name.
 - b. Date.
 - c. Name and address of Architect.
 - d. Name of Contractor.
 - e. Name of firm or entity that prepared submittal.
 - f. Names of subcontractor, manufacturer, and supplier.
 - g. Category and type of submittal.
 - h. Submittal purpose and description.
 - i. Specification Section number and title.
 - j. Specification paragraph number or drawing designation and generic name for each of multiple items.
 - k. Drawing number and detail references, as appropriate.
 - l. Location(s) where product is to be installed, as appropriate.
 - m. Related physical samples submitted directly.
 - n. Indication of full or partial submittal.
 - o. Submittal and transmittal distribution record.
 - p. Other necessary identification.
 - q. Remarks.
- E. Options: Identify options requiring selection by Architect.
- F. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract

Documents, including minor variations and limitations. Include same identification information as related submittal.

- G. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
 - 1. Note date and content of previous submittal.
 - 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 - 3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.
- H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- I. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

- A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
 - 1. Submit electronic submittals via email as PDF electronic files.
 - a. Architect will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
 - 2. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
 - a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
 - 1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
 - 2. Mark each copy of each submittal to show which products and options are applicable.
 - 3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.

- f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 - 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams showing factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 - 5. Submit Product Data before or concurrent with Samples.
 - 6. Submit Product Data in the following format:
 - a. PDF electronic file.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
 - 1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 - 2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches (215 by 280 mm), but no larger than 30 by 42 inches (750 by 1067 mm).
 - 3. Submit Shop Drawings in the following format:
 - a. PDF electronic file.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
 - 1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 - 2. Identification: Attach label on unexposed side of Samples that includes the following:
 - a. Generic description of Sample.
 - b. Product name and name of manufacturer.
 - c. Sample source.
 - d. Number and title of applicable Specification Section.
 - e. Specification paragraph number and generic name of each item.

3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
 4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
 5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
 - a. Number of Samples: Submit 1 full set of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.
 6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
 - a. Number of Samples: Submit 1 set of Samples. Architect will retain.
 - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least 3 sets of paired units that show approximate limits of variations.
- E. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
 2. Manufacturer and product name, and model number if applicable.
 3. Number and name of room or space.
 4. Location within room or space.
 5. Submit product schedule in the following format:
 - a. PDF electronic file.

- F. Coordination Drawing Submittals: Comply with requirements specified in Section 013100 "Project Management and Coordination."
- G. Contractor's Construction Schedule: Comply with requirements specified in Section 013200 "Construction Progress Documentation."
- H. Application for Payment and Schedule of Values: Comply with requirements specified in Section 012900 "Payment Procedures."
- I. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 014000 "Quality Requirements."
- J. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 017700 "Closeout Procedures."
- K. Maintenance Data: Comply with requirements specified in Section 017823 "Operation and Maintenance Data."
- L. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- M. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.
- N. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- O. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- P. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- Q. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- R. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- S. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- T. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:

1. Name of evaluation organization.
 2. Date of evaluation.
 3. Time period when report is in effect.
 4. Product and manufacturers' names.
 5. Description of product.
 6. Test procedures and results.
 7. Limitations of use.
- U. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- V. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- W. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- X. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.
- B. Project Closeout and Maintenance Material Submittals: See requirements in Section 017700 "Closeout Procedures."
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT'S ACTION

- A. Action Submittals: Architect will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.

- B. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.
- C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Submittals not required by the Contract Documents may be returned by the Architect without action.

END OF SECTION 013300

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.

1.3 USE CHARGES

- A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner's personnel, Architect, testing agencies, and authorities having jurisdiction.
- B. Water Service: Owner will pay water-service use charges for water used by all entities for construction operations.
- C. Electric Power Service: Owner will pay electric-power-service use charges for electricity used by all entities for construction operations.
- D. Water Service from Existing System: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
- E. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

1.4 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

PART 2 - PRODUCTS

2.1 TEMPORARY FACILITIES

- A. Field Offices, General: Not required.
- B. A construction field office on campus will be available to the Contractor.
- C. A construction waste/recycle receptacle can be located in the parking lot west of Willey Library at the Johnson Campus. Coordinate location with Owner.

2.2 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. HVAC Equipment: Owner authorizes use of permanent HVAC system.
 - 1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
 - 1. Locate facilities to limit site disturbance.
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
 - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Water Service: Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
- C. Sanitary Facilities: Contractor to provide and maintain self-contained units. Use of VTSU facilities is not allowed.

- D. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
- E. Electric Power Service: Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.
- F. Telephone Service: Provide superintendent with cellular telephone.

3.3 SUPPORT FACILITIES INSTALLATION

- A. General: Comply with the following:
 - 1. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
- B. Traffic Controls: Comply with requirements of authorities having jurisdiction.
 - 1. Protect existing site components including curbs, pavement, and utilities.
 - 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- C. Parking: Use designated areas of Owner's existing parking areas for construction personnel.
- D. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
 - 1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
 - 2. Remove snow and ice as required to minimize accumulations.
- E. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.
 - 1. Temporary Signs: Provide signs as required to inform public and individuals seeking entrance to Project.
 - 2. Provide temporary, directional signs for construction personnel and visitors.
- F. Waste Disposal Facilities: Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
- G. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
 - 1. Comply with work restrictions specified in Section 011000 "Summary."
- C. Temporary Erosion and Sedimentation Control: Comply with requirements of 2003 EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.
- D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- E. Tree and Plant Protection: Install temporary fencing located outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
- F. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each work day.
- G. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- H. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
- I. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
 - 1. Prohibit smoking in construction areas.

3.5 MOISTURE AND MOLD CONTROL

- A. Contractor's Moisture-Protection Plan: Avoid trapping water in finished work. Document visible signs of mold that may appear during construction.
- B. Exposed Construction Phase: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
 - 1. Protect porous materials from water damage.
 - 2. Protect stored and installed material from flowing or standing water.
 - 3. Keep porous and organic materials from coming into prolonged contact with concrete.
 - 4. Remove standing water from decks.

5. Keep deck openings covered or dammed.

3.6 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 1. Materials and facilities that constitute temporary facilities are property of Contractor.
 2. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 015000

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Requirements:
 - 1. Section 012500 "Substitution Procedures" for requests for substitutions.

1.3 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.4 ACTION SUBMITTALS

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
 - 2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Architect will notify Contractor of approval or rejection of proposed comparable product request within 7 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
 - a. Form of Approval: As specified in Section 013300 "Submittal Procedures."
 - b. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.
- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 013300 "Submittal Procedures." Show compliance with requirements.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
 - 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
 - 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 - 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 - 4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.
- C. Storage:
 - 1. Store products to allow for inspection and measurement of quantity or counting of units.
 - 2. Store materials in a manner that will not endanger Project structure.
 - 3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
 - 4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
 - 5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 - 6. Protect stored products from damage and liquids from freezing.

1.6 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
 - 1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
 - 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
 - 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 - 2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
 - 3. See other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 017700 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
 - 1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 - 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 - 3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
 - 4. Where products are accompanied by the term "as selected," Architect will make selection.
 - 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
 - 6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
- B. Product Selection Procedures:
 - 1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 3. Products:
 - a. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.
 - b. Non-Restricted List: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product.
 4. Manufacturers:
 - a. Restricted List: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.
 - b. Non-Restricted List: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed manufacturer's product.
 5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
- C. Visual Matching Specification: Where Specifications require "match Architect's sample", provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

- A. Conditions for Consideration: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:
1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
 2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 3. Evidence that proposed product provides specified warranty.
 4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
 5. Samples, if requested.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:
 - 1. Installation of the Work.
 - 2. Cutting and patching.
 - 3. Progress cleaning.
 - 4. Protection of installed construction.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for limits on use of Project site.
 - 2. Section 013300 "Submittal Procedures" for submitting surveys.
 - 3. Section 017419 "Construction Waste Management and Disposal".
 - 4. Section 024119 "Selective Demolition" for demolition and removal of selected portions of the building.

1.3 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

1.4 QUALITY ASSURANCE

- A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
 - 1. Structural Elements: When cutting and patching structural elements, shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection
 - 2. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.

3. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections.
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning site work, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services, and other utilities.
 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

- C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
 - 1. Description of the Work.
 - 2. List of detrimental conditions, including substrates.
 - 3. List of unacceptable installation tolerances.
 - 4. Recommended corrections.
- D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- B. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- C. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect according to requirements in Section 013100 "Project Management and Coordination."
- D. Electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

3.3 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level.
 - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 - 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
 - 4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- F. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
- G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
 - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
 - 2. Allow for building movement, including thermal expansion and contraction.
 - 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- J. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.4 CUTTING AND PATCHING

- A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- E. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 3. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 4. Proceed with patching after construction operations requiring cutting are complete.
- F. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
 3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
 - a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
 4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
 5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- G. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.5 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (27 deg C).
 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
 - a. Use containers intended for holding waste materials of type to be stored.

- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
 - 1. Remove liquid spills promptly.
 - 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 015000 "Temporary Facilities and Controls" and Section 017419 "Construction Waste Management and Disposal".
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.6 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 017300

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Salvaging nonhazardous demolition and construction waste.
 - 2. Recycling nonhazardous demolition and construction waste.
 - 3. Disposing of nonhazardous demolition and construction waste.
- B. Related Requirements:
 - 1. Section 024119 "Selective Demolition" for disposition of waste resulting from partial demolition of buildings, structures, and site improvements.

1.3 DEFINITIONS

- A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.
- C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
- E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.4 ACTION SUBMITTALS

- A. Waste Management Plan: Submit plan within 14 days of date established for the Notice to Proceed.

1.5 QUALITY ASSURANCE

- A. Waste Management Coordinator Qualifications: Experienced firm, with a record of successful waste management coordination of projects with similar requirements.
- B. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.
- C. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.
- D. Waste Management Review: During the Pre-Construction Meeting, review requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:
 - 1. Review and discuss waste management plan including responsibilities of waste management coordinator.
 - 2. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
 - 3. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.

1.6 WASTE MANAGEMENT PLAN

- A. General: Develop a waste management plan according to ASTM E 1609 and requirements in this Section. Plan shall consist of waste identification, and waste reduction work plan. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
- B. Waste Identification: Indicate anticipated types and quantities of demolition and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.
- C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
 - 1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
 - 2. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
 - 3. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.

4. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
5. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
- B. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.
- C. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.

3.2 SALVAGING DEMOLITION WASTE

- A. Salvaged Items for Reuse in the Work: Salvage items for reuse and handle as follows:
 1. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
 2. Store items in a secure area until installation.
 3. Protect items from damage during transport and storage.
 4. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.
- B. Salvaged Items for Sale and Donation: Not permitted on Project site.

3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

- A. General: Recycle paper and beverage containers used by on-site workers.
- B. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

- C. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.
 - 1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
 - a. Inspect containers and bins for contamination and remove contaminated materials if found.
 - 2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
 - 4. Store components off the ground and protect from the weather.
 - 5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor.

3.4 RECYCLING CONSTRUCTION WASTE

- A. Packaging:
 - 1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
 - 2. Polystyrene Packaging: Separate and bag materials.

3.5 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
 - 1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Burning: Do not burn waste materials.
- C. Disposal: Remove waste materials from Owner's property and legally dispose of them.

END OF SECTION 017419

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final completion procedures.
 - 3. Warranties.
 - 4. Final cleaning.
 - 5. Repair of the Work.
- B. Related Requirements:
 - 1. Section 017300 "Execution" for progress cleaning of Project site.

1.3 ACTION SUBMITTALS

- A. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.
- B. Certified List of Incomplete Items: Final submittal at Final Completion.

1.4 CLOSEOUT SUBMITTALS

- A. Certificate of Insurance: For continuing coverage.
- B. Inspection Certificates: From authorities having jurisdiction.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

1.6 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.
- B. Submittals Prior to Substantial Completion: Complete the following a minimum of 7 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 - 1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 - 2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, final completion construction and similar final record information.
 - 3. Submit closeout submittals specified in individual Sections, including specific warranties, maintenance service agreements, final certifications, and similar documents.
 - 4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Owner. Label with manufacturer's name and model number where applicable.
 - 5. Submit test/adjust/balance records.
 - 6. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of 7 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 - 1. Advise Owner of pending insurance changeover requirements.
 - 2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 - 3. Complete startup and testing of systems and equipment.
 - 4. Perform preventive maintenance on equipment used prior to Substantial Completion.
 - 5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
 - 6. Advise Owner of changeover in heat and other utilities.
 - 7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
 - 8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 - 9. Complete final cleaning requirements, including touchup painting.
 - 10. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 7 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for final completion.

1.7 FINAL COMPLETION PROCEDURES

- A. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:
 1. Submit a final Application for Payment according to Section 012900 "Payment Procedures."
 2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
 3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
- B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 7 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
 1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.8 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
 1. Organize list of spaces in sequential order.
 2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
 3. Include the following information at the top of each page:
 - a. Project name.
 - b. Date.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Page number.

1.9 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, or when delay in submittal of warranties might limit Owner's rights under warranty.

- B. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
 - 1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch (215-by-280-mm) paper.
 - 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 - 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
 - 4. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.
 - 1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.

- c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Clean transparent materials. Remove glazing compounds and other noticeable, vision-obscuring materials.
 - f. Remove labels that are not permanent.
 - g. Leave Project clean and ready for occupancy.
- C. Construction Waste Disposal: Comply with waste disposal requirements in Section 017419 "Construction Waste Management and Disposal".

3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.
- B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
 - 1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
 - 2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory.
 - 2. Emergency manuals.
 - 3. Operation manuals for systems, subsystems, and equipment.
 - 4. Product maintenance manuals.
 - 5. Systems and equipment maintenance manuals.
- B. Related Requirements:
 - 1. Section 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.

1.3 CLOSEOUT SUBMITTALS

- A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Architect will comment on whether content of operations and maintenance submittals are acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operations and maintenance manuals in the following format:
 - 1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Architect.
 - a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
 - b. Enable inserted reviewer comments on draft submittals.
 - 2. One paper copy. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves.

- C. Initial Manual Submittal: Submit draft copy of each manual at least 14 days before commencing demonstration and training. Architect will comment on whether general scope and content of manual are acceptable.
- D. Final Manual Submittal: Submit manual in final form prior to requesting inspection for Substantial Completion and at least 7 days before commencing demonstration and training. Architect will return copy with comments.
 - 1. Correct or revise each manual to comply with Architect's comments. Submit corrected manual within 15 days of receipt of Architect's comments and prior to commencing demonstration and training.

PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

- A. Directory: Prepare a single, comprehensive directory of emergency, operation, and maintenance data and materials, listing items and their location to facilitate ready access to desired information. Include a section in the directory for each of the following:
 - 1. List of documents.
 - 2. List of systems.
 - 3. List of equipment.
 - 4. Table of contents.
- B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
- C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
- D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

2.2 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 - 1. Title page.
 - 2. Table of contents.
 - 3. Manual contents.

- B. Title Page: Include the following information:
1. Subject matter included in manual.
 2. Name and address of Project.
 3. Name and address of Owner.
 4. Date of submittal.
 5. Name and contact information for Contractor.
 6. Name and contact information for Architect.
 7. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
 8. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- E. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 2. File Names and Bookmarks: Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.
- F. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.
1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch (215-by-280-mm) paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
 - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of

contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment.
4. Supplementary Text: Prepared on 8-1/2-by-11-inch (215-by-280-mm) white bond paper.
5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.3 EMERGENCY MANUALS

- A. Content: Organize manual into a separate section for each of the following:
 1. Type of emergency.
 2. Emergency instructions.
 3. Emergency procedures.
- B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
 1. Fire.
 2. Flood.
 3. Gas leak.
 4. Water leak.
 5. Power failure.
 6. Water outage.
 7. System, subsystem, or equipment failure.
 8. Chemical release or spill.
- C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- D. Emergency Procedures: Include the following, as applicable:
 1. Instructions on stopping.
 2. Shutdown instructions for each type of emergency.
 3. Operating instructions for conditions outside normal operating limits.
 4. Required sequences for electric or electronic systems.
 5. Special operating instructions and procedures.

2.4 OPERATION MANUALS

- A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 2. Performance and design criteria if Contractor has delegated design responsibility.
 3. Operating standards.
 4. Operating procedures.
 5. Operating logs.
 6. Wiring diagrams.
 7. Control diagrams.
 8. Piped system diagrams.
 9. Precautions against improper use.
 10. License requirements including inspection and renewal dates.
- B. Descriptions: Include the following:
1. Product name and model number. Use designations for products indicated on Contract Documents.
 2. Manufacturer's name.
 3. Equipment identification with serial number of each component.
 4. Equipment function.
 5. Operating characteristics.
 6. Limiting conditions.
 7. Performance curves.
 8. Engineering data and tests.
 9. Complete nomenclature and number of replacement parts.
- C. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
 2. Equipment or system break-in procedures.
 3. Routine and normal operating instructions.
 4. Regulation and control procedures.
 5. Instructions on stopping.
 6. Normal shutdown instructions.
 7. Seasonal and weekend operating instructions.
 8. Required sequences for electric or electronic systems.
 9. Special operating instructions and procedures.
- D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

2.5 PRODUCT MAINTENANCE MANUALS

- A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- C. Product Information: Include the following, as applicable:
 - 1. Product name and model number.
 - 2. Manufacturer's name.
 - 3. Color, pattern, and texture.
 - 4. Material and chemical composition.
 - 5. Reordering information for specially manufactured products.
- D. Maintenance Procedures: Include manufacturer's written recommendations and the following:
 - 1. Inspection procedures.
 - 2. Types of cleaning agents to be used and methods of cleaning.
 - 3. List of cleaning agents and methods of cleaning detrimental to product.
 - 4. Schedule for routine cleaning and maintenance.
 - 5. Repair instructions.
- E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.

2.6 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
- B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins.
 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 3. Identification and nomenclature of parts and components.
 4. List of items recommended to be stocked as spare parts.
- D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
1. Test and inspection instructions.
 2. Troubleshooting guide.
 3. Precautions against improper maintenance.
 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 5. Aligning, adjusting, and checking instructions.
 6. Demonstration and training video recording, if available.
- E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
1. Include procedures to follow and required notifications for warranty claims.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.
- B. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- C. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- D. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- E. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
- F. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
1. Do not use original project record documents as part of operation and maintenance manuals.
- G. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for project record documents, including the following:
 - 1. Record Drawings.
 - 2. Record Specifications.
 - 3. Record Product Data.
 - 4. Miscellaneous record submittals.
- B. Related Requirements:
 - 1. Section 017700 "Closeout Procedures" for general closeout procedures.
 - 2. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.3 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit 1 set of marked-up record prints.
 - 2. Number of Copies: Submit copies of record Drawings as follows:
 - a. Initial Submittal:
 - 1) Submit record digital data files and 1 set of plots.
 - 2) Architect and Owner will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
 - b. Final Submittal:
 - 1) Submit PDF electronic files of scanned record prints and 1 set of prints.
 - 2) Print each drawing, whether or not changes and additional information were recorded.
- B. Record Specifications: Submit 1 paper copy of Project's Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Revisions to routing of piping and conduits.
 - d. Revisions to electrical circuitry.
 - e. Actual equipment locations.
 - f. Duct size and routing.
 - g. Locations of concealed internal utilities.
 - h. Changes made by Change Order or Construction Change Directive.
 - i. Changes made following Architect's written orders.
 - j. Details not on the original Contract Drawings.
 - k. Field records for variable and concealed conditions.
 - l. Record information on the Work that is shown only schematically.
 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
1. Format: DWG, version acceptable to Owner.
 2. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
 3. Refer instances of uncertainty to Architect for resolution.

4. Architect will furnish Contractor one set of digital data files of the Contract Drawings for use in recording information.
 - a. See Section 013300 "Submittal Procedures" for requirements related to use of Architect's digital data files.
 - b. Architect will provide data file layer information. Record markups in separate layers.
- C. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
 1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 2. Format: Annotated PDF electronic file.
 3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
 4. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Architect.
 - e. Name of Contractor.

2.2 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
- B. Format: Submit record Specifications as annotated PDF electronic file.

2.3 RECORD PRODUCT DATA

- A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
 3. Note related Change Orders, record Specifications, and record Drawings where applicable.
- B. Format: Submit record Product Data as annotated PDF electronic file.

1. Include record Product Data directory organized by Specification Section number and title, electronically linked to each item of record Product Data.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.
- B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect's reference during normal working hours.

END OF SECTION 017839

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 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.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Demonstration of operation of systems, subsystems, and equipment.
 - 2. Training in operation and maintenance of systems, subsystems, and equipment.
- B. Related Sections include the following:
 - 1. Section 013100 "Project Management and Coordination" for requirements for preinstruction conferences.
 - 2. Section 017700 "Closeout Procedures".
 - 3. Divisions 2 through 16 Sections for specific requirements for demonstration and training for products in those Sections.

1.3 SUBMITTALS

- A. Instruction Program: Submit two copies of outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
 - 1. At completion of training, submit one complete training manual(s) for Owner's use.
- B. Attendance Record: For each training module, submit list of participants and length of instruction time.

1.4 QUALITY ASSURANCE

- A. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Division 1 Section "Quality Requirements," experienced in operation and maintenance procedures and training.

1.5 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by the Owner.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections, and as follows:
 - 1. Equipment.
 - 2. Refrigeration systems, including chillers, condensers, pumps and distribution piping.
 - 3. HVAC systems, including air-handling equipment, air distribution systems and terminal equipment and devices.
 - 4. HVAC instrumentation and controls.
 - 5. Lighting equipment and controls.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following:
 - 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Performance and design criteria if Contractor is delegated design responsibility.
 - c. Operating standards.
 - d. Regulatory requirements.
 - e. Equipment function.
 - f. Operating characteristics.
 - g. Limiting conditions.
 - h. Performance curves.
 - 2. Documentation: Review the following items in detail:
 - a. Emergency manuals.
 - b. Operations manuals.
 - c. Maintenance manuals.
 - d. Project Record Documents.
 - e. Identification systems.
 - f. Warranties and bonds.
 - g. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:
 - a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.
 - c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.
 - f. Special operating instructions and procedures.
4. Operations: Include the following, as applicable:
 - a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.
 - f. Safety procedures.
 - g. Instructions on stopping.
 - h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.
 - j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.
 - l. Required sequences for electric or electronic systems.
 - m. Special operating instructions and procedures.
5. Adjustments: Include the following:
 - a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
 - a. Diagnostic instructions.
 - b. Test and inspection procedures.
7. Maintenance: Include the following:
 - a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
8. Repairs: Include the following:
 - a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.

- d. Instructions for identifying parts and components.
- e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 INSTRUCTION

- A. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Mechanical and electrical engineers will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
 - 2. Owner will furnish an instructor to describe Owner's operational philosophy.
 - 3. Owner will furnish Contractor with names and positions of participants.
- B. Scheduling: Provide instruction at mutually agreed on times.
 - 1. Schedule training with Owner with at least seven days' advance notice.
- C. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

END OF SECTION 017900

SECTION 024119 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Demolition and removal of selected portions of building or structure.
 - 2. Salvage of existing items to be reused or recycled.
- B. Related Sections include the following:
 - 1. Section 011000 "Summary" for use of premises and Owner-occupancy requirements.
 - 2. Section 015000 "Temporary Facilities and Controls" for temporary construction and environmental-protection measures for selective demolition operations.

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
- C. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 MATERIALS OWNERSHIP

- A. Historic items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to Owner that may be encountered during selective demolition remain Owner's property. Carefully remove and salvage each item or object in a manner to prevent damage and deliver promptly to Owner.

1.5 SUBMITTALS

- A. Pre-Demolition Photographs: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by selective demolition operations. Submit before Work begins.

- B. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.
 - 1. Comply with submittal requirements in Section 017419 "Construction Waste Management."

1.6 QUALITY ASSURANCE

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

1.7 PROJECT CONDITIONS

- A. Owner may partially occupy the building. Conduct selective demolition so Owner's operations will not be disrupted.
 - 1. Comply with requirements specified in Section 011000 "Summary."
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - 1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Owner will remove hazardous materials under a separate contract.
- E. Storage or sale of removed items or materials on-site is not permitted.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped.
- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- C. Inventory and record the condition of items to be removed and reinstalled.

- D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems: Maintain services/systems indicated to remain and protect them against damage during selective demolition operations.

3.3 PREPARATION

- A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, walks, and other adjacent occupied and used facilities.
- B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

3.4 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 - 2. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on structure.
 - 3. Dispose of demolished items and materials promptly. Comply with requirements in Section 017419 "Construction Waste Management."
- B. Removed and Reinstalled Items:
 - 1. Remove salvaged items and store for reinstallation.
- C. 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.

3.5 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

3. Comply with requirements specified in Section 017419 "Construction Waste Management."

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.6 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.

3.7 SELECTIVE DEMOLITION SCHEDULE

A. Remove Existing Construction:

1. As identified in the Drawings and as required to accomplish the Work.

B. Remove and Salvage:

1. As indicated on the Drawings

C. Remove and Reinstall:

1. As indicated on the Drawings.
2. Designated HM door frame & sidelight.

END OF SECTION 024119

SECTION 040140 - STONE REPOINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Repointing joints or re-setting exterior stone windowsill with mortar.

- B. Related Requirements:

- 1. Section 012300 "Alternates" for Alternate to repoint deteriorated mortar joints at exterior stone windowsills.

1.3 SEQUENCING AND SCHEDULING

- A. Work Sequence: Perform stone repointing work in the following sequence, which includes work specified in this and other Sections:

- 1. Inspect masonry for open mortar joints and permanently or temporarily point them before cleaning to prevent the intrusion of water and other cleaning materials into the wall.
 - 2. Clean stone.
 - 3. Rake out mortar from joints surrounding stone to be replaced and from joints adjacent to stone repairs along joints.
 - 4. Rake out mortar from joints to be repointed.
 - 5. Point mortar joints.
 - 6. After repairs and repointing have been completed and cured, perform a final cleaning to remove residues from this work.

1.4 ACTION SUBMITTALS

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

- B. Samples for Initial Selection: For the following:

- 1. Pointing Mortar: Submit sets of mortar for pointing in the form of sample mortar strips, 6 inches (150 mm) long by 1/4 inch wide, set in aluminum or plastic channels.

- a. Have each set contain a close color range of at least three samples of different mixes of colored sands and cements that produce a mortar matching the existing, cleaned mortar when cured and dry.
- b. Submit with precise measurements on ingredients, proportions, gradations, and source of colored sands from which each Sample was made.

1.5 QUALITY ASSURANCE

- A. Engage an experienced stone repointing firm to perform work of this Section. Firm shall have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience in only installing standard unit masonry or new stone masonry is insufficient experience for stone repointing work.
 1. Field Supervision: Stone repointing specialist firms shall maintain experienced full-time supervisors on Project site during times that stone repointing work is in progress.
- B. Mockups: Prepare mockups of stone repointing to demonstrate aesthetic effects and to set quality standards for materials and execution.
 1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver packaged materials to Project site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store hydrated lime in manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two days.
- D. Store sand where grading and other required characteristics can be maintained and contamination avoided.

1.7 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit repointing work to be performed according to product manufacturers' written instructions and specified requirements.
- B. Temperature Limits: Repoint mortar joints only when air temperature is between 40 and 90 deg F (4 and 32 deg C) and is predicted to remain so for at least seven days after completion of the Work unless otherwise indicated.

- C. Cold-Weather Requirements: Comply with the following procedures for mortar-joint pointing unless otherwise indicated:
 - 1. When air temperature is below 40 deg F (4 deg C), heat mortar ingredients and existing stone to produce temperatures between 40 and 120 deg F (4 and 49 deg C).
 - 2. When mean daily air temperature is below 40 deg F (4 deg C), provide enclosure and heat to maintain temperatures above 32 deg F (0 deg C) within the enclosure for seven days after pointing.
- D. Hot-Weather Requirements: Protect mortar-joint pointing when temperature and humidity conditions produce excessive evaporation of water from mortar materials. Provide artificial shade and wind breaks, and use cooled materials as required to minimize evaporation. Do not apply mortar to substrates with temperatures of 90 deg F (32 deg C) and above unless otherwise indicated.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Source Limitations: Obtain each type of material for stone repointing (cement, sand, etc.) from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 MORTAR MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or Type II, except Type III may be used for cold-weather construction; white or gray, or both where required for color matching of mortar.
 - 1. Provide cement containing not more than 0.60 percent total alkali when tested according to ASTM C114.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Masonry Cement: ASTM C91/C91M.
 - 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. Cemex S.A.B. de C.V.
 - b. Essroc.
 - c. Hanson Brick and Tile; Lehigh Hanson.
 - d. Holcim (US) Inc.
 - e. Lafarge North America Inc.
 - f. QUIKRETE.
- D. Mortar Cement: ASTM C1329/C1329M.

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. Lafarge North America Inc.
- E. Mortar Sand: ASTM C144.
 1. Match size, texture, and gradation of existing mortar sand as closely as possible. Blend several sands if necessary to achieve suitable match.
 2. Color: Natural sand or ground marble, granite, or other sound stone of color necessary to produce required mortar color.
- F. Mortar Pigments: ASTM C979/C979M, compounded for use in mortar mixes, and having a record of satisfactory performance in stone mortars.
 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. Davis Colors.
 - b. Solomon Colors, Inc.

2.3 ACCESSORY MATERIALS

- A. Masking Tape: Non-staining, non-absorbent material; compatible with mortar, joint primers, sealants, and surfaces adjacent to joints; and that easily comes off entirely, including adhesive.
- B. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:
 1. Previous effectiveness in performing the work involved.
 2. Minimal possibility of damaging exposed surfaces.
 3. Consistency of each application.
 4. Uniformity of the resulting overall appearance.
 5. Do not use products or tools that could leave residue on surfaces.

2.4 MORTAR MIXES

- A. Measurement and Mixing: Measure cementitious materials and sand in a dry condition by volume or equivalent weight. Do not measure by shovel; use known measure. Mix materials in a clean, mechanical batch mixer.
 1. Mixing Pointing Mortar: Thoroughly mix cementitious materials and sand together before adding any water. Then mix again, adding only enough water to produce a damp, unworkable mix that retains its form when pressed into a ball. Maintain mortar in this dampened condition for 15 to 30 minutes. Add remaining water in small portions until mortar reaches desired consistency. Use mortar within one hour of final mixing; do not retemper or use partially hardened material.

- B. Colored Mortar: Produce mortar of color required by using specified ingredients. Do not alter specified proportions without Architect's approval.
 - 1. Mortar Pigments: Where mortar pigments are indicated, do not add pigment exceeding 10 percent by weight of the cementitious or binder materials, except for carbon black which is limited to 2 percent, unless otherwise demonstrated by a satisfactory history of performance.
- C. Do not use admixtures in mortar unless otherwise indicated.
- D. Mixes: Mix mortar materials in the following proportions:
 - 1. Pointing Mortar by Type: ASTM C270, Proportion Specification, Type N unless otherwise indicated; with cementitious material limited to portland cement and lime, masonry cement or mortar cement. Add mortar pigments to produce mortar colors required.

PART 3 - EXECUTION

3.1 PROTECTION

- A. Prevent mortar from staining face of surrounding stone and other surfaces.
 - 1. Cover sills, ledges, and other projecting items to protect them from mortar droppings.
 - 2. Keep wall area wet below pointing work to discourage mortar from adhering.
 - 3. Immediately remove mortar splatters in contact with exposed stone and other surfaces.

3.2 STONE REPOINTING, GENERAL

- A. Appearance Standard: Repointed surfaces are to have a uniform appearance as viewed from 50 feet away by Architect.
- B. Conform with Secretary of the Interior's Preservation Brief 2: "Repointing Mortar Joints in Historic Masonry Buildings".
- C. Inspect the building before starting work and review recommendations with Architect and College. The intent is to repoint only the badly-deteriorated mortar joints.

3.3 REPOINTING

- A. Rake out and repoint joints to the following extent:
 - 1. Joints at locations with the following defects:
 - a. Holes and missing mortar.
 - b. Cracks 1/8 inch (3 mm) or more in width and of any depth.
 - c. Eroded surfaces 1/4 inch (6 mm) or more deep.
 - d. Deterioration to point that mortar can be easily removed by hand, without tools.
 - e. Joints filled with substances other than mortar.

- B. Do not rake out and repoint joints where not required.
- C. Rake out joints as follows, according to procedures demonstrated in approved mockup:
 - 1. Remove mortar from joints to depth of joint width plus 1/8 inch (3 mm) and not less than that required to expose sound, unweathered mortar. Do not remove unsound mortar more than 2 inches (50 mm) deep; consult Architect for direction.
 - 2. Remove mortar from stone surfaces within raked-out joints to provide reveals with square backs and to expose stone for contact with pointing mortar. Brush, vacuum, or flush joints to remove dirt and loose debris.
 - 3. Do not spall edges of stone units or widen joints.
- D. Notify Architect of unforeseen detrimental conditions including voids in mortar joints, cracks, loose stone, rotted wood, rusted metal, and other deteriorated items.
- E. Pointing with Mortar:
 - 1. Rinse joint surfaces with water to remove dust and mortar particles. Time rinsing application so, at time of pointing, joint surfaces are damp but free of standing water. If rinse water dries, dampen joint surfaces before pointing.
 - 2. Apply pointing mortar first to areas where existing mortar was removed to depths greater than surrounding areas. Apply in layers not greater than 3/8 inch (9 mm) until a uniform depth is formed. Fully compact each layer, and allow it to become thumbprint hard before applying next layer.
 - 3. After deep areas have been filled to same depth as remaining joints, point joints by placing mortar in layers not greater than 3/8 inch (9 mm). Fully compact each layer and allow to become thumbprint hard before applying next layer. Where existing stone has worn or rounded edges, slightly recess finished mortar surface below face of stone to avoid widened joint faces. Take care not to spread mortar beyond joint edges onto exposed stone surfaces or to featheredge the mortar.
 - 4. When mortar is thumbprint hard, tool joints to match original appearance of joints as demonstrated in approved mockup. Remove excess mortar from edge of joint by brushing.
 - 5. Cure mortar by maintaining in thoroughly damp condition for at least 72 consecutive hours, including weekends and holidays.

3.4 FINAL CLEANING

- A. After mortar has fully hardened, thoroughly clean exposed stone surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or -fiber brushes, and clean water, applied by low-pressure spray.
 - 1. Do not use metal scrapers or brushes.
 - 2. Do not use acidic or alkaline cleaners.
- B. Clean adjacent non-stone surfaces. Use detergent and soft brushes or cloths.
- C. Clean mortar and debris from roof; remove debris from gutters and downspouts. Rinse off roof.
- D. Remove masking materials, leaving no residues that could trap dirt.

END OF SECTION 040140

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Steel framing and supports for mechanical and electrical equipment.
 - 2. Steel framing and supports for applications where framing and supports are not specified in other Sections.

1.3 SUBMITTALS

- A. Shop Drawings: Show fabrication and installation details for metal fabrications.
 - 1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm experienced in producing metal fabrications similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. AWS D1.2, "Structural Welding Code--Aluminum."
 - 3. AWS D1.3, "Structural Welding Code--Sheet Steel."
 - 4. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.5 PROJECT CONDITIONS

- A. Field Measurements: Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field

measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 METALS

- A. Metal Surfaces, General: For metal fabrications exposed to view upon completion of the Work, provide materials selected for their surface flatness, smoothness, and freedom from surface blemishes. Do not use materials whose exposed surfaces exhibit pitting, seam marks, roller marks, rolled trade names, roughness, "oil canning", stains, discoloration and, for steel sheet, variations in flatness exceeding those permitted by reference standards for stretcher-leveled sheet.

2.2 METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/ A 36M.
- B. Steel Tubing: Product type (manufacturing method) and as follows:
 - 1. Cold-Formed Steel Tubing: ASTM A 500, grade as indicated below:
 - a. Grade B, unless otherwise indicated or required for design loading.
- C. Uncoated Structural Steel Sheet: Product type (manufacturing method), grade as follows:
 - 1. Cold-Rolled Structural Steel Sheet: ASTM A 611, grade as follows:
 - a. Grade A, unless otherwise indicated or required by design loading.
- D. Uncoated Steel Sheet: Commercial quality, product type (method of manufacture) as follows:
 - 1. Cold-Rolled Steel Sheet: ASTM A 366.
- E. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T6.
- F. Brackets, Flanges and Anchors: Cast or formed metal of the same type material and finish as supported rails, unless otherwise indicated.
- G. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy to be welded.

2.3 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.

- B. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts and, where indicated, flat washers; ASTM F 593 (ASTM F 738M) for bolts and ASTM F 594 (ASTM F 836M) for nuts, Alloy Group 1 (A1).

2.4 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79.
 - 1. Use primer with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- D. Non-shrink, Nonmetallic Grout: Factory-packaged, non-staining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.5 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Shear and punch metals cleanly and accurately. Remove burrs.
- C. Ease exposed edges to a radius of approximately 1/32 inch (1 mm), unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- F. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

- G. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.
- H. Allow for thermal movement resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening up of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- I. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
- J. Remove sharp or rough areas on exposed surfaces.
- K. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports that are not a part of structural-steel framework as necessary to complete the Work.
- B. General: Provide steel framing and supports indicated and as necessary to complete the Work.
- C. Fabricate units from structural-steel shapes, plates, and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.
- D. Galvanize miscellaneous framing and supports where indicated.

2.7 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from structural-steel shapes, plates, and bars of profiles shown with continuously welded joints, and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work. Provide anchors, welded to trim, for embedding in concrete or masonry construction, spaced not more than 6 inches (150 mm) from each end, 6 inches (150 mm) from corners, and 24 inches (600 mm) o.c., unless otherwise indicated.
- C. Galvanize miscellaneous steel trim in the following locations. Hot dip galvanize after fabrication is complete. Finish must be smooth and uniform in appearance.

2.8 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.

2.9 STEEL FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:
 - 1. ASTM A 123, for galvanizing steel products.
 - 2. ASTM A 153/A 153M, for galvanizing steel hardware.
- B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed metal fabrications:
 - 1. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
- C. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting. Stainless steel will not be shop primed.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

- E. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

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

3.3 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

3.4 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

END OF SECTION 055000

SECTION 061053 - MISCELLANEOUS CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:

- 1. Wood blocking.
- 2. Plywood.

1.3 DEFINITIONS

- A. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater but less than 5 inches nominal (114 mm actual) in least dimension.
- B. Lumber grading agencies, and the abbreviations used to reference them, include the following:
 - 1. NeLMA: Northeastern Lumber Manufacturers' Association.
 - 2. NLGA: National Lumber Grades Authority.
 - 3. SPIB: The Southern Pine Inspection Bureau.

1.4 SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 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. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
3. Provide dressed lumber, S4S, unless otherwise indicated.

2.2 MISCELLANEOUS LUMBER AND PLYWOOD

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 1. Blocking.
 2. Plywood.
- B. For items of dimension lumber size, provide Construction or No. 2 grade lumber with 19 percent maximum moisture content of any species.
- C. For concealed boards, provide lumber with 19 percent maximum moisture content and any of the following species and grades:
 1. Eastern softwoods, No. 2 Common grade; NELMA.
- D. For blocking used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
- E. For plywood, use CDX plywood.

2.3 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Screws for Fastening to Cold-Formed Metal Framing or Deck: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
- F. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).
- G. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.

- H. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
 2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- B. Provide blocking as indicated and as required to support facing materials, fixtures, specialty items, and trim.
- C. Sort and select lumber so that natural characteristics will 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.
- D. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
1. NES NER-272 for power-driven fasteners.
 2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
- E. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads, unless otherwise indicated.

3.2 WOOD BLOCKING 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.

END OF SECTION 061053

SECTION 062023 - INTERIOR FINISH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Interior standing and running wood trim.
2. Adjustable shelving.
3. Solid surface counters and backsplashes.
4. Counter support brackets.
5. Flat panel wood cabinets and related hardware.
6. Shop finishing of cabinets, transparent finish.
7. Impact Wall Panel.

- B. Related Requirements:

1. Section 012300 "Alternates" for solid surface at existing windowsills.
2. Section 061053 "Miscellaneous Carpentry" for furring, blocking, and other carpentry work not exposed to view.
3. Section 099000 "Painting" for field priming and finishing of interior finish carpentry.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials, dimensions, profiles, textures, and colors and include construction and application details.
- B. Samples for Initial Selection: For each type of product involving selection of colors, profiles, or textures.
- C. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
 1. Show details full size.
 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.
- D. Samples for Verification:

1. For each species and cut of lumber and panel products with finish, with 50 sq. in. (300 sq. cm) for lumber and 8 by 10 inches (200 by 250 mm) for panels.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation. Protect materials from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.
- B. Deliver interior finish carpentry materials only when environmental conditions meet requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions meet requirements specified for installation areas.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install interior finish carpentry materials until building is enclosed and weatherproof, wet work in space is completed and nominally dry, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Do not install finish carpentry materials that are wet, moisture damaged, or mold damaged.
 1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.
- C. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.
 2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
- B. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.

1.7 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. General: Provide materials that comply with requirements of AWI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
 - B. Lumber Standards: Comply with DOC PS 20, "American Softwood Lumber Standard," for lumber and with applicable grading rules of inspection agencies certified by American Lumber Standards Committee Board of Review.
 - C. Inspection Agencies: Inspection agencies, and the abbreviations used to reference them, include the following:
 - 1. NELMA - Northeastern Lumber Manufacturers Association.
 - 2. NHLA - National Hardwood Lumber Association.
 - 3. NLGA - National Lumber Grades Authority.
 - 4. WCLIB - West Coast Lumber Inspection Bureau.
 - 5. WWPA - Western Wood Products Association.
 - D. Factory mark each piece of lumber with grade stamp of inspection agency indicating grade, species, moisture content at time of surfacing, and mill.
 - 1. For exposed lumber, mark grade stamp on end or back of each piece, or omit grade stamp and provide certificates of grade compliance issued by inspection agency.
 - E. Softwood Plywood: DOC PS 1.
 - F. MDF: ANSI A208.2, Grade 130, made with binder containing no urea-formaldehyde resin.
 - G. Veneer-Faced Plywood: HPVA HP-1, either softwood or hardwood core with hardwood veneer, made with adhesive containing no urea formaldehyde.
- ### 2.2 INTERIOR TRIM
- A. Lumber Trim for Transparent Finish:
 - 1. Species and Grade: Red oak, clear, plain or rift sawn.
 - 2. Maximum Moisture Content: 9 percent.
 - 3. Finger Jointing: Not allowed.
 - 4. Face Surface: Surfaced (smooth).
 - B. Moldings for Transparent Finish: See architectural details.

1. Hardwood Moldings:
 - a. Species: Red oak, clear, plain or rift sawn.
 - b. Maximum Moisture Content: 9 percent.
2. Finger Jointing: Not allowed.

2.3 CLOSET AND UTILITY SHELVING AND HARDWARE

- A. Grade: Custom.
- B. Shelf Material: 3/4-inch (19-mm) veneer-faced panel product with solid-lumber edge.
- C. Cleats: 3/4-inch (19-mm) solid lumber.
- D. Wood Species: Red Oak.
- E. Adjustable Shelves:
 1. Shelf Standards (typical unless otherwise noted): Knapp and Vogt (KV) 80 WH.
 2. Shelf Brackets (typical unless otherwise noted): KV 180 WH.

2.4 SOLID SURFACE MATERIAL

- F. Solid Surface Material: Corian or equal.
- G. Solid Surface Material Thickness: As indicated on drawings.
- H. Colors, Patterns, and Finishes: Provide materials and products that result in colors of composite surface material complying with the following requirements:
 1. As selected by Architect from manufacturer's full range.
- I. Fabricate tops, back splash and veneers in one piece, unless otherwise indicated. Comply with composite surface material manufacturer's written recommendations for adhesives, sealers, fabrication and finishing.
 1. Fabricate with shop-applied edges of materials and configuration indicated.
- J. Drill holes in countertops for plumbing fittings in shop.

2.5 COUNTER SUPPORT BRACKETS

- A. RAKKS' brackets, powder-coat finish, color as selected by Architect from manufacturer's standard colors. Provide sizes and models as indicated on the Drawings.

2.6 WOOD CABINETS

- A. Cabinets:

1. Type: Flat panel wall and base.
2. Wood: Red Birch, clear.
3. Plywood: Red Birch veneer.

B. Hardware:

1. Pulls: Bar pull, 3-3/4" center-to center x 1/2" diameter, back-mounted, solid metal. Amerock Bar Pull, #BP40515, or similiar, oil-rubber bronze finish.
2. Hinges: Semi-overlay, 170 degrees, self-closing.
3. Shelf Rests: BHMA A156.9, B04013, metal.
4. Drawer Slides: Standard duty, side-mounted, full extension, epoxy-coated steel with steel ball bearings.
5. Finish: Satin Chromium Plated.

C. Finish: Transparent, shop finish.

2.7 IMPACT WALL PANEL

A. Panel:

1. Type: Altro Whiterock wall panel, or equal.
2. Composition: Semi-rigid PVC with a tight molecular structure and incorporated UV stabilizers fully bonded with a heat fused design pattern.
3. Thickness: 2.5 mm.
4. Material: Class A.
5. Color/Pattern: As selected by Architect from manufacturer's full range.
6. Seams: Minimize joints and install heat welded seams to match panel color.

2.8 MISCELLANEOUS MATERIALS

- K. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.
- L. Low-Emitting Materials: Adhesives shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- M. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer for general carpentry use.
1. Wood glue shall have a VOC content of 30 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- N. Multipurpose Construction Adhesive: Formulation complying with ASTM D 3498 that is recommended for indicated use by adhesive manufacturer.
1. Adhesive shall have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.9 FABRICATION

- A. Back out or kerf backs of the following members except those with ends exposed in finished work:
 - 1. Interior standing and running trim wider than 5”.
- B. Ease edges of lumber to 1/16-inch (1.5-mm) radius.

2.10 SHOP FINISHING

- A. Shop finish transparent-finished interior architectural woodwork at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.
- B. Preparation for Finishing: Comply with referenced quality standard for sanding, filing, counter-sunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work.
 - 1. Backsealing: Apply one coat of sealer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to back of paneling and to end-grain surfaces.
- C. Transparent Finish:
 - 1. Grade: Custom.
 - 2. AWI Finish System: Water borne urethane.
 - 3. Staining: As noted.
 - 4. Sheen: Satin, 30-50 gloss units measured on 60-degree gloss meter per ASTM D 523.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrates of projections and substances detrimental to application.
- B. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours unless longer conditioning is recommended by manufacturer.

3.3 INSTALLATION, GENERAL

- A. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, too small to fabricate with proper jointing arrangements, or with defective surfaces, sizes, or patterns.
- B. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.
 - 1. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
 - 2. Where face fastening is unavoidable, countersink fasteners, fill surface flush, and sand unless otherwise indicated.
 - 3. Install to tolerance of 1/8 inch in 96 inches (3 mm in 2438 mm) for level and plumb. Install adjoining interior finish carpentry with 1/32-inch (0.8-mm) maximum offset for flush installation and 1/16-inch (1.5-mm) maximum offset for reveal installation.
 - 4. Coordinate interior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate interior finish carpentry.

3.4 STANDING AND RUNNING TRIM INSTALLATION

- A. Install with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Do not use pieces less than 24 inches (610 mm) long, except where necessary. Stagger joints in adjacent and related standing and running trim. Cope at returns, lap or miter (review with Architect) at outside corners, and cope at inside corners to produce tight-fitting joints with full-surface contact throughout length of joint. Use scarf joints for end-to-end joints. Plane backs of casings to provide uniform thickness across joints where necessary for alignment.
 - 1. Match color and grain pattern of trim for transparent finish (stain or clear finish) across joints.
 - 2. Install trim after gypsum-board joint finishing operations are completed.
 - 3. Install without splitting; drill pilot holes before fastening where necessary to prevent splitting. Fasten to prevent movement or warping. Countersink fastener heads on exposed carpentry work and fill holes.

3.5 CABINETS

- A. Cabinets: 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 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
 - 2. Maintain veneer sequence matching of cabinets with transparent finish.
 - 3. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches (400 mm) o.c. with No.10 wafer-head screws sized for 1-inch (25-mm) penetration into wood framing, blocking, or hanging strips.

3.6 COUNTERTOPS

- A. Countertops: Anchor securely with adhesive supports into underside of countertop.
 - 1. Install countertops with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
 - 2. Secure backsplashes to walls with adhesive.
 - 3. Caulk space between backsplash and wall with sealant specified in Division 7 Section "Joint Sealants."

3.7 ADJUSTING

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

3.8 CLEANING

- A. Clean interior finish carpentry on exposed and semi-exposed surfaces. Restore damaged or soiled areas and touch up factory-applied finishes, if any.

3.9 PROTECTION

- A. Protect installed products from damage from weather and other causes during construction.
- B. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.
 - 1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 062023

SECTION 072413 - POLYMER-BASED EXTERIOR INSULATION AND FINISH SYSTEM (EIFS)

PART 1 - GENERAL

1.1 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.

1.2 SUMMARY

- A. Section Includes: Polymer-based exterior insulation and finish system (EIFS).
 - 1. EIFS-clad barrier-wall assemblies that are field applied over substrate.
 - 2. Water-resistive barrier coatings.
- B. Related Requirements:
 - 1. Section 012300 "Alternates" for EIFS replacement at Penthouse.

1.3 DEFINITIONS

- A. Definitions in ASTM E2110 apply to Work of this Section.
- B. EIFS: Exterior insulation and finish system(s).
- C. IBC: International Building Code.
- D. Polymer-Based Exterior Insulation and Finish System: Class PB EIFS, as defined in ASTM E2568.

1.4 ACTION SUBMITTALS

- A. Product Data: For each EIFS component, trim, and accessory, including water-resistive barrier coatings.
- B. Shop Drawings:
 - 1. Include details for EIFS buildouts.
- C. Samples: For each exposed product and for each color and texture specified, 8 inches (200 mm) square in size.
- D. Samples for Initial Selection: For each type of finish-coat color and texture indicated.
 - 1. Include similar Samples of exposed accessories involving color selection.

- E. Samples for Verification: 24-inch- (600-mm-) square panels for each type of finish-coat color and texture indicated, prepared using same tools and techniques intended for actual work, including custom trim, each profile, and an aesthetic reveal.
- F.
 - 1. Include exposed trim and accessory Samples to verify color selected.
 - 2. Include a typical control joint filled with sealant of color selected, as specified in Section 079200 "Joint Sealants."

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Manufacturer Certificates: Signed by EIFS manufacturer, certifying the following:
 - 1. EIFS substrate is acceptable to EIFS manufacturer.
 - 2. Accessory products installed with EIFS, including joint sealants, flashing, water-resistant barriers, trim, whether furnished by EIFS manufacturer and whether specified in this Section, are acceptable to EIFS manufacturer.
- C. Product Certificates: For cementitious materials and aggregates and for insulation, from manufacturer.
- D. Product Test Reports: For each EIFS assembly and component, for tests performed by a qualified testing agency.
- E. Field quality-control reports.
- F. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

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

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An installer who is certified in writing by AWCI International as qualified to install Class PB EIFS using trained workers.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, to set quality standards for materials and execution, and to set quality standards for fabrication and installation.
 - 1. Build mockup of typical wall area identified in the field by the Architect.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original, unopened packages with manufacturers' labels intact and clearly identifying products.
- B. Store materials inside and under cover; keep them dry and protected from weather, direct sunlight, surface contamination, aging, corrosion, damaging temperatures, construction traffic, and other causes.
 1. Stack insulation board flat and off the ground.
 2. Protect plastic insulation against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
 3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.9 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions and ambient outdoor air, humidity, and substrate temperatures permit EIFS to be applied, dried, and cured according to manufacturers' written instructions and warranty requirements.
 1. Proceed with installation of adhesives or coatings only when ambient temperatures have remained, or are forecast to remain, above 40 deg F (4.4 deg C) for a minimum of 24 hours before, during, and after application. Do not apply EIFS adhesives or coatings during rainfall.

1.10 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace components of EIFS that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Bond integrity and weathertightness.
 - b. Deterioration of EIFS finishes and other EIFS materials beyond normal weathering.
 2. Warranty coverage includes the following EIFS components:
 - a. EIFS finish, including base coats, finish coats, and reinforcing mesh.
 - b. Insulation installed as part of EIFS including foam buildouts.
 - c. Insulation adhesive and mechanical fasteners.
 - d. EIFS accessories, including trim components and flashing.
 - e. Water-resistive barrier coatings.

- f. EIFS drainage components.
- 3. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 POLYMER-BASED EXTERIOR INSULATION AND FINISH SYSTEM (EIFS)

- A. Source Limitations: Obtain EIFS from single source from single EIFS manufacturer and from sources approved by EIFS manufacturer as tested and compatible with EIFS components.

2.2 PERFORMANCE REQUIREMENTS

- A. EIFS Performance: Comply with ASTM E2568 and with the following:
 - 1. Weathertightness: Resistant to water penetration from exterior.
 - 2. Structural Performance of Assembly and Components:
 - a. Wind Loads:
 - 1) Uniform pressure of acting inward or outward.
 - 3. Impact Performance: ASTM E2568, Standard impact resistance.
 - 4. Abrasion Resistance of Finish Coat: Sample consisting of 1-inch- (25.4-mm-) thick EIFS mounted on 1/2-inch- (12.7-mm-) thick gypsum board; cured for a minimum of 28 days and shows no cracking, checking, or loss of film integrity after exposure to 528 quarts (500 L) of sand when tested in accordance with ASTM D968, Method A.
 - 5. Mildew Resistance of Finish Coat: Sample applied to 2-by-2-inch (50.8-by-50.8-mm) clean glass substrate; cured for 28 days and shows no growth when tested in accordance with ASTM D3273 and evaluated in accordance with ASTM D3274.
 - 6. Drainage Efficiency: 90 percent average minimum when tested in accordance with ASTM E2273.

2.3 EIFS MATERIALS

- A. Water-Resistive Barrier Coating: EIFS manufacturer's standard formulation and accessories for use as water-resistive barrier coating; compatible with substrate.
 - 1. Water-Resistance: Comply with physical and performance criteria of ASTM E2570/E2570M.
- B. Insulation Adhesive: EIFS manufacturer's standard formulation designed for indicated use; compatible with substrate and complying with one of the following:
 - 1. Job-mixed formulation of portland cement, complying with ASTM C150/C150M, Type I, and polymer-based adhesive specified for base coat.
 - 2. Factory-blended dry formulation of portland cement, dry polymer admixture, and fillers specified for base coat.

3. Factory-mixed noncementitious formulation designed for adhesive attachment of insulation to substrates of type indicated, as recommended by EIFS manufacturer.
- C. Molded, (Expanded) Rigid Cellular Polystyrene Board Insulation: Comply with ASTM E2430/E2430M, unless otherwise noted, and the following:
1. Flame-Spread and Smoke-Developed Indexes: 25 and 450 or less, respectively, in accordance with ASTM E84.
 2. Dimensions: Provide insulation boards of not more than 24 by 48 inches (610 by 1219 mm), with thickness indicated on Drawings.
 3. Foam Buildouts: Provide with profiles and dimensions indicated on Drawings.
- D. Reinforcing Mesh: Balanced, alkali-resistant, open-weave, glass-fiber mesh treated for compatibility with other EIFS materials, made from continuous multi-end strands with retained mesh tensile strength of not less than 120 lbf/in. (21 dN/cm) in accordance with ASTM E2098/E2098M and the following:
1. Reinforcing Mesh for EIFS, General: Not less than weight required to comply with impact-performance level specified in "Performance Requirements" Article.
- E. Water-Resistant Base Coat: EIFS manufacturer's standard water-resistant formulation complying with one of the following:
1. Job-mixed formulation of portland cement complying with ASTM C150/C150M, Type I, white or natural color; and manufacturer's standard polymer-emulsion adhesive designed for use with portland cement.
 2. Job-combined formulation of manufacturer's standard polymer-emulsion adhesive and manufacturer's standard dry mix containing portland cement.
- F. Mechanical Fasteners: EIFS manufacturer's standard corrosion-resistant fasteners, consisting of thermal cap, standard washer and shaft attachments, and fastener indicated below; designed to resist Project's design loads; capable of pulling fastener head below surface of insulation board; and complying with the following:
1. For attachment to steel studs from 0.033 to 0.112 inch (0.84 to 2.84 mm) in thickness, provide steel drill screws complying with ASTM C954.
 2. For attachment to light-gage steel framing members not less than 0.0179 inch (0.45 mm) in thickness, provide steel drill screws complying with ASTM C1002.
 3. For attachment to wood framing members and plywood sheathing, provide steel drill screws complying with ASTM C1002, Type W.
- G. Primer: EIFS manufacturer's standard factory-mixed, elastomeric-polymer primer for preparing base-coat surface for application of finish coat.
- H. Finish Coat: EIFS manufacturer's standard acrylic-based coating with enhanced mildew resistance complying with the following:
1. Factory-mixed formulation of polymer-emulsion binder, colorfast mineral pigments, sound stone particles, and fillers.

2. Factory-mixed formulation of polymer-emulsion binder, colorfast mineral pigments, and fillers used with stone particles for embedding in finish coat to produce an applied-aggregate finish.
 - a. Aggregate: Marble chips of size and color as selected by Architect from manufacturer's full range of industry colors and color densities.
 3. Colors: As selected by Architect from manufacturer's full range.
 4. Textures: As selected by Architect from manufacturer's full range.
- I. Sealer: Manufacturer's waterproof, clear acrylic-based sealer for protecting finish coat.
- J. Water: Potable.
- K. Trim Accessories: Type as designated or required to suit conditions indicated and to comply with EIFS manufacturer's written instructions; manufactured from UV-stabilized PVC; and complying with ASTM D1784 and ASTM C1063.
1. Casing Bead: Prefabricated, one-piece type for attachment behind insulation, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg.
 2. Drip Screed/Track: Prefabricated, one-piece type for attachment behind insulation, with face leg extended to form a drip, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg.
 3. Expansion Joint: Closed-cell polyethylene backer rod and elastomeric sealant, 3/4-inch (19-mm) minimum.
 4. Louver Sill Flashing: Prefabricated type for both flashing and sloping sill over framing beneath windows; with end and back dams; designed to direct water to exterior.

2.4 MIXING

- A. Comply with EIFS manufacturer's requirements for combining and mixing materials. Do not introduce admixtures, water, or other materials, except as recommended by EIFS manufacturer. Mix materials in clean containers. Use materials within time period specified by EIFS manufacturer or discard.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roof edges, wall framing, flashings, openings, substrates, and junctures at other construction for suitable conditions where EIFS will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Begin coating application only after surfaces are dry.
2. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Protect contiguous work from moisture deterioration and soiling caused by application of EIFS. Provide temporary covering and other protection needed to prevent spattering of exterior finish coats on other work.
- B. Protect EIFS, substrates, and wall construction behind them from inclement weather during installation. Prevent penetration of moisture behind EIFS and deterioration of substrates.
- C. Prepare and clean substrates to comply with EIFS manufacturer's written instructions to obtain optimum bond between substrate and adhesive for insulation.

3.3 INSTALLATION OF EIFS, GENERAL

- A. Comply with ASTM C1397, ASTM E2511, and EIFS manufacturer's written instructions for installation of EIFS as applicable to each type of substrate.

3.4 APPLICATION OF SUBSTRATE PROTECTION

- A. Water-Resistive Barrier Coating: Apply over sheathing to provide a water-resistive barrier.
 1. Tape and seal joints, exposed edges, terminations, and inside and outside corners of sheathing unless otherwise indicated by EIFS manufacturer's written instructions.

3.5 INSTALLATION OF TRIM

- A. Trim: Apply trim accessories at perimeter of EIFS, at expansion joints, at louver sills, and elsewhere as indicated. Coordinate with installation of insulation.
 1. Drip Screed/Track: Use at bottom edges of EIFS unless otherwise indicated.
 2. Louver Sill Flashing: Use at windows unless otherwise indicated.
 3. Expansion Joint: Use where indicated on Drawings.
 4. Casing Bead: Use at other locations.

3.6 INSTALLATION OF INSULATION

- A. Board Insulation: Adhesively and mechanically attach insulation to substrate in compliance with ASTM C1397 and the following:
 1. Sheathing: Apply adhesive to insulation by notched-trowel method in a manner that results in coating the entire surface of sheathing with adhesive once insulation is adhered to substrate. Apply adhesive to a thickness of not less than 1/4 inch (6.4 mm) for factory mixed and not less than 3/8 inch (10 mm) for field mixed, measured from surface of insulation before placement.

2. Press and slide insulation into place. Apply pressure over entire surface of insulation to accomplish uniform contact, high initial grab, and overall level surface.
3. Allow adhered insulation to remain undisturbed for not less than 24 hours, before installing mechanical fasteners, beginning rasping and sanding insulation or before applying base coat and reinforcing mesh.
4. Mechanically attach insulation to substrate. Install top surface of fastener heads flush with plane of insulation. Install fasteners into or through substrates with the following minimum penetration:
 - a. Steel Framing: 5/16 inch (8 mm).
 - b. Wood Framing: 1 inch (25 mm).
5. Apply insulation over dry substrates in courses, with long edges of boards oriented horizontally.
6. Begin first course of insulation from a level base line and work upward.
7. Begin first course of insulation from screed/track and work upward. Work from perimeter casing beads toward interior of panels if possible.
8. Stagger vertical joints of insulation boards in successive courses to produce running bond pattern. Locate joints, so no piece of insulation is less than 12 inches (300 mm) wide or 6 inches (150 mm) high. Offset joints not less than 6 inches (150 mm) from corners of louver and door openings and not less than 4 inches (100 mm) from aesthetic reveals.
 - a. Adhesive Attachment: Offset joints of insulation not less than 6 inches (150 mm) from horizontal and 4 inches (100 mm) from vertical joints in sheathing.
 - b. Mechanical Attachment: Offset joints of insulation from horizontal joints in sheathing.
9. Interlock ends at internal and external corners.
10. Abut insulation tightly at joints within and between each course to produce flush, continuously even surfaces without gaps or raised edges between boards. If gaps greater than 1/16 inch (1.6 mm) occur, fill with insulation cut to fit gaps exactly; insert insulation without using adhesive or other material.
11. Cut insulation to fit openings, corners, and projections precisely and to produce edges and shapes complying with details indicated.
12. Rasp or sand flush entire surface of insulation to remove irregularities projecting more than 1/32 inch (0.8 mm) [1/16 inch (1.6 mm) from surface of insulation and to remove yellowed areas due to sun exposure; do not create depressions deeper than 1/16 inch (1.6 mm). Prevent airborne dispersal and immediately collect insulation raspings or sandings..
13. Cut aesthetic reveals in outside face of insulation with high-speed router and bit configured to produce grooves, rabbets, and other features that comply with profiles and locations indicated. Do not reduce insulation thickness at aesthetic reveals to less than 3/4 inch (19 mm).
14. Install foam buildouts and attach to structural substrate by adhesive and mechanical fastening.
15. Interrupt insulation for expansion joints where indicated.
16. Form joints for sealant application by leaving gaps between adjoining insulation edges and between insulation edges and dissimilar adjoining surfaces. Make gaps wide enough to produce joint widths indicated after encapsulating joint substrates with base coat and reinforcing mesh.
17. Form joints for sealant application with back-to-back casing beads for joints within EIFS and with perimeter casing beads at dissimilar adjoining surfaces. Make gaps between

- casing beads and between perimeter casing beads and adjoining surfaces of width indicated.
18. Before installing insulation and before applying field-applied reinforcing mesh, fully wrap board edges. Cover edges of board and extend encapsulating mesh not less than 2-1/2 inches (64 mm) over front and back face unless otherwise indicated on Drawings.
 19. Treat exposed edges of insulation as follows:
 - a. Except for edges forming substrates of sealant joints, encapsulate with base coat, reinforcing mesh, and finish coat.
 - b. Encapsulate edges forming substrates of sealant joints within EIFS or between EIFS and other work with base coat and reinforcing mesh.
 - c. At edges trimmed by accessories, extend base coat, reinforcing mesh, and finish coat over face leg of accessories.
 20. Coordinate installation of flashing and insulation to produce wall assembly that does not allow water to penetrate behind flashing and EIFS lamina.
- B. Expansion Joints: Install at locations indicated, where required by EIFS manufacturer, and as follows:
1. At expansion joints in substrates behind EIFS.
 2. Where EIFS adjoin dissimilar substrates, materials, and construction, including other EIFS.
 3. At floor lines in multilevel wood-framed construction.
 4. Where wall height or building shape changes.
 5. Where EIFS manufacturer requires joints in long continuous elevations.

3.7 APPLICATION OF BASE COAT

- A. Water-Resistant Base Coat: Apply full-thickness coverage to exposed insulation and to other surfaces indicated on Drawings.
- B. Base Coat: Apply full coverage to exposed insulation and foam buildouts with not less than 1/16-inch (1.6-mm) dry-coat thickness.
- C. Reinforcing Mesh: Embed reinforcing mesh in wet base coat to produce wrinkle-free installation with mesh continuous at corners, overlapped not less than 2-1/2 inches (64 mm) or otherwise treated at joints to comply with ASTM C1397. Do not lap reinforcing mesh within 8 inches (200 mm) of corners. Completely embed mesh, applying additional base-coat material if necessary, so reinforcing-mesh color and pattern are invisible.
- D. Additional Reinforcing Mesh: Apply strip-reinforcing mesh around openings, extending 4 inches (100 mm) beyond perimeter. Apply additional 9-by-12-inch (230-by-300-mm) strip-reinforcing mesh diagonally at corners of openings (re-entrant corners). Apply 8-inch- (200-mm-) wide, strip-reinforcing mesh at both inside and outside corners unless base layer of mesh is lapped not less than 4 inches (100 mm) on each side of corners.
1. At aesthetic reveals, apply strip-reinforcing mesh not less than 8 inches (200 mm) wide.
 2. Embed strip-reinforcing mesh in base coat before applying first layer of reinforcing mesh.

- E. Foam Buildouts: Fully embed reinforcing mesh in base coat.
- F. Double Base-Coat Application: Where indicated, apply second base coat in same manner and thickness as first application, except without reinforcing mesh. Do not apply until first base coat has cured.

3.8 APPLICATION OF FINISH COAT

- A. Primer: Apply over dry base coat.
- B. Finish Coat: Apply full-thickness coverage over dry primed base coat, maintaining a wet edge at all times for uniform appearance, to produce a uniform finish of color and texture matching approved sample and free of cold joints, shadow lines, and texture variations.
 - 1. Embed aggregate in finish coat to produce a uniform applied-aggregate finish of color and texture matching approved sample.
- C. Sealer Coat: Apply over dry finish coat, in number of coats and thickness required by EIFS manufacturer.

3.9 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
 - 1. As stipulated in Ch. 17 of the IBC.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. EIFS Tests and Inspections: In accordance with ASTM E2568.
- D. EIFS will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.10 CLEANING AND PROTECTION

- A. Remove temporary covering and protection of other work. Promptly remove coating materials from window and door frames and other surfaces outside areas indicated to receive EIFS coatings.

END OF SECTION 072413

SECTION 075323 - EPDM MEMBRANE ROOFING

This specification section contains brand named products.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:

1. Adhered membrane roofing system.
2. Substrate board.
3. Vapor retarder/air barrier.
4. Self-Adhered Flexible Flashing
5. Roof insulation.
6. Sheet Metal Flashing and Trim.
7. Walkways.
8. Rooftop anchors.

- B. Related Sections include the following:

1. Section 012300 "Alternates" for alternates affected by this section.
2. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
3. Section 079200 "Joint Sealants" for field-applied sheet metal flashing and trim sealants.

1.3 DEFINITIONS

- A. Roofing Terminology: Refer to ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.
- B. Design Uplift Pressure: The uplift pressure, calculated according to procedures in SPRI's "Wind Load Design Guide for Fully Adhered and Mechanically Fastened Roofing Systems," before multiplication by a safety factor.

1.4 ROOFING PERFORMANCE REQUIREMENTS

- A. General: Provide installed roofing membrane and base flashings that remain watertight; do not permit the passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure.

- B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing membrane manufacturer based on testing and field experience.
- C. SPRI's Directory of Roof Assemblies Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in SPRI's Directory of Roof Assemblies for roof assembly identical for that specified for this Project.
 - 1. Wind Uplift Load Capacity: 60 psf
 - 2. Hail Resistance: MH.

1.5 SHEET METAL FLASHING AND TRIM PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. SPRI Wind Design Standard: Manufacture and install roof edge flashings tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressure:
 - 1. Basic Design Wind Pressure: 36 PSF.
- D. Retain "Sheet Metal Standard for Copper" Paragraph below if applicable. The NRCA has a testing program and authorized fabricators for particular NRCA copper-sheet metal details. The CDA does not have a testing program or authorized fabricators for its details.
- E. Wind-Uplift Resistance: Comply with UL580 for Class 60 wind-uplift resistance.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

1.6 COORDINATION

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

1.7 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.
 - 2. Product Data: For adhesives and sealants, indicating VOC content.
 - 3. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.
 - 4. Product Data: For recycled content, indicating post-consumer and pre-consumer recycled content and cost.
 - 5. Environmental Product Declaration: For each product.
 - 6. Health Product Declaration: For each product.
 - 7. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
 - 8. Product Data: For recycled content, indicating post-consumer and pre-consumer recycled content and cost.
- C. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:
 - 1. Layout and thickness of insulation.
 - 2. Base flashings and membrane termination details.
 - 3. Flashing details at penetrations.
 - 4. Tapered insulation layout, thickness, and slopes.
 - 5. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
 - 6. Tie-in with air barrier.
- D. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.

1.8 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, fabricator and manufacturer.
- B. Manufacturer and Product Certificates:
 - 1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
 - a. Submit evidence of compliance with performance requirements.
 - 2. For each type of roof edge flashing that is ANSI/SPRI/FM 4435/ES-1 tested.
 - 3. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.
- C. Product Test Reports: For each product, for tests performed by a qualified testing agency, indicating compliance with specified requirements.

- D. Evaluation Reports: For components of roofing system, from ICC-ES.
- E. Sample Warranties: For special warranties.

1.9 CLOSEOUT SUBMITTALS

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

1.10 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's warranty.
- B. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
 - 1. For roof edge flashings that are ANSI/SPRI/FM 4435/ES-1 tested, shop shall be listed as able to fabricate required details as tested and approved.
- C. Manufacturer Qualifications: A qualified manufacturer that is listed in SPRI's Directory of Roof Assemblies for roofing system identical to that used for this Project.
- D. Source Limitations: Obtain components for membrane roofing system approved by roofing membrane manufacturer.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.
- B. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.
 - 1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
 - 2. Protect stored sheet metal flashing and trim from contact with water.
- C. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.
- D. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- E. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- F. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.12 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.13 WARRANTY

- A. Special Warranty: Manufacturer's standard form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period. Failure includes roof leaks. Special warranty shall cover full system watertightness.
 1. Special warranty includes roofing membrane, base flashings, roofing accessories, roof insulation, fasteners, cover boards, substrate board, vapor retarder, walkway products and other components of membrane roofing system.
 - a. Special warranty includes all roof curbs, parapet flashing, pre-fabricated metal roof edge system, metal fascias, penetration flashing, roof drains, roof-top anchors, lightning protection attachments, and other roof components integrated into the roof system.
 - b. Special warranty shall be provided by a single source manufacturer.
 - c. Special warranty shall not require periodic inspections or repairs at the Government's expense to maintain the warranty.
 2. Warranty Period:
 - a. 30 years from date of Substantial Completion.
 3. Roof Warranty Plate:
 - a. Manufacturer shall provide a warranty plate (stamped or engraved metal) to be installed inside the building, inside the Janitor's Closet, adjacent to the roof access ladder as identified on the roof plan.
 - b. Warranty plate shall indicate the warranty period, roofing manufacturer, roofing installer, general contractor, and date when the roof went into service.
- B. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
2. Finish Warranty Period: 30 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 EPDM ROOFING MEMBRANE

- A. EPDM Roofing Membrane: ASTM D 4637, Type I, Nonreinforced, uniform, flexible sheet made from EPDM, and as follows:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Elevate/Firestone Building Products Company.
 - b. Carlisle SynTec Incorporated.
 - c. GenFlex Roofing Systems.
 - d. Johns Manville International, Inc.
 - e. Versico Inc.
 2. Thickness:
 - a. 90 mils, nominal.
 3. Exposed Face Color: Black.
 4. Source Limitations: Obtain components for roofing system from manufacturers approved by roof membrane manufacturer.

2.2 AUXILIARY ROOFING MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.
 1. Liquid-type auxiliary materials shall meet VOC limits of authorities having jurisdiction.
- B. Sheet Flashing:
 1. 90 mils, nominal, EPDM, partially cured or cured, according to application.
- C. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.
- D. Liquid Flashing: Manufacturer's standard black one-part pourable sealer combined with manufacturer's standard flashing fabric.

- E. Protection Sheet: Epichlorohydrin or neoprene nonreinforced flexible sheet, 55 to 60 mils (1.4 to 1.5 mm) thick, recommended by EPDM manufacturer for resistance to hydrocarbons, non-aromatic solvents, grease, and oil.
- F. Slip Sheet: Manufacturer's standard, of thickness required for application.
- G. Bonding Adhesive: Manufacturer's standard bonding adhesive.
- H. Seaming Material: Single-component butyl splicing adhesive and splice cleaner or Manufacturer's standard synthetic-rubber polymer primer and 3-inch- (75-mm-) wide minimum, butyl splice tape with release film.
- I. Lap Sealant: Manufacturer's standard single-component sealant, color to match roofing membrane.
- J. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.
- K. Metal Termination Bars: Manufacturer's standard predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.
- L. Metal Battens: Manufacturer's standard aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch (25 mm) wide by 0.05 inch (1.3 mm) thick, prepunched.
- M. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.
- N. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.

2.3 SHEET METALS AND FINISHES

- A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- B. Copper Sheet: ASTM B370, cold-rolled copper sheet, H00 or H01 temper.
 - 1. Source Limitations: Obtain sheet from single source from single manufacturer.
- C. Metallic-Coated Steel Sheet: Provide aluminum-zinc alloy-coated steel sheet in accordance with ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation, Grade 40 (Grade 275); prepainted by coil-coating process to comply with ASTM A755/A755M.
 - 1. Surface: Smooth, flat.
 - 2. Exposed Coil-Coated Finish:
 - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.

3. Color: As selected by Architect from manufacturer's full range.
4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil (0.013 mm).

2.4 MISCELLANEOUS MATERIALS

- A. General: Provide accessories, materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of sheet metal unless otherwise indicated.
- B. Metal Roof Edge Splices: 6" wide concealed splices, provided at a rate of one per 10 foot section, with one extra section per every 100 lineal feet (or fraction thereof).
- C. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal.
 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
 - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
 - b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
 2. Fasteners: Type 304 stainless steel.
- D. Solder:
 1. For Copper: ASTM B32, Grade Sn50, 50 percent tin and 50 percent lead.
- E. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, non-sag, non-toxic, non-staining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
- F. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- G. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- H. Bituminous Coating: Cold-applied asphalt emulsion according to ASTM D 1187.
- I. Asphalt Roofing Cement: ASTM D4586, asbestos free, of consistency required for application.

2.5 SHEET METAL FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
 - 1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
 - 2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
 - 3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
 - 4. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
 - 5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
- B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.
- C. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."
- D. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
 - 1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.
 - 2. Use lapped expansion joints only where indicated on Drawings.
- E. Sealant Joints: Where movable, non-expansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.
- F. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- G. Seams:
 - 1. Fabricate non-moving seams in copper with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 - 2. Fabricate nonmoving seams in pre-finished metal with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.
- H. Do not use graphite pencils to mark metal surfaces.

2.6 SHEET METAL FABRICATIONS (MEMBRANE ROOFS)

- A. Base Flashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:
 - 1. Copper: 20 oz./sq. ft..
- B. Roof-Penetration Flashing, Flashing and Counterflashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:
 - 1. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.

2.7 MISCELLANEOUS SHEET METAL FABRICATIONS

- A. Equipment Support Flashing: Fabricate from the following materials:
 - 1. Galvanized Steel: 24 gauge.

2.8 SHEET METAL UNDERLAYMENT MATERIALS

- A. Flexible Flashing: Self-Adhering, High-Temperature Sheet Underlayment for use over wood blocking below sheet metal flashing and trim:
 - 1. Subject to compliance with requirements, provide the following:
 - a. W.R. Grace Vycor Plus, self-adhered, cross-laminated, high-density polyethylene sheet, width to suit application.
- B. Slip Sheet: Geotextile fleece g/m² minimum.

2.9 SUBSTRATE BOARD

- A. Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/2 inch (13 mm) thick.
 - 1. Subject to compliance with requirements, products may include, but are not limited to, the following:
 - a. "Dens-Deck Prime" manufactured by Georgia-Pacific Corporation.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening substrate panel to roof deck.

2.10 VAPOR RETARDER/AIR BARRIER

- A. Self-Adhering-Sheet Vapor Retarder/Air Barrier: ASTM D1970/D1970M, polyethylene film laminated to layer of rubberized asphalt adhesive, minimum 30-mil (0.76-mm) total thickness; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold applied, with slip-resisting

surface and release paper backing designed to work as a substrate to adhere insulation to. Provide primer when recommended by manufacturer.

1. Subject to compliance with requirements, products may include, but are not limited to, the following:
 - a. “V-Force Vapor Barrier Membrane” manufactured by Elevate/ Firestone.

2.11 SELF-ADHERED FLEXIBLE FLASHING

- A. Self-Adhered Sheet Membrane - Permeable (SASM-P): Self-adhered vapor permeable, water resistive air barrier consisting of a reinforced, modified polyolefin tri-laminate film surface and patented permeable adhesive technology with split-back poly-release film; having the following typical physical properties:

1. Subject to compliance with requirements, products may include, but are not limited to, the following:
 - a. Henry[®] Blueskin[®] VP160 Self-Adhered Water Resistive Air Barrier.
 - b. Color: Blue.
 - c. Thickness: 23 mils (0.58 mm).
 - d. Water Vapor Permeance (ASTM E96): 29 perms.
 - e. Air Leakage of Air Barrier Assemblies (ASTM E2357): Pass.
 - f. Air Permeance (ASTM E2178): Pass.
 - g. Nail Sealability (ASTM D1970): Pass.
 - h. Dry Tensile Strength (ASTM D882):
 - 1) 41 lbf /182N MD.
 - 2) 29 lbf /129N CD.
 - i. Surface Burning Characteristics (ASTM E84):
 - 1) Flame Spread: Class A.
 - 2) Smoke Development: Class A.
 - j. Low Application Temperature: 20 degrees F (-7 degrees C).

2.12 ROOF INSULATION

- A. General: Provide preformed roof insulation boards approved by the EPDM membrane manufacturer and that comply with requirements and referenced standards, selected from manufacturer's standard sizes and of thicknesses indicated.
- B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 felt or glass-fiber mat facer on both major surfaces, manufactured HCFC free, zero ozone depletion. LTTR Value = R-5.7 per inch minimum.
1. Compressive Strength: 20 psi (138 kPa).
 2. Size: 48 by 96 inches (1219 by 2438 mm).

3. Thickness:
 - a. Base Layer: 4 inches (101.6 mm). (LTTR = R-23.6) or as indicated on the Drawings
 - b. Upper Layer: 4 inches (101.6 mm). (LTTR = R-23.6) or as indicated on the Drawings.
 - c. Total System LTTR R-Value of R-45ci (U-0.022), minimum.

C. Tapered Insulation: Provide factory-tapered insulation boards.

1. Material: Match roof insulation.
2. Minimum Thickness: 1/4 inch (6.35 mm).
3. Slope:
 - a. Saddles and Crickets: 1/2 inch per foot (1:24) unless otherwise indicated on Drawings.

D. Available Manufacturers:

- a. Atlas Roofing Corporation.
- b. Carlisle SynTec Incorporated.
- c. Celotex Corporation.
- d. Firestone Building Products Company.
- e. GAF Materials Corp.
- f. GenFlex Roofing Systems.
- g. Johns Manville International, Inc.
- h. Koppers Industries.
- i. RMAX.

E. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.13 INSULATION ACCESSORIES

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.
- C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
 1. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
 2. Verify adhesives and sealants comply with the following limits for VOC content:
 - a. Plastic Foam Adhesives: 50 g/L.
 - b. Contact Adhesives: 80 g/L.
 - c. Other Adhesives: 250 g/L.
 - d. Single-Ply Roof Membrane Sealants: 450 g/L.

- e. Nonmembrane Roof Sealants: 300 g/L.
- f. Sealant Primers for Nonporous Substrates: 250 g/L.
- g. Sealant Primers for Porous Substrates: 775 g/L.

2.14 WALKWAYS

- A. Flexible Walkways: Factory-formed, non-porous, heavy-duty, solid rubber, slip-resistant, surface-textured walkway pads or rolls, approximately 3/16" thick and acceptable to membrane roofing system manufacturer.
- B. Color: Black.

2.15 ROOF-TOP ANCHORS

- A. Subject to compliance with requirements, products may include, but are not limited to, the following:
 - 1. Roof-top anchor: Commercial Roof Anchor, CRA-W Loop-Top Anchor, stainless steel riser (18 Inch riser height) with 16" square x 3/8" base plate. Provide with 52 bolt hole base plate w/ 40pc 40ga., 2 1/2" hex head screws for installation thru wood and Type B metal decking, min. 22ga. thickness to suit application.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of the Work:
 - 1. Verify that roof openings and penetrations are in place and set and braced and that roof drains are securely clamped in place.
 - 2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
 - 3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 5 Section "Steel Deck."
 - 4. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
 - 5. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

- C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.3 INSTALLATION OF SUBSTRATE BOARD

- A. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
 - 1. At steel roof decks, install substrate board at right angle to flutes of deck.
 - a. Locate end joints over crests of steel roof deck.
 - 2. Tightly butt substrate boards together.
 - 3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - 4. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to roofing system manufacturers' written instructions. Size fasteners to not extend through or beyond the bottom flute at exposed decks.

3.4 INSTALLATION OF VAPOR RETARDER /AIR BARRIER /FLEXIBLE FLASHING

- A. Ensure substrate is ready to receive air barrier in accordance with Air Barrier Manufacturer's installation guide and as specified in this Section.
- B. Temperature Limitation:
 - 1. Primary Air Barrier:
 - a) Substrate temperature must be above 20 degrees F (-7 degrees C) and rising.
 - 2. Auxiliary Products:
 - a) Temperature limitations may vary. Refer to Air Barrier Manufacturer's product TDS for product specific temperature limitations.
- A. Self-Adhering-Sheet Vapor Retarder/Air Barrier: Prime substrate if required by manufacturer. Install self-adhering-sheet vapor retarder/air barrier over substrate board, side and end lapping each sheet a minimum of 3-1/2 and 6 inches (90 and 150 mm), respectively.
 - 1. Extend vertically up parapet walls and projections to a minimum height and air seal as indicated on the drawings.
 - 2. Seal laps by rolling.
- B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.

1. The vapor retarder is the primary air seal for the roof and must be completely sealed air tight at all joints, penetrations and terminations.

C. Application of Flexible Flashing:

1. Self-Adhered Flashing:
 - a. Where required install adhesive/primer recommended by Air Barrier Manufacturer continuously at rate recommended ensuring complete substrate coverage of anticipated flashing installation area.
 - 1) Allow adhesive/primer to cure to a tacky film prior to application of flashing.
 - 2) Primed areas not covered by end of day must be re-primed prior to installation of flashing.
 - b. Measure and cut self-adhered flashing to ensure adequate length to achieve continuous coverage of desired installation.
 - c. Peel protective film from self-adhered flashing and align top of membrane verifying proper positioning prior to complete film removal and flashing placement.
 - d. Press self-adhered flashing firmly into place by applying hand pressure to the middle of the membrane and working the pressure to the edges; eliminating wrinkles and air bubbles.
 - e. Install self-adhered flashings in shingle fashion to eliminate reverse laps.
 - f. Where required, prime laps at rate recommended by Air Barrier Manufacturer to ensure complete coverage of anticipated lap installation.
 - g. Lap adjoining edges a minimum of two (2) inches.
 - h. Roll flashing and laps with countertop roller to obtain thorough adhesion.
 - i. Seal reverse laps at self-adhered flashing with sealant. Sealant recommendations may vary due to product or sequence of construction. Refer to Air Barrier Manufacturer details for recommended sealant.

3.5 INSTALLATION OF INSULATION

- A. Coordinate installing membrane roofing system components, so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with membrane roofing system manufacturer's written instructions for installing roof insulation.
- C. Install tapered insulation under area of roofing to conform to slopes indicated.
- A. Installation Over Vapor Retarder/Air Barrier, Cover Board, and Metal Deck:
 1. Install base layer of insulation with joints staggered not less than 24 inches (610 mm) in adjacent rows and with long joints continuous.
 - a. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - b. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.

- c. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches (610 mm).
 - 1) Trim insulation so that water flow is unrestricted.
 - d. Fill gaps exceeding 1/4 inch (6 mm) with foam-in-place insulation.
 - e. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
 - a. Mechanically attach base layer of insulation using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to metal decks.
 - 1) Fasten insulation in accordance with requirements in SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity.
 - 2) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
2. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than 12 inches (305 mm) from previous layer of insulation.
- a. Staggered end joints within each layer not less than 24 inches (610 mm) in adjacent rows.
 - b. Install with long joints continuous and with end joints staggered not less than 12 inches (305 mm) in adjacent rows.
 - c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - d. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
 - e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches (610 mm).
 - 1) Trim insulation so that water flow is unrestricted.
 - f. Fill gaps exceeding 1/4 inch (6 mm) with foam-in-place insulation.
 - g. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
 - h. Mechanically attach each layer of insulation to substrate with mechanical fasteners:
 - 1) Fasten insulation in accordance with requirements in SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity.
 - 2) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.

3.6 INSTALLATION OF UNDERLAYMENT

- A. Self-Adhering, High-Temperature Sheet Underlayment for use over wood blocking below sheet metal flashing and trim::
- 1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
 - 2. Prime substrate if recommended by underlayment manufacturer.

3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
 4. Apply in shingle fashion to shed water, with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses.
 5. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps and edges with roller.
 6. Roll laps and edges with roller.
 7. Cover underlayment within 14 days.
- B. When required by manufacturer, install slip sheet, wrinkle free, over underlayment before installing sheet metal flashing and trim.
1. Install in shingle fashion to shed water.
 2. Lap joints not less than 4 inches (100 mm).

3.7 INSTALLATION OF SHEET METAL FLASHING AND TRIM

- A. General: Install sheet metal flashing and trim to comply with performance requirements and cited sheet metal standard. Provide concealed fasteners where possible, and set units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
- B. Roof Edge Flashing:
1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
 2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch (75-mm) centers.
- C. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.
1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
 2. Extend counterflashing 4 inches (100 mm) over base flashing.
 3. Lap counterflashing joints minimum of 4 inches (100 mm).
 4. Secure in waterproof manner by means of snap-in installation and sealant or lead wedges and sealant unless otherwise indicated.
- D. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
1. Install fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, sealant.
 3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
 4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
 5. Install continuous cleats with fasteners spaced not more than 12 inches (300 mm) o.c.

6. Space individual cleats not more than 12 inches (300 mm) apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
 7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
 8. Do not field cut sheet metal flashing and trim by torch.
 9. Do not use graphite pencils to mark metal surfaces.
- E. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
1. Coat concealed side of uncoated sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
 2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.
- F. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.
1. Space movement joints at maximum of 10 feet (3 m) with no joints within 24 inches (600 mm) of corner or intersection.
 2. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.
 3. Use lapped expansion joints only where indicated on Drawings.
- G. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- H. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- I. Seal joints as required for watertight construction.
1. Use sealant-filled joints unless otherwise indicated.
 - a. Embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant.
 - b. Form joints to completely conceal sealant.
 - c. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way.
 - d. Adjust setting proportionately for installation at higher ambient temperatures.
 - 1) Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).
 2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."
- J. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter.
1. Pre-tin edges of sheets with solder to width of 1-1/2 inches (38 mm); however, reduce pre-tinning where pre-tinned surface would show in completed Work.
 2. Do not solder metallic-coated steel and aluminum sheet.

3. Do not pre-tin zinc-tin alloy-coated copper.
4. Do not use torches for soldering.
5. Heat surfaces to receive solder, and flow solder into joint.
 - a. Fill joint completely.
 - b. Completely remove flux and spatter from exposed surfaces.
6. Copper Soldering: Tin edges of uncoated sheets, using solder for copper.

3.8 SHEET METAL ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.
- B. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

3.9 INSTALLATION OF ADHERED ROOF MEMBRANE

- A. Adhere roof membrane over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll roofing membrane and allow to relax before installing.
- B. Unroll membrane roof membrane and allow to relax before installing.
- C. Accurately align roofing membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- D. Bonding Adhesive: Apply bonding adhesive to substrate and underside of roofing membrane at rate required by manufacturer and allow to partially dry before installing roofing membrane. Do not apply bonding adhesive to splice area of roofing membrane.
- E. Mechanically or adhesively fasten roofing membrane securely at terminations, penetrations, and perimeter of roofing.
- F. Apply roofing membrane with side laps shingled with slope of roof deck where possible.
- G. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping roofing membranes according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of roofing membrane terminations.
 1. Apply a continuous bead of in-seam sealant before closing splice if required by membrane roofing system manufacturer.
- H. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping roofing membranes according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of roofing membrane terminations.

- I. Repair tears, voids, and lapped seams in roofing that does not meet requirements.
- J. Spread sealant or mastic bed over deck drain flange at deck drains and securely seal roofing membrane in place with clamping ring.
- K. Adhere protection sheet and sacrificial layer of roof membrane over roof membrane at locations indicated.

3.10 INSTALLATION OF ROOF MEMBRANE SHEET FLASHINGS

- A. Install roof membrane sheet flashing according to membrane roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply bonding adhesive to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.11 INSTALLATION OF WALKWAY

- A. Rubber Walkways: Install rubber walkways according to manufacturer's written instructions, glue-down, in locations indicated.

3.12 FIELD QUALITY CONTROL

- A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Architect.
 - 1. Notify Architect or Owner 48 hours in advance of date and time of inspection.
- B. Repair or remove and replace components of membrane roofing system where test results or inspections indicate that they do not comply with specified requirements.
- C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.13 PROTECTING AND CLEANING

- A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for

deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

- B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- D. Clean and neutralize flux materials. Clean off excess solder.
- E. Clean off excess sealants.
- F. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended by sheet metal flashing and trim manufacturer. Maintain sheet metal flashing and trim in clean condition during construction.
- G. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 075323

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes through-penetration firestop systems for penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items.

1.3 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per UL 1479:
 - 1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
 - 2. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas:
 - a. Penetrations located outside wall cavities.
 - b. Penetrations located outside fire-resistance-rated shaft enclosures.
- C. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
 - 1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
 - 2. For floor penetrations with annular spaces exceeding 4 inches (100 mm) in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved, either by installing floor plates or by other means.
 - 3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

- D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each through-penetration firestop system, show each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item. Include firestop design designation of qualified testing and inspecting agency that evidences compliance with requirements for each condition indicated.
 - 1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetrating items.
 - 2. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular through-penetration firestop condition, submit illustration, with modifications marked, approved by through-penetration firestop system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
- C. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:
 - 1. Types of penetrating items.
 - 2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.
 - 3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.
- D. Product Certificates: For through-penetration firestop system products, signed by product manufacturer.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A firm with FM4991 certification experienced in installing through-penetration firestop systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its through-penetration firestop system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.
- B. Installation Responsibility: Assign installation of through-penetration firestop systems in Project to a single qualified installer.
- C. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, through one source from a single manufacturer.

1. If multiple trades are fire sealing penetrations, all trades must be using the same products and installation techniques.
- D. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in Part 1 "Performance Requirements" Article:
 1. Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL, or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.
 2. Through-penetration firestop systems are identical to those tested per testing standard referenced in "Part 1 Performance Requirements" Article. Provide rated systems complying with the following requirements:
 - a. Through-penetration firestop system products bear classification marking of qualified testing and inspecting agency.
 - b. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the following:
 - 1) UL in its "Fire Resistance Directory."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life if applicable, qualified testing and inspecting agency's classification marking applicable to Project, curing time, and mixing instructions for multi-component materials.
- B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Ventilate through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

1.8 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

- C. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined by Contracting Officer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, through-penetration firestop systems that may be incorporated into the Work include, but are not limited to, those systems indicated in the Through-Penetration Firestop System Schedule on Drawings that are produced by one of the following manufacturers:
 - 1. Grace, W. R. & Co. - Conn.
 - 2. Hilti, Inc.
 - 3. Nelson Firestop Products.
 - 4. 3M; Fire Protection Products Division.
 - 5. Tremco Sealants and Coatings.

2.2 FIRESTOPPING, GENERAL

- A. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E 84.
 - 1. Sealant shall have a VOC content of 250 g/L or less.
- B. Compatibility: Provide through-penetration firestop systems that are compatible with one another; with the substrates forming openings; and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.
- C. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:
 - 1. Permanent forming/damming/backing materials, including the following:
 - a. Slag-/rock-wool-fiber insulation.
 - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - d. Fillers for sealants.
 - 2. Temporary forming materials.
 - 3. Substrate primers.
 - 4. Collars.
 - 5. Steel sleeves.

2.3 FILL MATERIALS

- A. General: Provide through-penetration firestop systems containing the types of fill materials required by the manufacturer of the through-penetration firestop system.

2.4 MIXING

- A. For those products requiring mixing before application, comply with through-penetration firestop 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

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with firestop system 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 through-penetration firestop systems.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by through-penetration firestop 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. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

3.3 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

- A. General: Install through-penetration firestop systems to comply with Part 1 "Performance Requirements" Article and with firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.
- C. Install fill materials for firestop systems by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
 - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 CLEANING AND PROTECTING

- A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop 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 through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

END OF SECTION 078413

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes joint sealants for the following applications:
 - 1. Interior joints in the following vertical surfaces and horizontal nontraffic surfaces:
 - a. Perimeter joints between interior wall surfaces and frames of interior doors and windows.
 - b. Other joints as indicated.
- B. Related Sections include the following:
 - 1. Section 078413 "Penetration Firestopping" for fire-resistant building joint-sealant systems.
 - 2. Section 092900 "Gypsum Board" for sealing perimeter joints of gypsum board partitions to reduce sound transmission.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.
- B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.4 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- 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.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this Project and whose work has resulted in joint-sealant installations with a record of successful in-service performance.

- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instruction for multi-component materials.
- B. Store and handle materials in compliance with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.
 - 2. When joint substrates are wet.
- B. Joint-Width Conditions: Do not proceed with installation of joint sealants where joint widths are less or more than those allowed by joint sealant manufacturer for applications indicated.
- C. Joint-Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products specified in the sealant schedules at the end of Part 3.

2.2 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.
- B. VOC Content of Interior Sealants: Provide interior sealants and sealant primers that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - 1. Sealants: 250 g/L.
 - 2. Sealant Primers for Nonporous Substrates: 250 g/L.

3. Sealant Primers for Porous Substrates: 775 g/L.

- C. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range for this characteristic.

2.3 ELASTOMERIC JOINT SEALANTS

- A. Elastomeric Sealant Standards: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant in the Elastomeric Joint-Sealant Schedule at the end of Part 3, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

2.4 LATEX JOINT SEALANTS

- A. Latex Sealant Standard: Comply with ASTM C 834 for each product of this description indicated in the Latex Joint-Sealant Schedule at the end of Part 3.

2.5 JOINT-SEALANT BACKING

- A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

2.6 MISCELLANEOUS MATERIALS

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air.
 - 3. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
- B. Joint Priming: Prime joint substrates, where recommended in writing by joint-sealant manufacturer.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Acoustical Sealant Application Standard: Comply with recommendations in ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.
- D. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
1. Remove excess sealant from surfaces adjacent to joints.
 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.
 4. Provide flush joint configuration where indicated per Figure 5B in ASTM C 1193.
 5. Provide recessed joint configuration of recess depth and at locations indicated per Figure 5C in ASTM C 1193.

3.4 CLEANING

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

3.5 PROTECTION

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

3.6 ELASTOMERIC JOINT-SEALANT SCHEDULE

- A. Low-Modulus Nonacid-Curing Silicone Sealant: Where joint sealants of this type are indicated, provide products complying with the following:
1. Products: Provide one of the following:
 - a. 790; Dow Corning.
 - b. Silpruf; GE Silicones.
 - c. Spectrum 1; Tremco.
 2. Applications: Joints at metal siding and trim.

3.7 LATEX JOINT-SEALANT SCHEDULE

- A. Latex Sealant: Where joint sealants of this type are indicated, provide products complying with the following:
1. Products: Provide one of the following:
 - a. Chem-Calk 600; Bostik Inc.

- b. NuFlex 330; NUCO Industries, Inc.
 - c. LC 160 All Purpose Acrylic Caulk; Ohio Sealants, Inc.
 - d. AC-20; Pecora Corporation.
 - e. PSI-701; Polymeric Systems, Inc.
 - f. Sonolac; Sonneborn Building Products Div., ChemRex, Inc.
 - g. Tremflex 834; Tremco.
2. Applications: Joints in field painted vertical and overhead surfaces at perimeter of hollow metal frames in gypsum drywall and other interior painted joints. Paintable.

END OF SECTION 079200

SECTION 081213 - HOLLOW METAL FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes hollow-metal frames.
- B. Related Requirements:
 - 1. Section 081416 "Flush Wood Doors" for wood doors installed in hollow-metal frames.
 - 2. Section 087100 "Door Hardware".

1.3 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.4 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.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, fire-resistance ratings, and finishes.
- B. Shop Drawings: Include the following:
 - 1. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 - 2. Locations of reinforcement and preparations for hardware.
 - 3. Details of each different wall opening condition.
 - 4. Details of anchorages, joints, field splices, and connections.
 - 5. Details of accessories.
 - 6. Details of moldings, removable stops, and glazing.
 - 7. Indicate fire ratings for fire rated frames.

- C. Schedule: Provide a schedule of hollow-metal work 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.

1.6 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each type of frame assembly, for tests performed by a qualified testing agency.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal work 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 work 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 unit to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain hollow-metal work from single source from single manufacturer.

2.2 REGULATORY REQUIREMENTS

- A. Fire-Rated 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 at positive pressure according to NFPA 252 or UL 10C.
 - 1. Smoke- and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

2.3 INTERIOR FRAMES

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

B. Heavy-Duty Frames: SDI A250.8, Level 2.

1. Physical Performance: Level B according to SDI A250.4.
2. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch (1.3 mm).
3. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
4. Construction: Face welded.
5. Exposed Finish: Prime.

2.4 BORROWED LITES

- A. Hollow-metal frames of metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm) with minimum A40 coating.
- B. Construction: Face welded.

2.5 FRAME ANCHORS

- A. Jamb Anchors:
1. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch (1.0 mm) thick.
- B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch (1.0 mm), and as follows:
1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

2.6 MATERIALS

- A. Recycled Content of Steel Products: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.
- B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- C. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- D. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.
1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.
- E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

- F. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- G. Glazing: Comply with requirements in Division 8 Section "Glazing."

2.7 FABRICATION

- A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
 - 1. Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
 - 2. 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 butt welding.
 - 3. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 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. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. 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:
 - 1) Three anchors per jamb up to 60 inches (1524 mm) high.
 - 2) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
 - 3) Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) high.
 - 4) 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.
 - 6. Head Anchors: Two anchors per head for frames more than 42 inches (1067 mm) wide and mounted in metal-stud partitions.
 - 7. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
- C. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.

- D. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
 - 1. Reinforce frames to receive non-templated, mortised, and surface-mounted hardware.
 - 2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.
- E. Stops and Moldings: Provide stops and moldings around glazed lites and louvers where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
 - 1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow-metal work.
 - 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.
 - 4. Provide loose stops and moldings on inside of hollow-metal work.
 - 5. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.

2.8 LIGHT OPENINGS AND GLAZING

- A. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints at fabricator's shop. Fixed and removable stops to allow multiple glazed lites each to be removed independently. Coordinate frame rabbet widths between fixed and removable stops with the type of glazing and installation indicated.
- B. Moldings for Glazed Lites in doors and Loose Stops for Glazed Lites in Frames: Minimum 20 gauge thick, fabricated from same material as door face sheet in which they are installed.
- C. Fixed Frame Moldings: Formed integral with hollow-metal frames, a minimum of 5/8 inch (16 mm) high unless otherwise indicated. Provide fixed frame moldings and stops on outside of exterior and on secure side of interior doors and frames.
- D. Preformed Metal Frames for Light Openings: Manufacturer's standard frame formed of 0.048-inch-thick, cold-rolled steel sheet; with prime-coated finish; and approved for use indoors of fire protection rating indicated.

2.9 ACCESSORIES

- A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

2.10 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 SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 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.
- B. Drill and tap frames to receive non-templated, mortised, and surface-mounted hardware.

3.3 INSTALLATION

- A. General: Install hollow-metal work plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.
- B. Hollow-Metal Frames: Install hollow-metal frames for doors and other openings, of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.
 - 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - a. Install frames with removable stops located on secure side of opening.
 - b. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - c. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and 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.
 3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation inside frames.
 4. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb 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. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.
1. Secure stops 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.

3.4 PROTECTION, ADJUSTING AND CLEANING

- A. Final Adjustments: Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.
- B. Remove grout and other bonding material from hollow-metal work immediately after installation.
- C. 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.
- D. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081213

SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Solid-core doors with wood-veneer faces.
 - 2. Factory finishing of flush wood doors.
- B. Related Sections include the following:
 - 1. Section 081213 "Hollow Metal Frames".
 - 2. Section 087100 "Door Hardware".
 - 3. Section 088000 "Glazing" for glass in flush wood doors.

1.3 SUBMITTALS

- A. Product Data: For each type of door. Include details of core and edge construction, trim for openings, and louvers. Include factory finishing specifications.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.
 - 1. Indicate dimensions and locations of mortises and holes for hardware.
 - 2. Indicate dimensions and locations of cutouts.
 - 3. Indicate requirements for veneer matching.
 - 4. Indicate doors to be factory finished and finish requirements.
- C. 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. For each wood species and transparent finish, provide set of three samples showing typical range of color and grain to be expected in the finished work.
- D. Warranty: Sample of special warranty.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain flush wood doors through one source from a single manufacturer.
- B. Quality Standard: Comply with the following standard:
 - 1. AWI's "Architectural Woodwork Quality Standards, 7th Edition."
 - a. Provide AWI Quality Certification Labels or an AWI letter of licensing for Project indicating that doors comply with requirements of grades specified.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect doors during transit, storage, and handling to prevent damage, soiling, and deterioration. Comply with requirements of referenced standard and manufacturer's written instructions.
 - 1. Individually package doors in plastic bags or cardboard cartons.
 - 2. Comply with WDMA IS 1-97 standards for delivery, storage, and handling of doors.
- B. Mark each door with individual opening numbers used on Shop Drawings. Use removable tags or concealed markings.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until conditions for temperature and relative humidity have been stabilized and will be maintained in storage and installation areas during the remainder of the construction period to comply with requirements of the referenced quality standard for Project's geographical location.

1.7 WARRANTY

- A. Door Manufacturer's Warranty: Submit written warranty on door manufacturer's standard form, signed by manufacturer, Installer, and Contractor, agreeing to repair or replace defective doors that have warped (bow, cup, or twist) more than 1/4 inch (6.35 mm) in a 42-by-84-inch (1067-by-2134-mm) section or that show telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch (0.25 mm in a 75-mm) span, or do not comply with tolerances in referenced quality standard.
 - 1. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
 - 2. Warranty shall be in effect during the following period of time after the date of Project Acceptance:
 - a. Solid-Core Interior Doors: Life of installation.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:

- a. Warping (bow, cup, or twist) more than 1/4 inch (6.4 mm) in a 42-by-84-inch (1067-by-2134-mm) section.
 - b. 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

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Flush Wood Doors:
 - a. Marshfield Door Systems
 - b. Algoma Hardwoods
 - c. Eggers Industries

2.2 DOOR CONSTRUCTION, GENERAL

- A. Adhesives: Do not use adhesives containing urea-formaldehyde.
- B. Doors for Transparent Finish: Comply with the following requirements:
 1. Grade: Premium, with Grade A faces.
 2. Faces: Match existing door species & cut.
 3. Match between Veneer Leaves: Manufacturer's standard.
 4. Stiles: Same species as face.

2.3 SOLID-CORE DOORS

- A. Interior Veneer-Faced Doors: Comply with the following requirements:
 1. Grade: Custom (Grade A faces).
 2. Species: Red Oak (assumed), match existing.
 3. Cut: Plain sliced.
 4. Match between Veneer Leaves: Book match.
 5. Assembly of Veneer Leaves on Door Faces: Running match.
 6. Pair and Set Match: Provide for doors hung in same opening.
 7. Exposed Vertical Edges: Same species as faces or a compatible species.
 8. Core: Stave lumber core.
 9. Construction: Five plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering. Faces are bonded to core using a hot press.

10. Edge Construction: At hinge stiles, provide manufacturer's standard laminated-edge construction with improved screw-holding capability and split resistance and with outer stile matching face veneer.



EXISTING DOOR AT CORRIDOR

2.4 FABRICATION

- A. Fabricate flush wood doors in sizes indicated for Project site fitting.
- B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.
 1. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.
- C. Openings: Factory cut, glaze and trim openings through doors to comply with applicable requirements of referenced standards for kind(s) of door(s) required.

1. Light Openings: Factory trim openings with moldings of material and profile indicated.

2.5 FACTORY FINISHING

- A. General: Comply with AWI's "Architectural Woodwork Quality Standards Illustrated" for factory finishing.
- B. Finish doors at factory.
- C. Transparent Finish:
 1. Grade: Premium.
 2. Finish: AWI System TR-6 catalyzed polyurethane.
 3. Staining: As selected from manufacturer's full range.
 4. Effect: Open-grain finish.
 5. Sheen: Satin.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine installed door frames before hanging doors.
 1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with plumb jambs and level heads.
 2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Manufacturer's Written Instructions: Install wood doors and hardware to comply with manufacturer's written instructions, referenced quality standard, and as indicated.
 1. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.
- B. Job-Fit Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer. Machine doors for hardware. Seal cut surfaces after fitting and machining.
 1. Clearances: Provide 1/8 inch (3.2 mm) at heads and jambs. Provide 1/8 inch (3.2 mm) from bottom of door to top of decorative floor finish or covering. Where threshold is shown or scheduled, provide 1/4 inch (6.4 mm) from bottom of door to top of threshold.
- C. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 ADJUSTING AND PROTECTING

- A. Hardware: For installation, see Section 0871000 "Finish Hardware."
- B. Installation Instructions: Install doors to comply with manufacturer's written instructions and the referenced quality standard, and as indicated.
- C. 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.
- D. Protect doors as recommended by door manufacturer to ensure that wood doors are without damage or deterioration at the time of Project Acceptance.

END OF SECTION 081416

SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes access doors and frames for walls and ceilings.

1.3 ACTION 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. Schedule and drawing showing proposed locations and sizes for review by Architect, Engineer and Owner.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain doors and frames through one source from a single manufacturer.

1.5 COORDINATION

- A. Verification: Determine specific locations and sizes for access doors needed to gain access to concealed equipment. Access doors are not identified on the Drawings. Identify locations of all access doors required and provide rated or non-rated doors to match wall or ceiling system rating. Size doors as needed to comfortably access valves, dampers, junction boxes, and similar items. Review and coordinate final locations with Architect. Organize work to the greatest extent possible to avoid access panels in public spaces.

PART 2 - PRODUCTS

2.1 ACCESS DOORS AND FRAMES

- A. Flush Access Doors with Exposed Flanges:
 - 1. Description: Face of door flush with frame, with exposed flange and concealed hinge.
 - 2. Locations: Wall and ceiling.

3. Door Size: As required for access.
4. Uncoated Steel Sheet for Door: Nominal 0.060 inch (1.52 mm), 16 gage, factory primed.
5. Frame Material: Same material, thickness, and finish as door.
6. Latch and Lock: Cam latch, screwdriver operated.

2.2 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.

2.3 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.
- D. Latch Hardware:
 1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.

2.4 FINISHES

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

- D. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 - 1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

PART 3 - EXECUTION

3.1 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.

3.2 INSTALLATION

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

3.3 ADJUSTING

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

END OF SECTION 083113

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Mechanical door hardware

B. Section excludes:

1. Windows
2. Cabinets (casework), including locks in cabinets
3. Signage

C. Related Sections:

1. Division 01 "General Requirements" sections for Allowances, Alternates, Owner Furnished Contractor Installed, Project Management and Coordination.
2. Division 06 Section "Rough Carpentry"
3. Division 06 Section "Finish Carpentry"
4. Division 07 Section "Joint Sealants" for sealant requirements applicable to threshold installation specified in this section.
5. Division 08 Sections:
 - a. "Metal Doors and Frames"
 - b. "Flush Wood Doors"

1.2 REFERENCES

A. UL LLC

1. UL 10B - Fire Test of Door Assemblies
2. UL 10C - Positive Pressure Test of Fire Door Assemblies
3. UL 1784 - Air Leakage Tests of Door Assemblies
4. UL 305 - Panic Hardware

B. DHI - Door and Hardware Institute

1. Sequence and Format for the Hardware Schedule
2. Recommended Locations for Builders Hardware
3. Keying Systems and Nomenclature
4. Installation Guide for Doors and Hardware

C. NFPA – National Fire Protection Association

1. NFPA 70 – National Electric Code
2. NFPA 80 – 2016 Edition – Standard for Fire Doors and Other Opening Protectives
3. NFPA 101 – Life Safety Code

4. NFPA 105 – Smoke and Draft Control Door Assemblies
 5. NFPA 252 – Fire Tests of Door Assemblies
- D. ANSI - American National Standards Institute
1. ANSI A117.1 – 2017 Edition – Accessible and Usable Buildings and Facilities
 2. ANSI/BHMA A156.1 - A156.29, and ANSI/BHMA A156.31 - Standards for Hardware and Specialties
 3. ANSI/BHMA A156.28 - Recommended Practices for Keying Systems
 4. ANSI/WDMA I.S. 1A - Interior Architectural Wood Flush Doors
 5. ANSI/SDI A250.8 - Standard Steel Doors and Frames

1.3 SUBMITTALS

A. General:

1. Submit in accordance with Conditions of Contract and Division 01 Submittal Procedures.
2. Prior to forwarding submittal:
 - a. Review drawings and Sections from related trades to verify compatibility with specified hardware.
 - b. Highlight, encircle, or otherwise specifically identify on submittals: deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.

B. Action Submittals:

1. Product Data: Submit technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
2. Samples for Verification: If requested by Architect, submit production sample of requested door hardware unit in finish indicated and tagged with full description for coordination with schedule.
 - a. Samples will be returned to supplier. Units that are acceptable to Architect may, after final check of operations, be incorporated into Work, within limitations of key coordination requirements.
3. Door Hardware Schedule:
 - a. Submit concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate fabrication of other work critical in Project construction schedule.
 - b. Submit under direct supervision of a Door Hardware Institute (DHI) certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule published by DHI.
 - c. Indicate complete designations of each item required for each opening, include:
 - 1) Door Index: door number, heading number, and Architect's hardware set number.
 - 2) Quantity, type, style, function, size, and finish of each hardware item.
 - 3) Name and manufacturer of each item.
 - 4) Fastenings and other pertinent information.

- 5) Location of each hardware set cross-referenced to indications on Drawings.
 - 6) Explanation of all abbreviations, symbols, and codes contained in schedule.
 - 7) Mounting locations for hardware.
 - 8) Door and frame sizes and materials.
 - 9) Degree of door swing and handing.
 - 10) Operational Description of openings
4. Key Schedule:
 - a. After Keying Conference, provide keying schedule that includes levels of keying, explanations of key system's function, key symbols used, and door numbers controlled.
 - b. Use ANSI/BHMA A156.28 "Recommended Practices for Keying Systems" as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
 - c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
 - d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.
 - e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion. Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.
 - f. Prepare key schedule by or under supervision of supplier, detailing Owner's final keying instructions for locks.
- C. Informational Submittals:
1. Provide Qualification Data for Supplier, Installer and Architectural Hardware Consultant.
 2. Provide Product Data:
 - a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
 - b. Include warranties for specified door hardware.
- D. Closeout Submittals:
1. Operations and Maintenance Data: Provide in accordance with Division 01 and include:
 - a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
 - b. Catalog pages for each product.
 - c. Final approved hardware schedule edited to reflect conditions as installed.
 - d. Final keying schedule
 - e. Copy of warranties including appropriate reference numbers for manufacturers to identify project.
 - f. As-installed wiring diagrams for each opening connected to power, both low voltage and 110 volts.
- E. Inspection and Testing:
1. Submit written reports to the Owner and Authority Having Jurisdiction (AHJ) of the results of functional testing and inspection for:
 - a. Fire door assemblies, in compliance with NFPA 80.

- b. Required egress door assemblies, in compliance with NFPA 101.

1.4 QUALITY ASSURANCE

A. Qualifications and Responsibilities:

1. Supplier: Recognized architectural hardware supplier with a minimum of 5 years documented experience supplying both mechanical and electromechanical door hardware similar in quantity, type, and quality to that indicated for this Project. Supplier to be recognized as a factory direct distributor by the manufacturer of the primary materials with a warehousing facility in the Project's vicinity. Supplier to have on staff, a certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) available to Owner, Architect, and Contractor, at reasonable times during the Work for consultation.
2. Installer: Qualified tradesperson skilled in the application of commercial grade hardware with experience installing door hardware similar in quantity, type, and quality as indicated for this Project.
3. Architectural Hardware Consultant: Person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and meets these requirements:
 - a. For door hardware: DHI certified AHC or DHC.
 - b. Can provide installation and technical data to Architect and other related subcontractors.
 - c. Can inspect and verify components are in working order upon completion of installation.
4. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.

B. Certifications:

1. Fire-Rated Door Openings:
 - a. Provide door hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction.
 - b. Provide only items of door hardware that are listed products tested by UL LLC, Intertek Testing Services, or other testing and inspecting organizations acceptable to authorities having jurisdiction for use on types and sizes of doors indicated, based on testing at positive pressure and according to NFPA 252 or UL 10C and in compliance with requirements of fire-rated door and door frame labels.
2. Smoke and Draft Control Door Assemblies:
 - a. Provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105
 - b. Comply with the maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at tested pressure differential of 0.3-inch wg (75 Pa) of water.
3. Accessibility Requirements:
 - a. Comply with governing accessibility regulations cited in "REFERENCES" article 087100, 1.02.D3 herein for door hardware on doors in an accessible route. This project must comply with all Federal Americans with Disability Act regulations and all Local Accessibility Regulations.

C. Pre-Installation Meetings

1. Keying Conference

- a. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including:
 - 1) Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
 - 2) Preliminary key system schematic diagram.
 - 3) Requirements for key control system.
 - 4) Requirements for access control.
 - 5) Address for delivery of keys.

2. Pre-installation Conference

- a. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
- b. Inspect and discuss preparatory work performed by other trades.
- c. Review required testing, inspecting, and certifying procedures.
- d. Review questions or concerns related to proper installation and adjustment of door hardware.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site. Promptly replace products damaged during shipping
- B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package. Deliver each article of hardware in manufacturer's original packaging.
- C. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.
- D. Provide secure lock-up for door hardware delivered to Project. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.
- E. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.
- F. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

1.6 COORDINATION

- A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete.

- B. Installation Templates: Distribute for doors, frames, and other work specified to be factory or shop prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- C. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

1.7 WARRANTY

- A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within published warranty period.
 - 1. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.
 - 2. Warranty Period: Beginning from date of Substantial Completion, for durations indicated in manufacturer's published listings.
 - a. Mechanical Warranty
 - 1) Locks
 - a) Schlage L Series: 10 years
 - 2) Closers
 - a) LCN 4000 Series: 30 years
 - b) LCN 1460 Series: 30 years

1.8 MAINTENANCE

- A. Furnish complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.
- B. Turn over unused materials to Owner for maintenance purposes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The Owner requires use of certain products for their unique characteristics and project suitability to ensure continuity of existing and future performance and maintenance standards. After investigating available product offerings, the Awarding Authority has elected to prepare proprietary specifications. These products are specified with the notation: "No Substitute."
 - 1. Where "No Substitute" is noted, submittals and substitution requests for other products will not be considered.
- B. Approval of alternate manufacturers and/or products other than those listed as "Scheduled Manufacturer" or "Acceptable Manufacturers" in the individual article for the product category are only to be considered by official substitution request in accordance with section 01 25 00.

- C. Approval of products from manufacturers indicated in "Acceptable Manufacturers" is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer's product.
- D. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect's approval.

2.2 MATERIALS

- A. Fabrication
 - 1. Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. provide screws according to manufacturer's recognized installation standards for application intended.
 - 2. Finish exposed screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work including prepared for paint surfaces to receive painted finish.
 - 3. Provide concealed fasteners wherever possible for hardware units exposed when door is closed. Coordinate with "Metal Doors and Frames", "Flush Wood Doors", "Stile and Rail Wood Doors" to ensure proper reinforcements. Advise the Architect where visible fasteners, such as thru bolts, are required.
- B. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.
 - 1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.

2.3 HINGES

- A. Manufacturers and Products:
 - 1. Scheduled Manufacturer and Product:
 - a. Ives 5BB series
 - 2. Acceptable Manufacturers and Products:
 - a. Hager BB1191/1279 series
 - b. McKinney TB series
 - c. Best FBB series
- B. Requirements:
 - 1. Provide hinges conforming to ANSI/BHMA A156.1.
 - 2. Provide five knuckle, ball bearing hinges.
 - 3. 1-3/4 inch (44 mm) thick doors, up to and including 36 inches (914 mm) wide:
 - a. Exterior: Standard weight, bronze or stainless steel, 4-1/2 inches (114 mm) high
 - b. Interior: Standard weight, steel, 4-1/2 inches (114 mm) high
 - 4. 1-3/4 inch (44 mm) thick doors over 36 inches (914 mm) wide:
 - a. Exterior: Heavy weight, bronze/stainless steel, 5 inches (127 mm) high

- b. Interior: Heavy weight, steel, 5 inches (127 mm) high
- 5. Adjust hinge width for door, frame, and wall conditions to allow proper degree of opening.
- 6. Provide three hinges per door leaf for doors 90 inches (2286 mm) or less in height, and one additional hinge for each 30 inches (762 mm) of additional door height.
- 7. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
 - a. Steel Hinges: Steel pins
 - b. Non-Ferrous Hinges: Stainless steel pins
 - c. Out-Swinging Exterior Doors: Non-removable pins
 - d. Out-Swinging Interior Lockable Doors: Non-removable pins
 - e. Interior Non-lockable Doors: Non-rising pins

2.4 MORTISE LOCKS

A. Manufacturers and Products:

- 1. Scheduled Manufacturer and Product:
 - a. Schlage L9000 series
- 2. Acceptable Manufacturers and Products:
 - a. No Substitute

B. Requirements:

- 1. Provide mortise locks conforming to ANSI/BHMA A156.13 Series 1000, Grade 1, and UL Listed for 3-hour fire doors.
- 2. Indicators: Where specified, provide indicator window measuring a minimum 2-inch x 1/2 inch with 180-degree visibility. Provide messages color-coded with full text and/or symbols, as scheduled, for easy visibility.
- 3. Provide locks manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance.
- 4. Provide lock case that is multi-function and field reversible for handing without opening case. Cylinders: Refer to "KEYING" article, herein.
- 5. Provide locks with standard 2-3/4 inches (70 mm) backset with full 3/4 inch (19 mm) throw stainless steel mechanical anti-friction latchbolt. Provide deadbolt with full 1-inch (25 mm) throw, constructed of stainless steel.
- 6. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
- 7. Lever Trim: Solid brass, bronze, or stainless steel, cast or forged in design specified, with wrought roses and external lever spring cages. Provide thru-bolted levers with 2-piece spindles.
 - a. Lever Design: 12

2.5 CYLINDERS

A. Manufacturers:

- 1. Scheduled Manufacturer and Product:
 - a. Owner's existing Schlage SFIC (Small Format Interchangeable Core) System.

2. Acceptable Manufacturers and Products:
 - a. No Substitute
- B. Requirements:
 1. Provide cylinders/cores to match Owner's existing key system, compliant with ANSI/BHMA A156.5; latest revision; cylinder face finished to match lockset, manufacturer's series as indicated. Refer to "KEYING" article, herein.

2.6 KEYING

- A. Scheduled System:
 1. Existing factory registered system:
 - a. Provide cylinders/cores keyed into Owner's existing factory registered keying system. Comply with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.
- B. Requirements:
 1. Construction Keying:
 - a. Temporary Construction Cylinder Keying.
 - 1) Provide construction cores that permit voiding construction keys without cylinder removal, furnished in accordance with the following requirements.
 - a) Split Key or Lost Ball Construction Keying System.
 - b) 3 construction control keys, and extractor tools or keys as required to void construction keying.
 - c) 12 construction change (day) keys.
 - 2) Owner or Owner's Representative will void operation of temporary construction keys.
 - b. Replaceable Construction Cores.
 - 1) Provide temporary construction cores replaceable by permanent cores, furnished in accordance with the following requirements.
 - a) 3 construction control keys
 - b) 12 construction change (day) keys.
 - 2) Owner or Owner's Representative will replace temporary construction cores with permanent cores.
 2. Permanent Keying:
 - a. Provide permanent cylinders/cores keyed by the manufacturer according to the following key system.
 - 1) Master Keying system as directed by the Owner.
 - b. Forward bitting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements will be cause for replacement of cylinders/cores involved at no additional cost to Owner.
 - c. Provide keys with the following features:
 - 1) Material: Nickel silver; minimum thickness of .107-inch (2.3mm)
 - 2) Patent Protection: Keys and blanks protected by one or more utility patent(s).

- 3) Geographically Exclusive: Where High Security or Security cylinders/cores are indicated, provide nationwide, geographically exclusive key system complying with the following restrictions.
- d. Identification:
 - 1) Mark permanent cylinders/cores and keys with applicable blind code for identification. Do not provide blind code marks with actual key cuts.
 - 2) Identification stamping provisions must be approved by the Architect and Owner.
 - 3) Stamp cylinders/cores and keys with Owner's unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with "DO NOT DUPLICATE" along with the "PATENTED" or patent number to enforce the patent protection.
 - 4) Failure to comply with stamping requirements will be cause for replacement of keys involved at no additional cost to Owner.
 - 5) Forward permanent cylinders/cores to Owner, separately from keys, by means as directed by Owner.
- e. Quantity: Furnish in the following quantities.
 - 1) Permanent Control Keys: 3.
 - 2) Master Keys: 6.
 - 3) Change (Day) Keys: 3 per cylinder/core that is keyed differently
 - 4) Key Blanks: Quantity as determined in the keying meeting.

2.7 KEY CONTROL SYSTEM

A. Manufacturers:

1. Scheduled Manufacturer:
 - a. Telkee
2. Acceptable Manufacturers:
 - a. No Substitute
 - b. HPC
 - c. Lund

B. Requirements:

1. Provide key control system, including envelopes, labels, tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by system manufacturer, with capacity for 150% of number of locks required for Project.
 - a. Provide complete cross index system set up by hardware supplier, and place keys on markers and hooks in cabinet as determined by final key schedule.
 - b. Provide hinged-panel type cabinet for wall mounting.

2.8 DOOR CLOSERS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
 - a. LCN 4040XP series

2. Acceptable Manufacturers and Products:
 - a. No Substitute
- B. Requirements:
 1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. ISO 9000 certify closers. Stamp units with date of manufacture code.
 2. Provide door closers with fully hydraulic, full rack and pinion action with high strength cast iron cylinder, and full complement bearings at shaft.
 3. Cylinder Body: 1-1/2-inch (38 mm) diameter piston with 5/8-inch (16 mm) diameter double heat-treated pinion journal. QR code with a direct link to maintenance instructions.
 4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
 5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards. Provide snap-on cover clip, with plastic covers, that secures cover to spring tube.
 6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck. Provide graphically labelled instructions on the closer body adjacent to each adjustment valve. Provide positive stop on reg valve that prevents reg screw from being backed out.
 7. Provide closers with solid forged steel main arms and factory assembled heavy-duty forged forearms for parallel arm closers.
 8. Pressure Relief Valve (PRV) Technology: Not permitted.
 9. Finish for Closer Cylinders, Arms, Adapter Plates, and Metal Covers: Powder coating finish which has been certified to exceed 100 hours salt spray testing as described in ANSI Standard A156.4 and ASTM B117, or has special rust inhibitor (SRI).
 10. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.
 11. Closers shall be capable of being upgraded by adding modular mechanical or electronic components in the field.

2.9 DOOR CLOSERS

- A. Manufacturers and Products:
 1. Scheduled Manufacturer and Product:
 - a. LCN 1460 series
 2. Acceptable Manufacturers and Products:
 - a. No Substitute
- B. Requirements:
 1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory.
 2. Provide door closers with fully hydraulic, full rack and pinion action cast iron cylinder.

3. Closer Body: 1-1/4-inch (32 mm) diameter, with 5/8-inch (16 mm) diameter heat-treated pinion journal.
4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck.
7. Pressure Relief Valve (PRV) Technology: Not permitted.
8. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.10 PROTECTION PLATES

A. Manufacturers:

1. Scheduled Manufacturer:
 - a. Ives
2. Acceptable Manufacturers:
 - a. Burns
 - b. Rockwood

B. Requirements:

1. Provide protection plates with a minimum of 0.050 inch (1 mm) thick, beveled four edges as scheduled. Furnish with sheet metal or wood screws, finished to match plates.
2. Sizes plates 2 inches (51 mm) less width of door on single doors, pairs of doors with a mullion, and doors with edge guards. Size plates 1 inch (25 mm) less width of door on pairs without a mullion or edge guards.
3. At fire rated doors, provide protection plates over 16 inches high with UL label.

2.11 DOOR STOPS AND HOLDERS

A. Manufacturers:

1. Scheduled Manufacturer:
 - a. Ives
2. Acceptable Manufacturers:
 - a. Burns
 - b. Rockwood

B. Provide door stops at each door leaf:

1. Provide wall stops wherever possible. Provide concave type where lockset has a push button of thumbturn.
2. Where a wall stop cannot be used, provide universal floor stops.
3. Where wall or floor stop cannot be used, provide overhead stop.

4. Provide roller bumper where doors open into each other and overhead stop cannot be used.

2.12 SILENCERS

A. Manufacturers:

1. Scheduled Manufacturer:
 - a. Ives
2. Acceptable Manufacturers:
 - a. No Substitute
 - b. Burns
 - c. Rockwood
 - d. Trimco

B. Requirements:

1. Provide "push-in" type silencers for hollow metal or wood frames.
2. Provide one silencer per 30 inches (762 mm) of height on each single frame, and two for each pair frame.
3. Omit where gasketing is specified.

2.13 THRESHOLDS, SEALS, DOOR SWEEPS, AUTOMATIC DOOR BOTTOMS, AND GASKETING

A. Manufacturers:

B. Scheduled Manufacturer:

1. Zero International

C. Acceptable Manufacturers:

1. National Guard
2. Reese
3. Pemko

D. Seals and Gasketing: Provide continuous gasketing on exterior openings, to the head and jambs, forming a continuous seal between the door and the frame. Provide smoke, light, or sound gasketing on interior doors where indicated.

1. Provide self-tapping fasteners for aluminum extruded gasketing being applied to hollow metal frames.
 - a. Provide non-corrosive fasteners for all exterior applications.
 - b. Provide security fasteners where indicated.
2. Provide neoprene, EPDM, silicone, or nylon brush inserts as specified in hardware sets. Provide non brush inserts of solid or sponge cell, as specified in hardware sets. Vinyl inserts are not allowed except where specified in hardware sets.

- E. Smoke Labeled Gasketing: At all smoke labeled openings, provide smoke listed perimeter gasketing assemblies complying with NFPA 105 listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for smoke control ratings indicated based on testing according to UL 1784.
- F. Sound-Rated Gasketing: Provide acoustic gasketing to meet Sound Transmission Class (STC) rating required.
- G. Meeting-Stile Gasketing: Provide meeting-stile gasketing that fastens to the meeting stiles forming a continuous seal when doors are closed.
- H. Door Sweeps or Shoes: Apply to the bottom of the door to close the gap between the door bottom and finished floor or saddle threshold.
 - 1. Provide solid neoprene, EPDM, silicone, or nylon brush type of seal as specified in hardware sets. Vinyl inserts are not allowed except where specified in hardware sets.
 - 2. Door sweeps or shoes with integral rain drip must meet ADA requirements

2.14 FINISHES

- A. FINISH: 613, Oil-Rubbed Bronze.
 - 1. Push Plates, Pulls, and Push Bars: 613
 - 2. Protection Plates: 613
 - 3. Overhead Stops and Holders: 613
 - 4. Door Closers: Powder Coat to Match Existing
 - 5. Wall Stops: 613
 - 6. Weatherstripping: Clear Anodized Aluminum

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance. Verify doors, frames, and walls have been properly reinforced for hardware installation.
- B. Submit a list of deficiencies in writing and proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
 - 2. Custom Steel Doors and Frames: HMMA 831.

3. Interior Architectural Wood Flush Doors: ANSI/WDMA I.S. 1A
 4. Installation Guide for Doors and Hardware: DHI TDH-007-20
- B. Install door hardware in accordance with NFPA 80, NFPA 101 and provide post-install inspection, testing as specified in section 1.03.E unless otherwise required to comply with governing regulations.
- C. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.
- D. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.
- E. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.
- F. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- G. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.
- H. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated.
- I. Lock Cylinders:
1. Install construction cores to secure building and areas during construction period.
 2. Replace construction cores with permanent cores as indicated in keying section.
 3. Furnish permanent cores to Owner for installation.
- J. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.
- K. Door Closers: Mount closers/operators on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Mount closers/operators so they are not visible in corridors, lobbies and other public spaces unless approved by Architect.
- L. Overhead Stops/Holders: Mount overhead stops/holders on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.
- M. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they may impede traffic or present tripping hazard.
- N. Perimeter Gasketing:
1. Apply to head and jamb, forming seal between door and frame.

2. Install gasketing in a manner eliminating need to cut any seal to install surface mounted hardware. Install compatible mounting bracket for surface mounted hardware unless minimum 1/4 inch thick solid aluminum seals are provided for mounting of surface applied hardware.
- O. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- P. Door Bottoms and Sweeps: Apply to bottom of door, forming seal with threshold when door is closed.

3.3 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
1. Spring Hinges: Adjust to achieve positive latching when door can close freely from an open position of 30 degrees.
 2. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
 3. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
- B. Occupancy Adjustment: Approximately three to six months after date of Substantial Completion, examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors and door hardware.

3.4 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items per manufacturer's instructions to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.5 DOOR HARDWARE SCHEDULE

- A. The intent of the hardware specification is to specify the hardware for interior and exterior doors, and to establish a type, continuity, and standard of quality. However, it is the door hardware supplier's responsibility to thoroughly review existing conditions, schedules, specifications, drawings, and other Contract Documents to verify the suitability of the hardware specified.

- B. Discrepancies, conflicting hardware, and missing items are to be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application.
- C. Hardware items are referenced in the following hardware schedule. Refer to the above specifications for special features, options, cylinders/keying, and other requirements.
- D. Hardware Sets:

143349 OPT0461171 Version 1

Legend:

 Link to catalog cut sheet

Hardware Group No. 01

For use on Door #(s):

234 235 239 243 244

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		MFR
3	EA	HINGE	5BB1 AS REQUIRED		IVE
1	EA	OFFICE/ENTRY LOCK	L9050BDC 12 09-544		SCH
1	EA	SFIC CORE	TO MATCH OWNER'S EXISTING SYSTEM		SCH
1	EA	STOP AS REQUIRED	WS407CCV/FS436/FS438		IVE
1	EA	GASKETING	488S		ZER
1	EA	DOOR SWEEP	39A		ZER

Hardware Group No. 02

For use on Door #(s):

233

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		MFR
3	EA	HINGE	5BB1 AS REQUIRED		IVE
1	EA	CLASSROOM SECURITY	L9071BDC 12		SCH
2	EA	SFIC CORE	TO MATCH OWNER'S EXISTING SYSTEM		SCH
1	EA	SURFACE CLOSER	4040XP, REG OR PA ARM AS REQ,		LCN
1	EA	STOP AS REQUIRED	WS407CCV/FS436/FS438		IVE
1	EA	DOOR SWEEP	39A		ZER
3	EA	SILENCER	SR64/65 AS REQ		IVE

Hardware Group No. 03

For use on Door #(s):

217A 218 241

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		MFR
3	EA	HINGE	5BB1 AS REQUIRED		IVE
1	EA	CLASSROOM LOCK	L9070BDC 12		SCH
1	EA	SFIC CORE	TO MATCH OWNER'S EXISTING SYSTEM		SCH
1	EA	STOP AS REQUIRED	WS407CCV/FS436/FS438		IVE
3	EA	SILENCER	SR64/65 AS REQ		IVE

Hardware Group No. 04

For use on Door #(s):

238

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		MFR
3	EA	HINGE	5BB1HW AS SPECIFIED		IVE
1	EA	CLASSROOM LOCK	L9070BDC 12		SCH
1	EA	SFIC CORE	TO MATCH OWNER'S EXISTING SYSTEM		SCH
1	EA	STOP AS REQUIRED	WS407CCV/FS436/FS438		IVE
3	EA	SILENCER	SR64/65 AS REQ		IVE

Hardware Group No. 05

For use on Door #(s):

240

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		MFR
3	EA	HINGE	5BB1HW AS SPECIFIED		IVE
1	EA	CLASSROOM SECURITY	L9071BDC 12		SCH
2	EA	SFIC CORE	TO MATCH OWNER'S EXISTING SYSTEM		SCH
1	EA	SURFACE CLOSER	1461 STD		LCN
1	EA	STOP AS REQUIRED	WS407CCV/FS436/FS438		IVE
1	EA	GASKETING	488S		ZER
1	EA	DOOR SWEEP	39A		ZER

Hardware Group No. 06

For use on Door #(s):

217.1 217 242

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		MFR
3	EA	HINGE	5BB1 AS REQUIRED		IVE
1	EA	CLASSROOM SECURITY	L9071BDC 12		SCH
2	EA	SFIC CORE	TO MATCH OWNER'S EXISTING SYSTEM		SCH
1	EA	SURFACE CLOSER	1461 STD		LCN
1	EA	STOP AS REQUIRED	WS407CCV/FS436/FS438		IVE
1	EA	GASKETING	488S		ZER
1	EA	DOOR SWEEP	39A		ZER

END OF SECTION

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
 - 1. Glazing products.
 - 2. Interior one-way mirror glazing.
- B. Related Sections: The following sections contain requirements that relate to this section:
 - 1. Section 081213 "Hollow Metal Frames" for frames receiving glazing.

1.3 DEFINITIONS

- A. Manufacturer: A firm that produces primary glass or fabricated glass as defined in referenced glazing publications.

1.4 SUBMITTALS

- A. Product Data: For each glass product and glazing material indicated.
- B. Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.
- C. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.
- D. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- E. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Source Limitations for Clear Glass: Obtain clear float glass from one primary-glass manufacturer.
- C. Source Limitations for Glazing Accessories: Obtain glazing accessories from one source for each product and installation method indicated.
- D. Safety Glass: Category II materials complying with testing requirements in 16 CFR 1201 and ANSI Z97.1.
 - 1. Subject to compliance with requirements, permanently mark safety glass with certification label of Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction.
- E. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. GANA Publications: GANA'S "Glazing Manual" and "Laminated Glass Design Guide."
 - 2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR-A7, "Sloped Glazing Guidelines."
 - 3. SIGMA Publications: SIGMA TM-3000, "Vertical Glazing Guidelines," and SIGMA TB-3001, "Sloped Glazing Guidelines."

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
 - 1. Do not install liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40 deg F (4.4 deg C).

1.8 WARRANTY

- A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in

addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products indicated in schedules at the end of Part 3.

2.2 PRIMARY FLOAT GLASS

- A. Float Glass: ASTM C 1036, Type I (transparent glass, flat), Quality q3 (glazing select); class as indicated in schedules at the end of Part 3.

2.3 HEAT-TREATED FLOAT GLASS

- A. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed, unless otherwise indicated.
- B. Fabrication Process: By vertical (tong-held) or horizontal (roller-hearth) process, at manufacturer's option, except provide horizontal process where indicated as tongless or free of tong marks.
- C. Heat-Treated Float Glass: ASTM C 1048; Type I (transparent glass, flat); Quality q3 (glazing select); class, kind, and condition as indicated in schedules at the end of Part 3.

2.4 ONE-WAY GLAZING

- A. Reflective-Coated Vision Glass: ASTM C1376, Kind CV (coated vision glass), coated by manufacturer's standard process, and complying with other requirements specified.

2.5 ELASTOMERIC GLAZING SEALANTS

- A. General: Provide products of type indicated, complying with the following requirements:
 - 1. Compatibility: Select glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 - 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
- B. Elastomeric Glazing Sealant Standard: Comply with ASTM C 920 and other requirements indicated for each liquid-applied, chemically curing sealant in the Glazing Sealant Schedule at

the end of Part 3, including those referencing ASTM C 920 classifications for type, grade, class, and uses.

1. Additional Movement Capability: Where additional movement capability is specified in the Glazing Sealant Schedule, provide products with the capability, when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719, to withstand the specified percentage change in the joint width existing at time of installation and remain in compliance with other requirements in ASTM C 920 for uses indicated.

2.6 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tape: Preformed, butyl-based elastomeric tape with a solids content of 100 percent; 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; packaged on rolls with a release paper backing; 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.
- B. Expanded Cellular Glazing Tape: Closed-cell, PVC foam tape; factory coated with adhesive on both surfaces; packaged on rolls with release liner protecting adhesive; and complying with AAMA 800 for the following types:
 1. Type 1, for glazing applications in which tape acts as the primary sealant.
 2. Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.7 GLAZING GASKETS

- A. Lock-Strip Gaskets: Neoprene extrusions in size and shape indicated, fabricated into frames with molded corner units and zipper lock strips, complying with ASTM C 542, black.
- B. Dense Compression Gaskets: Molded or extruded gaskets of material indicated below, complying with standards referenced with name of elastomer indicated below, and of profile and hardness required to maintain watertight seal:
 1. EPDM, ASTM C 864.
 2. Silicone, ASTM C 1115.
 3. Any material indicated above.
- C. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned gaskets of material indicated below; complying with ASTM C 509, Type II, black; and of profile and hardness required to maintain watertight seal:
 1. EPDM.
 2. Silicone.
 3. Any material indicated above.

2.8 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions with a Shore A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.9 FABRICATION OF GLASS AND OTHER GLAZING PRODUCTS

- A. Fabricate glass and other glazing products in sizes required to glaze 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 standard, to comply with system performance requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing glazing, 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 system.
 - 3. Minimum required face or edge clearances.
 - 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.
- 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 sealant-substrate 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 the length plus width is larger than 50 inches (1270 mm) as follows:
 - 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 in each series with uniform pattern, draw, bow, and similar characteristics.
- 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.

3.4 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. Where framing joints are vertical, cover these joints by applying tapes to heads and sills first and then to jambs. Where framing joints are horizontal, cover these 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 just 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.

3.5 GASKET GLAZING (DRY)

- A. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with stretch allowance 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. 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. Install gaskets so they protrude past face of glazing stops.

3.6 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.
- D. Sealant shall have a VOC content of 250 g/L or less.
- E. 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", Version 1.2-2017 (also known as Section 01350).

3.7 PROTECTION AND CLEANING

- A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Prior to removing non-permanent labels from glass, Architect will inspect labels to insure each unit is in correct location. Retain two typical sets of labels from each different type of glass. Fix to paper sheets and insert in Owner's Operation and Maintenance manuals. Remove nonpermanent labels, and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove them immediately as recommended by glass manufacturer.
- C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for build-up of dirt, scum, alkaline deposits, or stains; remove as recommended by glass manufacturer.
- D. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged in any way, including natural causes, accidents, and vandalism, during construction period.
- E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended by glass manufacturer.

3.8 MONOLITHIC FLOAT-GLASS SCHEDULE

- A. Uncoated Clear Float Glass: Where glass as designated below is indicated, provide Type I (transparent glass, flat), Class 1 (clear) glass lites complying with the following:
 - 1. Uncoated Clear Annealed Float Glass FG-[#]: Annealed or Kind HS (heat strengthened), Condition A (uncoated surfaces) where heat strengthening is required to resist thermal stresses induced by differential shading of individual glass lites and to comply with performance requirements.
 - 2. Uncoated Clear Heat-Strengthened Float Glass FG-[#]: Kind HS (heat strengthened).
 - 3. Uncoated Clear Fully Tempered Float Glass FG-[#]: Kind FT (fully tempered).
- B. Reflective-Coated Vision Glass: ASTM C1376, Kind CV (coated vision glass), coated by manufacturer's standard process, and complying with other requirements specified.

SECTION 090561 - MOISTURE VAPOR EMISSION CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications Sections apply to this Section.

1.2 SUMMARY

- A. This Section includes a moisture management system formulated to suppress excessive moisture vapor emissions in existing concrete prior to installing finish flooring.
- B. The supply and installation of products in this section is an Additive Alternate. The Contractor will perform moisture testing on the existing concrete slabs to receive new resilient tile flooring in a minimum of eight locations to determine moisture levels within 30 days of start of construction. Include testing in Bid. This Additive Alternative may or may not be accepted following results of the moisture testing.**
- C. Related Sections include the following:
 - 1. Section 012300 "Alternates".
 - 2. Section 096519 "Resilient Tile Flooring".
 - 3. Section 096810 "Carpet Tile".

1.3 REFERENCES

- A. ASTM F2170 - Relative Humidity in Concrete Floor Slabs Using in situ Probes
- B. ASTM F1869 - Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
- C. ASTM 710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring
- D. ASTM C1583 - Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension
- E. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials
- F. ASTM D1308 - Chemical Resistance of Finishes

1.4 DEFINITIONS

- A. MVE: Moisture vapor emission.
- B. MVER: Moisture vapor emission rate.

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used. Include manufacturer's Material Safety Data Sheets.

1.6 QUALITY ASSURANCE

- A. Installation of the product must be completed by a certified applicator, using mixing equipment and tools approved by the manufacturer.
- B. Manufacturer Experience: Provide products of this section by companies which have successfully specialized in production of this type of work for not less than 5 years. Contact Manufacturer Representative prior to installation.
- C. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.7 WARRANTY

- A. Certified applicator must file a pre-installation checklist with the manufacturer and receive written confirmation of the approval to proceed in order to obtain the extended 10-year Warranty.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Deliver products in original packaging, labeled with product identification, manufacturer, batch number and shelf life.
- B. Store products in a dry area with temperature maintained between 50° and 85° F (10° and 29° C) and Protect from direct sunlight.
- C. Handle products in accordance with manufacturer's printed recommendations.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with MVE-control system manufacturer's written instructions for substrate and ambient temperatures, humidity, ventilation, and other conditions affecting system installation.
 - 1. Store system components in a temperature-controlled environment and protected from weather and at ambient temperature of not less than 65 deg F and not more than 85 deg F at least 48 hours before use.
 - 2. Maintain ambient temperature and relative humidity in installation areas within range recommended in writing by MVE-control system manufacturer, but not less than 65 deg F or more than 85 deg F and not less than 40 or more than 60 percent relative humidity, for 48 hours before installation, during installation, and for 48 hours after installation unless longer period is recommended in writing by manufacturer.
 - 3. Install MVE-control systems where concrete surface temperatures will remain a minimum of 5 deg F higher than the dew point for ambient temperature and relative

humidity conditions in installation areas for 48 hours before installation, during installation, and for 48 hours after installation unless longer period is recommended in writing by manufacturer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. MVE-Control System Capabilities: Capable of suppressing MVE without failure where installed on concrete that exhibits the following conditions:
 - 1. MVER: Maximum 25 lb of water/1000 sq. ft. when tested according to ASTM F 1869.
 - 2. Relative Humidity: Maximum 100 percent when tested according to ASTM F 2170 using in situ probes.
- B. Water-Vapor Transmission: Through MVE-control system, maximum 0.06 perm when tested according to ASTM E 96/E 96M.
- C. Tensile Bond Strength: For MVE-control system, greater than 200 psi with failure in the concrete according to ASTM D 7234.

2.2 TOPICAL MOISTURE VAPOR EMISSION SYSTEM

- A. One-Coat Moisture Control System for Concrete to Receive Underlayments and Toppings
 - 1. Basis of Design Products:
 - a. ARDEX MC™ RAPID; Manufactured by ARDEX Engineered Cements: 400 Ardex Park Drive, Aliquippa, Pa 15001 USA 724-203-5000
 - 2. Performance and Physical Properties: Meet or exceed the following values for material cured at 70° F+/-3°F (21° C+/-3°C) and 50% +/-5%relative humidity:
 - a. Application: Manual
 - b. Material Requirements on CSP 3 Prepared Concrete: Max 270 sq. ft. per mixed unit for 10 mils
 - c. Permeability (ASTM E96): <0.1 perms
 - d. 14 pH solution (ASTM D1308): No effect
 - e. Working Time: 20 minutes
 - f. Pot Lift: 20 minutes
 - g. VOC: 0g/L, calculated SCAQMD 1168
 - h. Walkable: Minimum of 4 hours
 - i. Prime and Install Underlayment: Minimum 4 hours, maximum 24 hours

2.3 HYDRAULIC CEMENT UNDERLAYMENT

A. Hydraulic Cement-based Self-Leveling Underlayment.

1. Acceptable Products:

- a. ARDEX K 15[®]; Manufactured by ARDEX Engineered Cements: 400 Ardex Park Drive, Aliquippa, Pa 15001 USA, (724) 203-5000, www.ardex.com

- i. Primer: ARDEX P 82[™] Ultra Prime

- b. ARDEX K 55[™] MICROTEC; Manufactured by ARDEX Engineered Cements: 400 Ardex Park Drive, Aliquippa, Pa 15001 USA, (724) 203-5000, www.ardex.com

- i. Primer: ARDEX P 82[™] Ultra Prime

2. Performance and Physical Properties: Meet or exceed the following values for material cured at 70° F+/-3°F (21° C+/-3°C) and 50% +/-5% relative humidity:

- a. Application: Barrel Mix or Pump.
- b. Flow Time: 10 minutes.
- c. Initial Set: Approx. 30 minutes.
- d. Final Set: Approx. 90 minutes.
- e. Compressive Strength: Minimum 4100 psi at 28 days, ASTM C109M.
- f. Flexural Strength: 1000 psi at 28 days, ASTM C78.
- g. VOC: 0 g/l, calculated SCAQMD 1168.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install MVE-control system according to ASTM F 3010 and manufacturer's written instructions to produce a uniform, monolithic surface free of surface deficiencies such as pin holes, fish eyes, and voids.

- 1. Install primers as required to comply with manufacturer's written instructions.

- B. Do not apply MVE-control system across substrate expansion, isolation, and other moving joints.

- C. Apply system, including component coats if any, in thickness recommended in writing by MVE-control system manufacturer for MVER indicated by pre-installation testing.

- D. Cure MVE-control system components according to manufacturer's written instructions. Prevent contamination or other damage during installation and curing processes.

- E. After curing, examine MVE-control system for surface deficiencies. Repair surface deficiencies according to manufacturer's written instructions.

- F. Install cementitious underlayment over cured membrane if required to maintain manufacturer's warranty and in thickness required to maintain the warranty.

3.2 PREPARATION

- A. Concrete Subfloors: Prepare substrate in accordance with manufacturer's instructions.
 - 1. Prior to proceeding please refer to ASTM F710 Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring. All concrete subfloors must be sound, solid, clean, and free of all oil, grease, dirt, curing compounds and any substance that might act as a bond breaker before application.
 - 2. Mechanical preparation of the surface is required to obtain a minimum ICRI concrete surface profile of 3 (CSP 3). This substrate preparation must be by mechanical means, such as shot blasting.
 - 3. The concrete must have a minimum tensile strength of at least 150 psi for areas to receive normal foot traffic, and 200 psi for area of heavy commercial traffic when tested in accordance with ASTM C1583. The concrete surface can be damp, but must be free of standing water.
 - 4. Prior to beginning the installation, measure the relative humidity within the concrete (ASTM F2170). Alternatively, you can also measure the surface relative humidity in accordance with ASTM F2420. For these relative humidity methods, the RH shall not exceed 100%.
 - 5. If the concrete substrate is too uneven to provide a uniform film thickness of the ARDEX MC™ RAPID (typically CSP 6 or higher), the substrate can be pre-smoothed using ARDEX K 301™ Self-Leveling Exterior Concrete Topping or ARDEX MRP™ Moisture Resistant Patch.
- B. Joint Preparation
 - 1. Moving Joints: Honor all expansion and isolation joints up through the moisture mitigation system and underlayment. A flexible sealing compound such as ARDEX ARDISEAL™ Rapid Plus will be installed at joints.
 - 2. Saw Cuts and Control Joints: Fill all non-moving joints with ARDEX ARDIFIX™ Joint Filler, as recommended by the manufacturer.

3.3 APPLICATION OF ARDEX MC™ RAPID:

- A. Examine substrates and conditions under which materials will be installed. Do not proceed with installation until unsatisfactory conditions are corrected.
- B. Coordinate installation with adjacent work to ensure proper sequence of construction. Protect adjacent areas from contact due to mixing and handling of materials.
- C. Mixing: Comply with manufacturer's printed instructions and the following.
 - 1. Each individual 22lb. unit contains separate, pre-measured quantities of hardener (Part B) and the resin (Part A). After opening each container, stir the individual components thoroughly before blending. The hardening agent (Part B) is added to the resin (Part A).
 - 2. Pour all of the hardener into the resin portion and stir thoroughly for a minimum of 3 minutes using a low speed drill and an epoxy mixing paddle. Once mixed, pour some of

the epoxy back into the hardener container, stir for 10 seconds, and then pour all of the contents back into the resin container. Mix for an additional 30 seconds before applying.

D. Application: Comply with manufacturer's printed instructions and the following.

1. Apply the first coat of freshly mixed ARDEX MC™ RAPID to the prepared concrete surface in a uniform direction at an application rate of up to 270 sq. ft. per unit to achieve a coating thickness of 10 mils. Use a short-nap paint roller or notched squeegee for smoother surfaces, and a longer nap roller for more uneven substrates. To minimize the potential for pinhole formation, work the ARDEX MC™ RAPID into the surface with the roller to ensure maximum penetration. ARDEX MC™ RAPID can also be worked into the surface with a paintbrush for hard to reach areas and corners. Once the area is completely coated, allow to dry for a minimum of 4 hours (max. 24 hours). It is not necessary to re-test the substrate for moisture emissions prior to installing the floor covering.
2. For ARDEX Underlayment applications of ¼" or less, prime the surface of the ARDEX MC™ RAPID with ARDEX P 82™ ULTRA PRIME. Allow the AREX P 82™ ULTRA PRIME to dry thoroughly (min. 3 hours; max. 24 hours) before installing the underlayment.
3. For ARDEX Underlayment applications greater than ¼" (6mm), or if the ARDEX MC™ RAPID was not worked into the surface sufficiently enough to prevent pinholes, a third coat with sand broadcast is needed. No ARDEX P82™ ULTRA PRIME in required.

- a. Working at a 90° angle to the direction the first coat was applied; apply the ARDEX MC™ RAPID at a coverage rate of 10 mils. While this coat is still in a fresh state (maximum 20 minutes), broadcast an excess of fine sand (less than 1/50 of an inch in grain size or 98.5% passing sieve size #35 or #30) consistently over the entire area.

Note: When broadcasting sand, use a NIOSH approved dust mask in conformance with OSHA requirements regarding the handling of sand. Do not stand or walk on the freshly applied epoxy when broadcasting the sand.

- b. Once an area has been completely covered with sand, the surface of the sand can be walked on, being careful not to expose the epoxy at any time. Use approximately 1 lb. of sand per square foot of area. Once the sand broadcast is complete, avoid all traffic over the surface for a minimum of 4 hours.
- c. After 4 hours, broom sweep and vacuum the surface to remove all loose sand. The clean, prepared surface of the sand is the priming system for the ARDEX Underlayment. No additional priming is required.
- d. Following the application of MC RAPID and primer or sand broadcast, install the ARDEX Underlayment, such as ARDEX K 15® Premium Self-Leveling Concrete Underlayment, or Topping in accordance with printed instructions found in the corresponding technical brochure.
- e. It is not necessary to re-test the substrate for moisture emissions prior to installing the coating or floor covering.

3.4 FIELD QUALITY CONTROL

- A. Where specified, field sampling of the Ardex products is to be done by taking an entire unopened bag/unit of the product being installed to an independent testing facility to perform testing. There is no in-situ test method applicable for this system.

3.5 PROTECTION

- A. Prior to the installation of the finish flooring, the surface of the underlayment should be protected from abuse by other trades by the use of plywood, Masonite or other suitable protection course.

END OF SECTION 090561

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
 - 2. Interior suspension systems (e.g., supports for ceilings, suspended soffits, etc.).

- B. Related Requirements:

- 1. Section 092900 "Gypsum Board".

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 NON-LOAD-BEARING STEEL FRAMING, GENERAL

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

- 1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
 - 2. Protective Coating: Meeting requirements of ASTM C645-08; C-channel, roll-formed from hot-dipped galvanized steel; complying with ASTM A1003 and ASTM A653 G40 or equivalent corrosion resistant coating. (NOTE: Galvannealed products are NOT ACCEPTABLE per ASTM C645).

2.2 SUSPENSION SYSTEM COMPONENTS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- (1.59-mm-) diameter wire, or double strand of 0.0475-inch- (1.21-mm-) diameter wire.
- B. Hanger Attachments to Concrete:

1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.
 - a. Type: Postinstalled, expansion anchor.
 2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.
- C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch (4.12-mm) diameter.
- D. Grid Suspension System for Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armstrong World Industries, Inc.; Drywall Grid Systems.
 - b. Chicago Metallic Corporation; Fire Front 650-C Drywall Furring System.
 - c. USG Corporation; Drywall Suspension System.

2.3 STEEL FRAMING FOR FRAMED ASSEMBLIES

- A. Steel Studs and Runners: ASTM C 645.
1. Provide 20 gauge-equivalent framing.
 2. Minimum Base-Metal Thickness: 0.0296 inch (0.75 mm) or members that can show certified third-party testing in accordance with ICC – ES – AC86 that meets ASTM C645-08 Section 9.2.
- B. Slip-Type Head Joints: Where indicated, provide one of the following:
1. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch- (50.8-mm-) deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging, cold-formed channel bridging and spacing bar with clip angles located within 12 inches (305 mm) of the top of studs to provide lateral bracing.
 2. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- (50.8-mm) deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
 3. Deflection Track: Steel sheet top runner 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.
 - a. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

- 1) Dietrich Metal Framing; SLP-TRK® Slotted Deflection Track by Brady Innovations.
 - 2) Steel Network Inc. (The); VertiTrack VTD Series.
 - 3) Superior Metal Trim; Superior Flex Track System (SFT).
- C. Headers and Jambs: Manufacturer's proprietary shape used to form header beams and jambs, columns or posts, of web depths indicated, unpunched, with stiffened flanges.
- D. Flat Strap and Backing Plate: Sheet for bracing in length and width indicated.
1. Galvanized Sheet Steel: Minimum Base-Metal Thickness: 0.0296 inch (0.75 mm).

2.4 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.
1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, furnishings, equipment or similar construction.
- C. Install bracing at terminations in assemblies.

- D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING SUSPENSION SYSTEMS

- A. Install suspension system components in sizes and spacings indicated on Drawings, but not less than those required by referenced installation standards for assembly types and other assembly components indicated.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
 - 3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 - 4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 - 5. Do not attach hangers to steel roof deck.
 - 6. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
 - 7. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Seismic Bracing: Sway-brace suspension systems with hangers used for support.
- 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.

3.5 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.
- B. Install studs so flanges within framing system point in same direction.
- C. Install tracks (runners) 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 penetrating 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 runner track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb, unless otherwise indicated.
 - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (12.7-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
 - 4. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
- D. 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.

END OF SECTION 092216

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Interior gypsum board.
 - 2. Sound attenuation blankets.
 - 3. Acoustical sealant.
- B. Related Sections include the following:
 - 1. Section 061053 "Miscellaneous Carpentry" for wood blocking.
 - 2. Section 092216 "Non-Structural Steel Framing" for non-structural framing and suspension systems that support gypsum board.
 - 3. Section 099000 "Painting" for primers and finish paint applied to gypsum board surfaces.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes. Stack panels flat to prevent sagging.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Do not install interior products until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.

2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. 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.

2.2 PANELS, GENERAL

- A. Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. American Gypsum Co.
 2. CertainTeed Corporation.
 3. Georgia Pacific Building Products.
 4. National Gypsum Company.
 5. USG Corporation.
- B. Gypsum Board, Type X: ASTM C 1396/C 1396M.
 1. Thickness: 5/8 inch (15.9 mm) unless noted otherwise.
 2. Long Edges: Tapered.

2.4 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
 1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, or paper-faced galvanized steel sheet. All interior trim is tapeable. Plastic trim is permitted only for tear-away tapeable trim.
 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. Pre-Mask L Bead: Exposed flange receives joint compound with pull-away strip.

- f. Tear-Away L Bead: Exposed flange receives joint compound with tear-away strip for use when abutting smooth dissimilar material such as aluminum window frames.

2.5 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
 - 1. Interior Gypsum Wallboard: Paper.
- C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
 - 1. Prefilling: At open joints 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 drying-type, all-purpose compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 - 3. Fill Coat: For second coat, use drying-type, all-purpose compound.
 - 4. Finish Coat: For finish coats, sandable topping compound.

2.6 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. 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.
- C. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining urea formaldehyde free thermosetting resins with mineral fibers manufactured from slag wool or rock wool.
- D. Acoustical Sealant:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Accumetric LLC.
 - b. Grabber Construction Products.
 - c. Pecora Corporation.
 - d. Specified Technologies, Inc.
 - e. Tremco Inc., Tremco Acoustical Sealant.
 - f. United State Gypsum Company.

- g. USG Acoustical Sealant.
- 2. Acoustical Sealant for Exposed and Concealed Joints: Non-sag, paintable, nonstaining, latex sealant, with a VOC content of 250 g/l or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), complying with ASTM C 834 that effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames and framing, for compliance with requirements and other conditions affecting performance.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Install 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.
- C. 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.
- D. Form control and expansion joints with space between edges of adjoining gypsum panels.
- E. 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.
- F. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4-inch wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

- G. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- H. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
 - 1. Type X: All surfaces, unless otherwise indicated.
- B. Single-Layer Application:
 - 1. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - 5. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
 - 6. Install gypsum panels with uniform 1/4" gap between bottom of panels and concrete slab.

3.4 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints 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. Pre-Mask L Bead: Use at transitions to dissimilar materials and as indicated.

3.5 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, rounded or beveled edges, and damaged surface areas.

- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and areas to be fire taped only.
 - 2. Level 4: At panel surfaces that will be exposed to view, unless otherwise indicated.
 - 3. Level 5: At panel surfaces at Immersive Lab 240.
- E. Provide smooth, uniform surface behind base.

3.6 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 092900

SECTION 095120 - ACOUSTICAL TILE CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Acoustical tile ceilings and suspension systems.
 - 2. Wood slat acoustic ceiling and suspension system.
- B. Related Sections: The following sections contain requirements that relate to this section:
 - 1. Section 012300 "Alternates".
 - 2. Division 15 Sections and drawings for grilles, registers, and diffusers in acoustical ceilings.
 - 3. Division 16 Section "Lighting" for lighting fixtures in acoustical ceilings.

1.3 DEFINITIONS

- A. AC: Articulation Class.
- B. CAC: Ceiling Attenuation Class.
- C. LR: Light Reflectance coefficient.
- D. NRC: Noise Reduction Coefficient.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
 - 1. Manufacturers' product data for each product specified, including printed statement of VOC content and material safety data sheets.
 - 2. Manufacturers' product data indicating recycled content.
- B. Samples for Initial Selection: For components with factory-applied color finishes.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has successfully completed acoustical ceilings similar in material, design, and extent to that indicated for Project.
- B. Single-Source Responsibility for Ceiling Units and Suspension System: Obtain each type of

acoustical ceiling unit and suspension grid from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.

- C. Coordination of Work: Coordinate layout and installation of acoustical ceiling units and suspension system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system components, and partition system.
- D. Fire-Test-Response Characteristics: Provide acoustical panel ceilings that comply with the following requirements:
 - 1. Surface-burning characteristics of acoustical panels comply with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84.
 - a. Smoke Developed Index: 450 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical ceiling units to project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical ceiling units, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical ceiling units carefully to avoid chipping edges or damaging units in any way.

1.7 PROJECT CONDITIONS

- A. Space Enclosure: Do not install interior acoustical ceilings until space is enclosed and weatherproof, wet work in space is completed and nominally dry, work above ceilings is complete, and ambient conditions of temperature and humidity will be continuously maintained at values near those indicated for final occupancy.

1.8 EXTRA MATERIALS

- A. Submit extra materials to Owner. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with appropriate labels.
 - 1. Acoustical Ceiling Units: Furnish quantity of full-size units equal to 2.0 percent of each type of amount installed.

1.9 COORDINATION

- A. Coordinate layout and installation of acoustical panels and suspension system with other

construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 ACOUSTICAL CEILING UNITS, GENERAL

- A. Standard for Acoustical Ceiling Units: Provide manufacturers' standard units of configuration indicated that comply with ASTM E 1264 classifications as designated by reference to types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.
- B. Provide fire resistance rated assemblies where scheduled and indicated.
- C. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.

2.2 ACOUSTICAL CEILING TILES

- A. Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to the following:
 - a. Armstrong World Industries.
- B. See the Room Finish Schedule for Ceiling type, size and height for each room.
- C. The following schedule is based on products manufactured by Armstrong World Industries.

SUSPENDED ACOUSTIC CEILING SCHEDULE

TYPE	FIRE RESISTANCE SYSTEM	SIZE/ ACOUSTIC PERFORMANCE	EDGE	PATTERN	COLOR
1	Non-Rated	2 x 2 LR: Not less than 0.82. NRC: Not less than 0.70. CAC: Not less than 35. Recycled Content: Not less than 70%.	Tegular on exposed 9/16" Suprafine Exposed Tee System	Cirrus Beveled Tegular, Thickness: 5/8"	White Black @ Immersive Lab 240
2	Class A Rating	24" x 48" Panel with 1/2" x 1-1/2" (12) Vertical Slats with Black Bio Acoustic Infill Batt, 5823, 5/8" thick	15/16" Tegular Suspension; Color: Black	Woodworks Grille Tegular Vertical Slats	Red Oak (GRK), Solid Wood Finish

2.3 METAL SUSPENSION SYSTEMS, GENERAL

- A. Standard for Metal Suspension Systems: Provide manufacturer's standard concealed metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable ASTM C 635 requirements.
- B. Finishes and Colors: Provide manufacturer's standard factory-applied finish for exposed moldings.
 - 1. Color of exposed suspension components will match the ceiling tile color.
- C. Attachment Devices: Size for 5 times design load indicated in ASTM C 635, Table 1, Direct Hung, unless otherwise indicated.
- D. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft temper.
 - 1. Gage: Provide wire sized so that stress at 3 times hanger design load (ASTM C 635, Table 1, Direct-Hung) will be less than yield stress of wire, but provide not less than 0.106-inch diameter (12-gage).
- E. Edge Moldings and Trim: Metal of types and profiles indicated or, if not indicated, provide manufacturer's standard molding for edges and penetrations of ceiling that fits with type of edge detail and suspension system indicated.
 - 1. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

2.4 SUSPENSION SYSTEMS

- A. Direct-Hung Double-Web Suspension System: Main and cross runners roll-formed from and capped with electrolytic zinc-coated cold-rolled steel sheet; other characteristics as follows:
 - 1. Structural Classification: Intermediate duty, as needed to adequately support the ceiling system, lighting, diffusers and other ceiling supported items.
 - 2. Some ceiling areas have congested mechanical and electrical systems above and may require intermediate support systems. (See the mechanical and electrical drawings).
 - 3. Paint: Factory applied baked polyester finish to match ceiling tiles exactly.
 - 4. Fire-resistance rated and non-fire-resistance rated systems as scheduled and indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and structural framing to which ceiling system attaches or abuts, with Installer present, for compliance with requirements specified in this and other sections that affect installation and anchorage of ceiling system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Coordination: Furnish layouts for preset inserts, clips, and other ceiling anchors whose

installation is specified in other sections.

- B. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less-than-half-width units at borders, and comply with reflected ceiling plans.

3.3 ABOVE-CEILING INSPECTION

- A. Installation of ceiling system may not begin until above-ceiling inspection by Owner and Architect is complete and all work above the ceiling is complete and has been verified by the Architect.
- B. Schedule above-ceiling inspection a minimum 7 days before it is needed. Allow additional time for completion of Punch List work.

3.4 INSTALLATION

- A. General: Install acoustical ceiling systems to comply with installation standard below per manufacturer's instructions and Cisca "Ceiling Systems Handbook."
 - 1. Standard for Installation of Ceiling Suspension Systems: Comply with ASTM C 636.
 - 2. Standards for Installation of Ceiling Suspension Systems: Comply with ASTM C 636 and ASTM E 580 as applicable to acoustical snap-in metal pan ceilings.
- B. Arrange acoustical units and orient directionally patterned units (if any) as instructed by Architect in the field.
- C. Suspend ceiling hangers from building structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the 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 referenced standards.
 - 3. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eyescrews, or other devices that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - 4. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eyescrews, or other devices that are secure and appropriate for structure to which hangers are attached as well as for type of hanger involved, and in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
 - 5. When steel framing does not permit installation of hanger wires at spacing required,

- install carrying channels or other supplemental support for attachment of hanger wires.
- 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 inches (1200 mm) o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
- 9. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs.
- D. Install edge moldings of type indicated at perimeter of acoustical ceiling area and at locations where necessary to conceal edges of acoustical units.
 - 1. Field cut tegular edges at all perimeters, and field paint any visible cut edges to match color of tile.
 - 2. Attach moldings to substrate at intervals not over 16 inches (o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to tolerance of 1/8 inch in 12'-0". Miter corners accurately and connect securely.
 - 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Protect lighting fixtures and air ducts to comply with requirements of UL testing designs for fire-resistance-rated assemblies.
- F. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- G. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
 - 1. Arrange directionally patterned acoustical panels as follows:
 - a. Install panels with pattern running in one direction parallel to short axis of space.
 - 2. For reveal-edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
 - 3. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

3.5 CLEANING

- A. Clean exposed surfaces of acoustical ceilings, including trim, edge moldings, and suspension members. Comply with manufacturer's instructions for cleaning and touch-up of minor finish damage. Remove and replace work that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095120

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Resilient base.
 - 2. Resilient molding accessories.

1.3 ACTION SUBMITTALS

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

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C).

1.5 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive resilient products during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
- C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 THERMOPLASTIC-RUBBER BASE

- 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. AB: American Biltrite.
 - 2. Allstate Rubber Corp.
 - 3. Armstrong World Industries, Inc.
 - 4. Johnsonite; a Tarkett company.
 - 5. Nora Systems, Inc.
 - 6. Roppe Corporation, USA.
- B. Product Standard: ASTM F 1861, Type TP (rubber, thermoplastic).
 - 1. Group: I (solid, homogeneous).
 - 2. Style and Location:
 - a. Style B, Cove.
- C. Thickness: 0.125 inch (3.2 mm).
- D. Height: 4 inches (102 mm).
- E. Lengths: Coils in manufacturer's standard length.
- F. Outside Corners: Job formed.
- G. Inside Corners: Job formed.
- H. Colors: As selected by Architect from full range of manufacturer's colors.

2.2 INSTALLATION MATERIALS

- A. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.
 - 1. Adhesives shall have a VOC content of 50 g/L or less, except that adhesive for rubber stair treads shall have a VOC content of 60 g/L or less.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- C. Do not install resilient products until they are the same temperature as the space where they are to be installed.
 1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
- D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Job-Formed Corners:
 1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches (76 mm) in length.
 - a. Form without producing discoloration (whitening) at bends.

2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches (76 mm) in length.
 - a. Miter or cope corners to minimize open joints.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient-product installation:
 1. Remove adhesive and other blemishes from exposed surfaces.
- C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

END OF SECTION 096513

SECTION 096519 - RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Vinyl composition floor tile.
- B. Related Requirements:
 - 1. Section 012300 "Alternates".
 - 2. Section 090561 "Moisture Vapor Emission Control".
 - 3. Section 096513 "Resilient Base and Accessories".

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Initial Selection: For each type of floor tile indicated.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of floor tile to include in maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C). Store floor tiles on flat surfaces.

1.6 FIELD CONDITIONS

- A. Close spaces to traffic during floor tile installation.
- B. Close spaces to traffic for 48 hours after floor tile installation.

- C. Install floor tile after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 VINYL COMPOSITION FLOOR TILE

- A. Wearing Surface: Smooth.
- B. Thickness: 0.125 inch (3.2 mm).
- C. Size: 12 by 12 inches (305 by 305 mm).
- D. Colors and Patterns: From manufacturer's full range.

2.2 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
- C. Floor Polish: Provide protective, liquid floor-polish products. Use same product as Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.

2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install floor tiles until materials are the same temperature as space where they are to be installed.
 1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.3 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Lay out floor tiles to match existing.
- C. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- D. Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.
- B. Perform the following operations immediately after completing floor tile installation:
 1. Remove adhesive and other blemishes from surfaces.
 2. Sweep and vacuum surfaces thoroughly.
 3. Damp-mop surfaces to remove marks and soil.
- C. Protect floor tile from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish: Remove soil, adhesive, and blemishes from floor tile surfaces before applying liquid floor polish.
 1. Apply one coat.

END OF SECTION 096519

SECTION 096543 - LINOLEUM FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes linoleum sheet flooring.
- B. Related Requirements:
 - 1. Section 012300 "Alternates".
 - 2. Section 090561 "Moisture Vapor Emissions".
 - 3. Section 096513 "Resilient Base and Accessories".

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of linoleum flooring. Include flooring layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
- C. Samples for Initial Selection: For each type of linoleum flooring indicated.
 - 1. Heat-Welding Bead: Include manufacturer's standard-size Samples, but not less than 9 inches long, of each color required.
- D. Heat-Welded Seam Samples: For each linoleum flooring product and welding bead color and pattern combination required; with seam running lengthwise and in center of 6-by-9-inch Sample applied to rigid backing and prepared by Installer for this Project.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of linoleum flooring to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for flooring installation.
 - 1. Engage an installer who employs workers for this Project who are trained or certified by flooring manufacturer for installation techniques required.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store flooring and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 65 deg F (18 deg C) or more than 90 deg F (32 deg C).
 - 1. Floor Tile: Store on flat surfaces.
 - 2. Sheet Flooring: Store rolls upright.

1.7 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive flooring during the following time periods:
 - 1. 72 hours before installation.
 - 2. During installation.
 - 3. 72 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer.
- C. Close spaces to traffic during flooring installation.
- D. Close spaces to traffic for 72 hours after flooring installation.
- E. Install flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For linoleum flooring, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 LINOLEUM SHEET FLOORING

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Forbo Flooring, Inc.
- B. Linoleum Sheet Flooring: ASTM F 2034, Type I, linoleum sheet with backing.
 - 1. Roll Size: In manufacturer's standard length but not less than 78 inches wide.
- C. Thickness: 0.10 inch.

- D. Heat-Welding Bead: For seamless installation, solid-strand product of linoleum flooring manufacturer.
 - 1. Color: As selected by Architect from manufacturer's full range to contrast with linoleum flooring.
- E. Colors and Patterns: As selected by Architect from full range of manufacturer's colors.

2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by linoleum flooring manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by flooring and adhesive manufacturers to suit products and substrate conditions indicated.
 - 1. Use adhesives that have a VOC content of not more than 50 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of flooring.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to linoleum flooring manufacturer's written instructions to ensure adhesion of flooring.
- B. Concrete Substrates: Prepare according to ASTM F 710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with flooring adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by linoleum flooring manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by linoleum flooring manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing.
 - 4. Moisture Testing: Perform tests recommended by linoleum flooring manufacturer, but not less stringent than the following:

- a. Perform anhydrous calcium chloride test according to ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
 - b. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level.
 - c. Based on the test results, the Owner may elect to install a Moisture Vapor Emission Control system under Bid Option #3.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install flooring until it is the same temperature as space where it is to be installed.
 - 1. At least 72 hours in advance of installation, move flooring and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by flooring.

3.3 INSTALLATION, GENERAL

- A. Comply with manufacturer's written instructions for installing flooring.
- B. Scribe and cut flooring to butt neatly and tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings.
- C. Extend flooring into toe spaces, door reveals, closets, and similar openings.
- D. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on flooring as marked on substrates. Use chalk or other nonpermanent marking device.
- E. Install flooring on covers for telephone and electrical ducts and similar items in finished floor areas. Maintain overall continuity of color and pattern between pieces of flooring installed on covers and adjoining flooring. Tightly adhere flooring edges to substrates that abut covers and to cover perimeters.
- F. Adhere flooring to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- G. Heat-Welded Seams: For seamless installation, comply with ASTM F 1516. Rout joints and heat weld with welding bead to permanently fuse sections into a seamless flooring. Prepare, weld, and finish seams to produce surfaces flush with adjoining flooring surfaces.

3.4 LINOLEUM SHEET FLOORING INSTALLATION

- A. Unroll linoleum sheet flooring and allow it to stabilize before cutting and fitting.
- B. Lay out linoleum sheet flooring as follows:

1. Maintain uniformity of flooring direction.
2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches (152 mm) away from parallel joints in flooring substrates.
3. Match edges of flooring for color shading at seams.
4. Avoid cross seams.
5. Eliminate deformations that result from hanging method used during drying process (stove bar marks).

3.5 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting linoleum flooring.
- B. Perform the following operations immediately after completing linoleum flooring installation:
 1. Remove adhesive and other blemishes from exposed surfaces.
 2. Sweep and vacuum surfaces thoroughly.
 3. Damp-mop surfaces to remove marks and soil.
- C. Protect linoleum flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

END OF SECTION 096543

SECTION 096810 - CARPET TILE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes modular carpet tile to be installed over existing concrete slabs after existing finishes are removed.
- B. Related Requirements:
 - 1. Section 012300 "Alternates".
 - 2. Section 090561 "Moisture Vapor Emission Control".
 - 3. Section 096513 "Resilient Floor Tile and Accessories" for rubber base transition strips.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
 - 2. Include installation recommendations.
- B. Shop Drawings: Show the following:
 - 1. Carpet tile color.
 - 2. Type of installation.
 - 3. Pattern of installation.
 - 4. Type, color, and location of edge, transition, and other accessory strips.
- C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
 - 1. Carpet Tile: Full-size Sample.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
 - 1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
 - 2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd. (8.3 sq. m).

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI 104.

1.8 FIELD CONDITIONS

- A. Comply with CRI 104 for temperature, humidity, and ventilation limitations.
- B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at occupancy levels during the remainder of the construction period.
- C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.

1.9 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
 - 1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
 - 2. Failures include, but are not limited to, more than 10 percent edge raveling, snags, runs, dimensional stability, excess static discharge, loss of tuft bind strength, loss of face fiber, and delamination.
 - 3. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE

- A. Products: Subject to compliance with requirements, provide the following:

1. Carpet, Type 1: J&J Flooring, Kinetex Mirror Image Collection, 'Carbon Copy' 1854, 24" x 24" with polyester felt cushion, select from manufacturer's standard ranges and colors.
2. Carpet, Type 2: J&J Flooring, Kinetex 'Soundtrack' 1847, 24" x 24" with polyester felt cushion, select from manufacturer's standard ranges and colors.

2.2 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, non-staining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.
 1. Adhesives shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Adhesives 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."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance. Examine carpet tile for type, color, pattern, and potential defects.
- B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:
 1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet tile manufacturer.
 2. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
 - a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with application of resinous flooring only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. of slab area in 24 hours.
 - b. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

3.2 PREPARATION

- A. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.

- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider and protrusions more than 1/32 inch (0.8 mm) unless more stringent requirements are required by manufacturer's written instructions.
- C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

- A. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: As recommended in writing by carpet tile manufacturer.
- C. Maintain dye lot integrity. Do not mix dye lots in same area.
- D. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- E. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use non-permanent, non-staining marking device.
- G. Install pattern parallel to walls and borders.

3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer.
 - 2. Remove yarns that protrude from carpet tile surface.
 - 3. Vacuum carpet tile using commercial machine with face-beater element.
- B. Protect installed carpet tile to comply with CRI 104, Section 16, "Protecting Indoor Installations."
- C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 096810

SECTION 099000 - PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including Division 1 Specification sections, apply to this section.

1.2 SUMMARY

- A. This Section includes surface preparation, painting, and finishing of exposed interior and exterior items and surfaces.
 - 1. Surface preparation, priming, and finish coats specified in this section are in addition to shop priming and surface treatment specified under other sections.
- B. Paint exposed interior surfaces whether or not colors are designated in "schedules", except where a surface or material is specifically indicated not to be painted or is to remain natural. Where an item or surface is not specifically mentioned, paint the same as similar adjacent materials or surfaces. If color or finish is not designated, the Architect will select from standard colors or finishes available.
 - 1. Painting includes field painting exposed bare and covered pipes and ducts, hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment that do not have a factory applied final finish in finished spaces only (not in mechanical/electrical/data rooms).
- C. Painting is not required on prefinished items, finished metal surfaces, concealed surfaces, operating parts, and labels.
 - 1. Labels: Do not paint over Underwriter's Laboratories, Factory Mutual or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.
- D. Related Sections: The following sections contain requirements that relate to this section:
 - 1. Section 081213 "Hollow Metal Frames" for shop priming steel frames.
 - 2. Section 081416 "Flush Wood Doors" for factory finishing.
 - 3. Section 062023 "Interior Finish Carpentry" for shop finishing of wood cabinets.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's technical information, label analysis, and application instructions and VOC content for each material proposed for use.

1. List each material and cross-reference the specific coating and finish system and application. Identify each material by the manufacturer's catalog number and general classification.
- B. Samples for initial color selection in the form of manufacturer's color charts.
 1. After color selection, the Architect will furnish color chips for surfaces to be coated.
- C. Samples for verification purposes: Provide samples of each color and material to be applied, with texture to simulate actual conditions, on representative samples of the actual substrate. Define each separate coat, including primers. Use representative colors when preparing samples for review. Resubmit until required sheen, color, and texture area.
 1. Provide a list of material and application for each coat of each sample. Each sample as to location and application.

1.4 QUALITY ASSURANCE

- A. Single-Source Responsibility: Provide primers and block fillers produced by the same manufacturer as the finish coats.
- B. Coordination of Work: Review other sections in which primers are provided to ensure compatibility of the total systems for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
 1. Notify the Architect of problems anticipated using the materials specified.
- C. Field Samples: On wall surfaces and other exterior and interior components, duplicate finishes of prepared samples. Provide full coat finish samples on at least 100 sq. ft. of surface until required sheen, color and texture are obtained. Simulate finished lighting conditions for review of in-place work.
 1. Final acceptance of colors will be from job-applied field samples.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the job site in the manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:
- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 degrees F. Maintain containers used in storage in a clean condition, free of foreign materials and residue.
 1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.6 JOB CONDITIONS

- A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 degrees F and 90 degrees F.

- B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45 degrees F and 95 degrees F.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Manufacturers: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - 1. Benjamin Moore Paint Co.

2.2 PAINT MATERIALS, GENERAL

- A. Material Compatibility: Provide primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
- B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
- C. Chemical Components of Interior Paints and Coatings: Provide products that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and the following chemical restrictions:
 - 1. Flat Paints and Coatings: VOC content of not more than 50 g/L.
 - 2. Non-Flat Paints and Coatings: VOC content of not more than 150 g/L.
 - 3. Anticorrosive Coatings: VOC content of not more than 250 g/L.
 - 4. Varnishes and Sanding Sealers: VOC content of not more than 350 g/L.
 - 5. Stains: VOC content of not more than 250 g/L.
 - 6. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).

2.3 PRIMERS

- A. Interior Gypsum Board Primer: Factory-formulated latex-based primer for interior application.
 - 1. Benjamin Moore; Fresh Start Multi-Purpose Interior Latex Primer (N023): Applied at a dry film thickness of not less than 1.3 mils.

2.4 INTERIOR FINISH PAINT MATERIAL

- A. Latex-Based Interior Eggshell Paint: Latex-based paint for use as an eggshell finish over prime-coated gypsum drywall:

1. Benjamin Moore; Aura Interior Latex Eggshell (N524): Applied at a dry film thickness of not less than 1.6 mils (0.041 mm).
- B. Semi-Gloss Acrylic Latex: For use on primed ferrous metal surfaces, opaque finish.
 1. Benjamin Moore; DTM Acrylic Semi-Gloss (P29): Applied at a dry film thickness of not less than 1.5 mils.
- C. Interior Waterborne Clear Satin Varnish: Factory formulated clear low luster acrylic based polyurethane varnish on wood to receive a transparent finish.
 1. Benjamin Moore; Stays Clear Acrylic Polyurethane, low luster (423).
- D. Interior Waterborne Stain: Flat.
 1. Benjamin Moore; Interior Wood Finishes Waterborne Stain (205).

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions under which painting will be performed for compliance with requirements for application of paint. Do not begin paint application until unsatisfactory conditions have been corrected and surfaces to receive paint are thoroughly dry.
 1. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

3.2 PREPARATION

- A. General Procedures: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items in place that are not to be painted, or provide surface-applied protection prior to surface preparation and painting. Remove these items if necessary for complete painting of the items and adjacent surfaces. Following completion of painting operations in each space or area, have items reinstalled by workers skilled in the trades involved.
- B. Cleaning: Before applying paint or other surface treatments, clean substrates of substances that could impair bond of the various coatings. Remove oil and grease before cleaning.
 1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
- C. Surface Preparation: Clean and prepare surfaces to be painted in accordance with the manufacturer's instructions for each particular substrate condition and as specified.
 1. Provide barrier coats over incompatible primers or remove and reprime. Notify Architect in writing of problems anticipated with using the specified finish-coat material with substrates primed by others.
 2. Ferrous Metals: Clean non-galvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or

- mechanical cleaning methods that comply with recommendations of the Steel Structures Painting Council.
- a. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by the paint manufacturer, and touch up with the same primer as the shop coat.
- D. Materials Preparation: Carefully mix and prepare paint materials in accordance with manufacturer's directions.
1. Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue.
 2. Stir material before application to produce a mixture of uniform density; stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.
 3. Use only thinners approved by the paint manufacturer, and only within recommended limits.
- E. Tinting: Tint primer to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.3 APPLICATION

- A. Apply paint in accordance with manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied.
- B. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
1. Surface treatments, and finishes are indicated in "Schedules."
 2. Provide finish coats that are compatible with primers used.
 3. The number of coats and film thickness required is the same regardless of the application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. Sand between applications where sanding is required to produce an even smooth surface in accordance with the manufacturer's directions.
 4. Apply additional coats when undercoats, stains, or other conditions show through final coat of paint until paint film is of uniform finish, color, and appearance. Give special attention to ensure that surfaces, including edges, corners, crevices, welds, and exposed fasteners, receive a dry film thickness equivalent to that of flat surfaces.
 5. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convactor covers, covers for finned tube radiation, grilles, and similar components are in place. Extend coatings in these areas as required to maintain the system integrity and provide desired protection.
 6. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Paint surfaces behind permanently fixed equipment or furniture with prime coat only before final installation of equipment.
 7. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint.
 8. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
 9. Omit primer on metal surfaces that have been shop-primed and touch up painted unless a non-compatible primer has been used.

- C. Items such as primed grilles, louvers, and vents requiring field painting will be painted in controlled dust free environment by low pressure spray or electrostatic painting process.
- D. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
 - 1. Allow sufficient time between successive coats to permit proper drying. Do not recoat until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure and where application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.
- E. Exposed mechanical items to be painted include but are not limited to:
 - 1. Mechanical equipment that is indicated to have a factory-primed finish for field painting.
 - 2. Accessory items.
 - 3. Access doors.
 - 4. Primed louvers.
 - 5. Exposed piping and conduit.
- F. Electrical items to be painted include but are not limited to items exposed in occupied spaces.
- G. Prime Coats: Before applying finish coats, apply a prime coat, as recommended by manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.
- H. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.
- I. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.4 CLEANING

- A. Cleanup: At the end of each work day, remove empty cans, rags, rubbish, and other discarded paint materials from the site.
- B. Upon completion of painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping, using care not to scratch or damage adjacent finished surfaces.

3.5 PROTECTION

- A. Protect work of other trades, whether to be painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as acceptable to Owner.
- B. Provide "wet paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their work after completion of painting operations.
 - 1. At completion of construction activities of other trades, touch up and restore damaged or

defaced painted surfaces.

3.8 INTERIOR PAINT SCHEDULE

- A. General: The following paint systems for various substrates are based on Benjamin Moore recommendations.
- B. Gypsum Drywall Systems:
 - 1. Eggshell Latex Finish on New and Existing Gypsum Board: 2 coats on primer.
 - a. Primer: Latex primer (tinted).
 - b. First Coat: Latex-Based Interior Eggshell Paint.
 - c. Second Coat: Latex-Based Interior Eggshell Paint.
- C. Ferrous Metal Opaque Finish: Provide the following system over primed and painted ferrous metal.
 - 1. Semi-gloss acrylic enamel finish: Two finish coats over primer.
 - a. First Coat: Universal Metal Primer.
 - b. Second Coat: Semi-Gloss DTM Acrylic Coating.
 - c. Third Coat: Semi-Gloss DTM Acrylic Coating (new ferrous metal only).
- D. Natural-Finish Woodwork (New): Provide the following finish systems over natural finished woodwork:
 - 1. Polyurethane Finish: 3 finish coats.
 - a. First Coat: Transparent stain, as required to match existing transparent finished wood trim.
 - b. Second Coat: Interior Waterborne Clear Satin Varnish.
 - c. Third Coat: Interior Waterborne Clear Satin Varnish.
 - d. Fourth Coat: Interior Waterborne Clear Satin Varnish.

END OF SECTION 099000

SECTION 101000 - VISUAL DISPLAY BOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Porcelain enamel markerboards.

1.3 SUBMITTALS

- A. Product Data: For each type of visual display board indicated.
- B. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors and textures available for the following:
 - 1. Markerboards: Actual sections of porcelain enamel finish for each type of markerboard required.
- C. Shop Drawings: For visual display units.
 - 1. Include plans, elevations, sections, details and attachment to other work.
 - 2. Show locations of panel joints.
 - 3. Include sections of typical trim members.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who is an authorized representative of all visual display boards manufacturer for both installation and maintenance.
- B. Source Limitations: Obtain visual display boards through one source from a single manufacturer.

1.5 PROJECT CONDITIONS

- A. Field Measurements: Verify field measurements before preparation of Shop Drawings and before fabrication to ensure proper fitting. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.
2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating boards without field measurements. Coordinate wall construction to ensure actual dimensions correspond to established dimensions.

1.6 WARRANTY

- A. Porcelain Enamel Markerboard Warranty: Submit a written warranty executed by manufacturer agreeing to replace porcelain enamel boards that do not retain their original writing and erasing qualities, become slick and shiny, or exhibit crazing, cracking, or flaking within the specified warranty period, provided the manufacturer's written instructions for handling, installation, protection, and maintenance have been followed.
 1. Warranty Period: 50 years from date of Project Acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Porcelain Enamel Markerboards:
 - a. Best-Rite Chalkboard Co.
 - b. Carolina Chalkboard Co.
 - c. Claridge Products and Equipment, Inc.
 - d. Greensteel, Inc.

2.2 PORCELAIN ENAMEL MARKERBOARD

- A. Porcelain Enamel Markerboards: Balanced, high-pressure, factory-laminated, porcelain enamel markerboards of 3-ply construction consisting of face sheet, core material, and backing.
 1. Surface Face Sheet: Enameling grade steel coated with LCS 3 porcelain enamel, or equal, 3-coat process. Low-gloss LCS surface.
 2. Color: White.
 3. Core: 7/16" MDF core, formaldehyde free with vapor barrier.
 4. Trim: 5/16" aluminum-face trim, satin anodized finish, with full length 2-1/2" marker tray.
 5. Size: See Drawings for sizes.
 6. Joints: Concealed spline joints, see Interior Elevation Drawings for locations.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine wall surfaces, with Installer present, for compliance with requirements and other conditions affecting installation of visual display boards.
 - 1. Surfaces to receive markerboards shall be free of dirt, scaling paint, and projections or depressions that would affect smooth, finished surfaces of markerboards.
 - 2. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Deliver factory-built visual display boards completely assembled in one piece without joints, where possible. If dimensions exceed panel size, provide 2 or more pieces of equal length as acceptable to Architect. When overall dimensions require delivery in separate units, prefabricate components at the factory, disassemble for delivery, and make final joints at the site. Use splines at joints to maintain surface alignment.
- B. Install units in locations and at mounting heights indicated and according to manufacturer's written instructions. Keep perimeter lines straight, plumb, and level. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
- C. Coordinate Project-site-assembled units with grounds, trim, and accessories. Join parts with a neat, precision fit.

3.3 ADJUSTING AND CLEANING

- A. Verify that accessories required for each unit have been properly installed and that operating units function properly.
- B. Clean units according to manufacturer's written instructions.

END OF SECTION 101000

SECTION 102123 - CUBICLE CURTAINS AND TRACK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cubicle-curtain support systems.
2. Cubicle curtains.

B. Related Requirements:

1. Section 061053 "Miscellaneous Carpentry" for supplementary wood framing and blocking for mounting items requiring anchorage.
2. Section 092216 "Non-Structural Metal Framing" for supplementary metal framing and blocking for mounting items requiring anchorage.
3. Section 095120 "Acoustic Tile Ceilings".

1.2 ACTION SUBMITTALS

A. Product Data:

1. Cubicle-curtain support systems.
2. Cubicle curtains.

B. Product Data Submittals: For each product.

1. For each type of curtain fabric indicated, include durability, laundry temperature limits, fade resistance, applied curtain treatments, and fire-test-response characteristics.

C. Shop Drawings: For curtains and tracks.

1. Show layout and types of cubicles, sizes of curtains, number of carriers, anchorage details, and conditions requiring accessories. Indicate dimensions taken from field measurements.
2. Include details of blocking for track support.

D. Samples for Verification: For each type of product required, prepared on Samples of size indicated below:

1. Curtain Fabric: Not less than 10 inches square and showing complete pattern repeat, from dye lot used for the Work, with specified treatments applied. Mark top and face of material.
2. Mesh Top: Not less than 10 inches square.
3. Curtain Track: Not less than 10 inches long.
4. Curtain Carrier: Full-size unit.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For curtains, tracks, and hardware to include in operation and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Curtain Carriers and Track End Caps: Full-size units equal to 3 percent of amount installed for each size indicated, but no fewer than 1 unit.
 - 2. Curtains: Full-size units equal to 10 percent of amount installed for each size indicated, but no fewer than 1 unit.

PART 2 - PRODUCTS

2.1 CUBICLE-CURTAIN SUPPORT SYSTEMS

- A. Extruded-Aluminum Curtain Track: Not less than 1 inches wide by 3/4 inch high.
 - 1. Track Minimum Wall Thickness: 0.050 inch.
 - 2. Finish: Baked Acrylic Enamel, Color: White.
- B. Curtain-Track Mounting: Ceiling grid clips.
- C. Curtain-Track Accessories: Fabricate splices, end caps, connectors, end stops, coupling and joining sleeves, wall flanges, brackets, ceiling clips, and other accessories from same material and with same finish as track.
- D. Curtain Glide Carriers: One-piece nylon glide with nylon hook.
- E. Exposed Fasteners: Stainless steel.

2.2 CUBICLE CURTAINS

- A. Fabric: Curtain manufacturer's standard, 100 percent polyester; inherently and permanently flame resistant, stain resistant, and antimicrobial.
 - 1. Color & Pattern: As selected by Architect from manufacturer's full range.
- B. Curtain Grommets: Two-piece, rolled-edge, rustproof, nickel-plated brass; spaced not more than 6 inches o.c.; machined into top hem.
- C. Mesh Top: Not less than 20-inch high mesh top.
 - 1. Mesh: No. 50 nylon mesh.

2.3 CURTAIN FABRICATION

A. Continuous Curtain Panels:

1. Width: Equal to track length from which curtain is hung plus 10 percent of added fullness, but not less than 12 inches of added fullness.
2. Length: Equal to floor-to-ceiling height, minus depth of track and carrier at top, and minus clearance above the finished floor of 12 inches.
3. Mesh Top: Top hem of mesh not less than 1 inch and not more than 1-1/2 inches wide, triple thickness, reinforced with integral web, and double lockstitched. Double lockstitch bottom of mesh directly to 1/2-inch triple thickness, top hem of curtain fabric.
4. Bottom Hem: Not less than 1 inch and not more than 1-1/2 inches wide, double thickness and single lockstitched.
5. Side Hems: Not less than 1/2 inch and not more than 1-1/4 inches wide, with double turned edges, and single lockstitched.
6. Vertical Seams: Not less than 1/2 inch wide, double turned and double stitched.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install tracks level and plumb, according to manufacturer's written instructions.
- B. For tracks of up to 20 feet in length, provide track fabricated from single, continuous length.
 1. Curtain-Track Mounting: Surface.
- C. Surface-Track Mounting: Fasten tracks to ceilings at intervals recommended by manufacturer. Fasten tracks to structure at each splice and tangent point of each corner. Center fasteners in track to ensure unencumbered carrier operation. Attach track to ceiling as follows:
 1. Attach track to suspended ceiling grid with manufacturer's proprietary clip.
- D. Track Accessories: Install splices, end caps, connectors, end stops, coupling and joining sleeves, and other accessories as required for a secure and operational installation.
- E. Curtain Carriers: Provide curtain carriers adequate for 6-inch spacing along full length of curtain plus an additional carrier.
- F. Cubicle Curtains: Hang curtains on each curtain track.

END OF SECTION 102123

SECTION 104413 - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fire protection cabinets for the following:
 - a. Portable fire extinguishers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire protection cabinets.
 - 1. Fire Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For fire protection cabinets to include in maintenance manuals.

1.5 COORDINATION

- A. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers are accommodated.
- B. Coordinate sizes and locations of fire protection cabinets with wall depths.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

- B. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.2 FIRE PROTECTION CABINET

- A. Cabinet Type: Suitable for fire extinguisher.
- B. Cabinet Size: size to accommodate 10 ABC extinguishers.
- C. Cabinet Construction: Non-rated and rated. Provide UL rated cabinets when installed in rated wall construction. Match rating of wall assembly.
- D. Cabinet Material: Steel sheet.
- E. Fully- and Semi-Recessed Cabinets: Cabinet box recessed in walls of sufficient depth to suit style of trim indicated.
 - 1. 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).
 - 2. Provide rated and non-rated, fully- and semi-recessed cabinets as indicated on the Drawings.
- F. Cabinet Trim Material: Steel sheet.
- G. Door Material: Steel sheet.
- H. Door Style: Fully glazed panel with frame.
- I. Door Glazing: Tempered float glass (clear).
- J. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
 - 1. Provide projecting door pull and friction latch or recessed door pull and friction latch.
 - 2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.
- K. Finishes:
 - 1. Manufacturer's standard baked-enamel paint for the following:
 - a. Exterior of cabinet, door and trim except for those surfaces indicated to receive another finish.
 - b. Interior of cabinet and door.
 - 2. Steel: Baked enamel or powder coat.

2.3 FABRICATION

- A. Fire Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
 - 1. Weld joints and grind smooth.
 - 2. Provide factory-drilled mounting holes.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.
 - 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.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.4 GENERAL FINISH REQUIREMENTS

- 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 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 not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.5 STEEL FINISHES

- A. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning" or SSPC-SP 8, "Pickling". After cleaning, apply a conversion coating suited to the organic coating to be applied over it.
- B. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).
 - 1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls and partitions for suitable framing depth and blocking where recessed cabinets will be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare recesses for recessed fire protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

- A. General: Install fire protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights indicated below:
 - 1. Fire Protection Cabinets: 44 inches (1118 mm) above finished floor to top of cabinet unless noted otherwise.
- B. Fire Protection Cabinets: Fasten cabinets to structure, square and plumb.
 - 1. Unless otherwise indicated, provide recessed fire protection cabinets.
- C. Identification: Apply vinyl lettering at locations indicated.

3.4 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 104413

SECTION 21 00 10
FIRE SUPPRESSION SPRINKLERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes fire-suppression sprinklers, piping, and equipment for the following building systems:
 - 1. Wet-pipe, fire-suppression sprinklers, including piping, valves, specialties, and automatic sprinklers.
- B. Related Sections include the following:
 - 1. Division 7 Section "Penetration Firestopping" for through-penetration firestop systems.

1.03 DEFINITIONS

- A. Working Plans: Documents, including drawings, calculations, and material specifications prepared according to NFPA 13 for obtaining approval from authorities having jurisdiction.

1.04 FIRE FLOW TESTING

- A. Fire flow testing is to be furnished by the contractor in cooperation with the water utility prior to conducting fire suppression design. Fire flow testing to be in accordance with NFPA 291 guidance. There is an existing fire pump.

1.05 SYSTEM PERFORMANCE REQUIREMENTS

- A. Design sprinklers and obtain approval from authorities having jurisdiction.
- B. Design sprinkler piping according to the following and obtain approval from authorities having jurisdiction:
 - 1. Include 20 percent margin of safety for available water flow and pressure.
 - 2. Include losses through water-service piping, valves, and backflow preventers.
 - 3. Sprinkler Occupancy Hazard Classifications:
 - a. Mechanical/Boiler Room(s): Ordinary Hazard, Group 1.
 - b. Electrical Room(s): Ordinary Hazard, Group 1
 - c. Storage Rooms: Ordinary Hazard, Group 1.
 - d. Office Space: Light Hazard Occupancy.
 - e. Corridors: Light Hazard Occupancy.
 - f. Clinical Space: Light Hazard Occupancy.
 - 4. Minimum Density for Automatic-Sprinkler Piping Design to meet design requirements shown on the drawings and to be in compliance with NFPA 13 and according to the Authority Having Jurisdiction .
 - 5. Maximum Protection Area per Sprinkler to be in compliance with NFPA 13 and according to the Authority Having Jurisdiction .
- C. Components and Installation: Capable of producing piping systems with 175-psig minimum working-pressure rating, unless otherwise indicated.

1.06 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: For the following:
 - 1. Pipe and fitting materials and methods of joining for sprinkler piping.
 - 2. Pipe hangers and supports.
 - 3. Piping seismic restraints.

4. Valves, including specialty valves, accessories, and devices.
5. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
- C. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction. Include hydraulic calculations.
- D. 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" and "Contractor's Material and Test Certificate for Underground Piping."
- E. Maintenance Data: For each type of sprinkler specialty to include in maintenance manuals specified in Division 1.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has designed and installed fire-suppression piping similar to that indicated for this Project and obtained design approval and inspection approval from authorities having jurisdiction.
- B. Design Responsibility: Preparation of working plans, calculations, and field test reports by a technician possessing NICET Level III or NICET Level IV certification for water-based fire protection systems layout or a Professional Engineer licensed in the field of Fire Protection Engineering in the state of the project location. Base calculations on results of fire-hydrant flow test.
- C. Manufacturer Qualifications: Firms whose equipment, specialties, and accessories are listed by product name and manufacturer in UL's "Fire Protection Equipment Directory" and FM's "Fire Protection Approval Guide" and that comply with other requirements indicated.
- D. Sprinkler Components: Listing/approval stamp, label, or other marking by a testing agency acceptable to authorities having jurisdiction.
- E. NFPA Standards: Piping, equipment, specialties, accessories, installation, and testing complying with the following:
 1. NFPA 13, "Installation of Sprinkler Systems."

1.08 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 and hinged cover, with space for a minimum of six spare sprinklers plus sprinkler wrench. Include the number of sprinklers required by NFPA 13 and wrench for sprinklers. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project. Coordinate mounting location in the field with Owner.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 1. Specialty Valves and Devices:
 - a. Central Sprinkler Corp.
 - b. Firematic Sprinkler Devices, Inc.
 - c. Grinnell Corp.
 - d. Reliable Automatic Sprinkler Co., Inc.

- e. Viking Corp.
 - f. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- 2. Sprinkler, Drain and Alarm Test Fittings:
 - a. Central Sprinkler Corp.
 - b. Fire-End and Croker Corp.
 - c. Grinnell Corp.
 - d. Victaulic Co. of America.
 - e. Gruvlok, An ASC Engineered Solution
 - f. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- 3. Sprinklers:
 - a. Firematic Sprinkler Devices, Inc.
 - b. Globe Fire Sprinkler Corp.
 - c. Viking Corp.
 - d. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- 4. Fire-Protection-Service Valves:
 - a. Central Sprink, Inc.
 - b. Central Sprinkler Corp.
 - c. Grinnell Corp.
 - d. McWane, Inc.; Kennedy Valve Div.
 - e. Nibco, Inc.
 - f. Victaulic Co. of America.
 - g. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- 5. Keyed Couplings for Steel Piping:
 - a. Central Sprink, Inc.
 - b. Ductilic, Inc.
 - c. Grinnell Corp.
 - d. Victaulic Co. of America.
 - e. Gruvlok, An ASC Engineered Solution
 - f. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

2.02 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.03 STEEL PIPE AND FITTINGS

- A. Threaded-End, Schedule 40 Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, hot-dip galvanized where indicated and 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.
- B. Grooved-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795; with factory- or field-formed, roll-grooved ends.
 - 1. Grooved-Joint Piping Systems:

- a. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1) Victaulic Co. of America.
 - 2) Gruvlok, An ASC Engineered Solution
 - 3) Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- 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, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.

2.04 JOINING MATERIALS

- A. Steel, Keyed Couplings: UL 213 and AWWA C606, for steel-pipe dimensions. Include ASTM A 536, ductile-iron housing, rubber gaskets, and steel bolts and nuts.

2.05 FIRE-PROTECTION-SERVICE VALVES

- A. General: UL listed and FM approved, with minimum 175-psig nonshock working-pressure rating. Valves for grooved-end piping may be furnished with grooved ends instead of type of ends specified.
- B. Gate Valves, NPS 2 and Smaller: UL 262; cast-bronze, threaded ends; solid wedge; OS&Y; and rising stem.

2.06 SPRINKLERS

- A. Automatic Sprinklers: With heat-responsive element complying with the following:
 - 1. UL 1767, for early suppression, fast-response applications.
- B. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.
- C. Sprinkler installation orientation, special service conditions, and sprinkler types include the following, as defined by NFPA 13:
 - 1. Concealed sprinklers.
 - 2. Pendent sprinklers.
 - 3. Recessed sprinklers, including escutcheon.
 - 4. Sidewall sprinklers.
 - 5. Upright sprinklers.
 - 6. Concealed, dry sprinklers
 - 7. Pendent, dry sprinklers.
 - 8. Sidewall, dry sprinklers.
 - 9. Quick-response sprinklers.
- D. Sprinkler Finishes: Chrome-plated, bronze, and painted.
- E. Special Coatings: Wax, lead, and 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: Painted steel, two piece, with 1-inch vertical adjustment. Color: white.
- G. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

2.07 SPECIALTY SPRINKLER FITTINGS

- A. Specialty Fittings: UL listed and FM approved; made of steel, ductile iron, or other materials compatible with piping.
- B. Sprinkler, Drain and Alarm Test Fittings: UL-listed, cast- or ductile-iron body; with threaded inlet and outlet, test valve, and orifice and sight glass.
- C. Sprinkler, Branch-Line Test Fittings: UL-listed, brass body; with threaded inlet and capped drain outlet and threaded outlet for sprinkler.

PART 3 EXECUTION

3.01 PIPING APPLICATIONS

- A. Flanges, unions, and transition and special fittings with pressure ratings the same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.
- B. Wet-Pipe, Sprinkler Branch Piping: Use the following:
 - 1. NPS 2 and Smaller: Standard-weight steel pipe with threaded ends, cast- or malleable-iron threaded fittings, and threaded joints.
 - 2. NPS 2-1/2 to NPS 4: Schedule 40 steel pipe with grooved ends, malleable-iron grooved fittings.
 - 3. NPS 5 and NPS 6: Schedule 10 steel pipe with grooved ends; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.

3.02 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Fire-Protection-Service Valves: UL listed and FM approved for applications where required by NFPA 13.
 - a. Shutoff Duty: Use gate valves.
 - 2. General-Duty Valves: For applications where UL-listed and FM-approved valves are not required by NFPA 13.
 - a. Shutoff Duty: Use gate, ball, or butterfly valves.
 - b. Throttling Duty: Use globe, ball, or butterfly valves.

3.03 JOINT CONSTRUCTION

- A. Brazed Joints: Use AWS A5.8, BCuP-3 or BCuP-4 filler metals.
- B. Locking-Lug-Fitting, Twist-Locked Joints: Follow fitting manufacturer's written instructions.
- C. Dissimilar-Piping-Material Joints: Construct joints using adapters or couplings compatible with both piping materials. Use dielectric fittings if both piping materials are metal.

3.04 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- C. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.
- D. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.

- E. Install "Inspector's Test Connections" in sprinkler piping, complete with shutoff valve, sized and located according to NFPA 13.
- F. Install sprinkler piping with drains for complete system drainage.
- G. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to sprinkler risers when sprinkler branch piping is connected to sprinkler risers.
- H. Hangers and Supports: Comply with NFPA 13 for hanger materials and installation.
- I. Earthquake Protection: Install piping according to NFPA 13 to protect from earthquake damage.
- J. Install piping with grooved joints according to manufacturer's written instructions. Construct rigid piping joints, unless otherwise indicated.
- K. Install pressure gages on riser or feed main and at each sprinkler test connection. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

3.05 SPECIALTY SPRINKLER FITTING INSTALLATION

- A. Install specialty sprinkler fittings according to manufacturer's written instructions.

3.06 SPRINKLER APPLICATIONS

- A. General: Use sprinkler head types as noted on the fire protection drawings. Use dry-type sprinklers in spaces subject to freezing.
 - 1. Sprinkler Finishes: Use sprinklers with the following finishes:
 - a. Upright, Pendent, and Sidewall Sprinklers: Painted in finished spaces exposed to view; chrome plated bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.
 - b. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.

3.07 SPRINKLER INSTALLATION

- A. Install sprinklers in patterns indicated.
- B. Furnish and install escutcheon for each sprinkler head.
- C. Install sprinklers in suspended ceilings in center of acoustical panels and tiles.
- D. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

3.08 LABELING AND IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and in Division 21 Section "Identification for Fire Suppression Piping and Equipment."

3.09 FIELD QUALITY CONTROL

- A. Flush, test, and inspect sprinkler piping according to NFPA 13, "System Acceptance" Chapter and as required by the Authority Having Jurisdiction.
- B. Require test to be witnessed by Authority Having Jurisdiction.
- C. Replace piping system components that do not pass test procedures and retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.
- D. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.10 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers having paint other than factory finish.

3.11 PROTECTION

- A. Protect sprinklers from damage until Substantial Completion.

3.12 COMMISSIONING

- A. Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.
- B. Verify that specified tests of piping are complete.
- C. Verify that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type.
- D. Verify that sprinklers are correct types, have correct finishes and temperature ratings, and have guards as required for each application.
- E. Fill wet-pipe sprinkler piping with water.
- F. Energize circuits to electrical equipment and devices.
- G. Coordinate with fire alarm tests. Operate as required.

3.13 DEMONSTRATION

- A. Demonstrate equipment, specialties, and accessories. Review operating and maintenance information.
- B. Schedule demonstration with Owner with at least seven days' advance notice.

END OF SECTION 21 00 10

SECTION 21 05 00
COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SECTION INCLUDES

- A. Above ground piping.
- B. Mechanical couplings.
- C. Pipe hangers and supports.
- D. Escutcheons.
- E. Pipe sleeves.
- F. Nonshrink grout for equipment and sleeve installations.

1.03 RELATED REQUIREMENTS

- A. Section 078413 - Penetration Firestopping.
- B. Section 21 05 53 - Identification for Fire Suppression Piping and Equipment: Piping identification.
- C. Section 21 0010 - Fire Suppression Sprinklers: Sprinkler systems design.

1.04 REFERENCE STANDARDS

- A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications; 2015.
- B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2011.
- C. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard; 2013.
- D. ASME B16.9 - Factory-Made Wrought Buttwelding Fittings; 2012.
- E. ASME B16.11 - Forged Fittings, Socket-welding and Threaded; 2011.
- F. ASME B16.25 - Buttwelding Ends; 2012.
- G. ASME B36.10M - Welded and Seamless Wrought Steel Pipe; 2004.
- H. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999 (Reapproved 2014).
- I. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- J. ASTM A135/A135M - Standard Specification for Electric-Resistance-Welded Steel Pipe; 2009 (Reapproved 2014).
- K. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2015.
- L. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984 (Reapproved 2014).
- M. ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use; 2013.
- N. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings; 2012.
- O. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2012.
- P. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2009.
- Q. AWWA C606 - Grooved and Shouldered Joints; 2011.
- R. FM (AG) - FM Approval Guide; current edition.
- S. NFPA 13 - Standard for the Installation of Sprinkler Systems; 2016.

**COMMON WORK RESULTS FOR FIRE
SUPPRESSION**

1.05 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The use of the word "Provide": Whenever the word "Provide" is used in the specifications and/or on the drawings, it shall mean "furnish and install", "connect", "apply", "erect", "construct", or similar terms, unless otherwise indicated.
- G. The use of the word "Piping": "Piping" shall include but not be limited to, in addition to piping or mains, all fittings, flanges, unions, valves, strainers, drains, traps, insulation, vents, hangers and other accessories relative to such piping.
- H. The use of the word "Material": Whenever the word material is used in the specifications and/or on the drawings, it shall mean any "product", "equipment", "device", "assembly", or "item" required under the contract, as indicated by trade or brand name, manufacturer's name, standard specification reference or other description.
- I. The term "Fire Protection Contractor", "Fire Suppression Contractor", "Sprinkler Contractor" or "Contractor" refer to the Sub Contractor or his Sub Contractors responsible for the furnishing and installation of all work indicated on the Fire Protection drawings and in the Fire Suppression Specifications.
- J. The term "Accessible" indicates ease of access with or without the use of ladders and without requiring extensive removal of other equipment, such as ductwork, piping, conduit, etc to gain access. "Accessible ceiling" indicates acoustical tile type hung ceilings. Concealed spline or gypsum board ceilings with access panes shall not be considered accessible ceilings.

1.06 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide manufacturer's catalog information. Indicate valve data and ratings.
- C. Shop Drawings: Indicate pipe materials used, jointing methods, supports, and floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
- D. Coordination Drawings: Detail major elements, components, and systems of fire suppression equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
 - 1. Planned piping layout, including valve and specialty locations and valve-stem movement.
 - 2. Clearances for installing and maintaining insulation.
 - 3. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.

COMMON WORK RESULTS FOR FIRE SUPPRESSION

4. Equipment and accessory service connections and support details.
 5. Exterior wall and foundation penetrations.
 6. Fire-rated wall and floor penetrations.
 7. Sizes and location of required concrete pads and bases.
 8. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
 9. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 10. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.
 11. For complete piping systems installations with identification of seismic support systems.
- E. Prior to the purchasing of materials or the start of work, prepare a $\frac{1}{2}'' = 1'-0''$ scale coordination drawing showing size, size and location of fire suppression pipes, equipment, and appurtenances, relative to other trades. Distribute drawing to other trades, and Submit drawing to Design Professional for review and approval. No demolition or new work shall proceed until all trades have indicated their respective services on the coordination drawing, and the Engineer has reviewed and approved the coordination drawings. Coordination drawings shall not be utilized as the final as built drawings required in this specification.
- F. Project Record Documents: Record actual locations of components and tag numbering.
- G. Operation and Maintenance Data: Include installation instructions and spare parts lists.

1.07 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified in this section.
1. Minimum ten years experience.
 2. Approved by manufacturer.
- C. Comply with FM (AG), UL (DIR), and ITS (DIR) or Warnock Hersey requirements.
- D. Valves: Bear FM (AG), UL (DIR), and ITS (DIR) or Warnock Hersey product listing label or marking. Provide manufacturer's name and pressure rating marked on valve body.
- E. Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.
- F. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- G. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code (BPVC): Section IX, "Welding, Brazing and Fusing Qualifications."
1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store valves in shipping containers, with labeling in place.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.09 COORDINATION

- A. Do not install any part of a system until all critical components of the systems and related systems have been approved. Coordinate individual parts of systems.
- B. Coordinate contract work with other work specified in other Sections. Relocate work if required for proper installation and functioning of other systems, at no extra cost to the Owner.
- C. Install products in accordance with manufacturer's instructions. Notify Design Professional if Contract Documents conflict with manufacturer's instructions. Comply with Design Professional's interpretations.
- D. In general, air duct, heating and sprinkler piping, and drainage lines take precedence over water, gas, and electrical conduits. The design professional will make final decisions regarding the arrangement of work which cannot be agreed upon by the contractors.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Welding Materials and Procedures: Comply with ASME BPVC-IX.
- B. Provide system pipes, fittings, sleeves, escutcheons, seals, and other related accessories.

2.02 ABOVE GROUND PIPING

- A. Steel Pipe: See also Division 21 Section, "Fire Suppression Sprinklers".
 - 1. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings and ASME B16.4, threaded fittings.
 - 2. Malleable Iron Fittings: ASME B16.3, threaded fittings and ASTM A47/A47M.
 - 3. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.
 - 4. Mechanical Formed Fittings: Carbon steel housing with integral pipe stop and O-ring pocked and O-ring, uniformly compressed into permanent mechanical engagement onto pipe.

2.03 PIPE SLEEVES

- A. The following materials are for wall, partition, elevated floor, and roof penetrations:
- B. Galvanized-Steel Sheet: 0.0276-inch (24 gauge) minimum thickness; round tube closed with welded longitudinal joint.
- C. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 10 (minimum) pipe, galvanized, plain ends.
- D. Cast Iron will Not be permitted: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe.
- E. 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.

2.04 PIPE HANGERS AND SUPPORTS

- A. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
- B. Hangers for Pipe Sizes 2 inches and Over: Carbon steel, adjustable, clevis.
- C. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- D. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.
- E. Wall Support for Pipe Sizes 4 inches and Over: Welded steel bracket and wrought steel clamp.
- F. Vertical Support: Steel riser clamp.

- G. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

2.05 MECHANICAL COUPLINGS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Anvil International: www.anvilintl.com/#sle.
 - 2. Tyco Fire Protection Products: www.tyco-fire.com/#sle.
 - 3. Victaulic Company; FireLock Style 009H: www.victaulic.com/#sle.
 - 4. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Rigid Mechanical Couplings for Grooved Joints:
 - 1. Dimensions and Testing: Comply with AWWA C606.
 - 2. Minimum Working Pressure: 300 psig.
 - 3. Housing Material: Fabricate of ductile iron complying with ASTM A536.
 - 4. Housing Coating: Factory applied orange enamel.
 - 5. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
 - 6. Bolts and Nuts: Hot-dipped-galvanized or zinc-electroplated steel.

2.06 ESCUTCHEONS

- A. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type if required to conceal protruding fittings and sleeves.
 - 1. ID: Closely fit around pipe, tube, and insulation of insulated piping.
 - 2. OD: Completely cover opening.
 - 3. Cast Brass: Split casting, with set screw.
 - a. Finish: Rough brass.
 - b. Finish: Polished chrome-plate.

2.07 GROUT

- A. This article shall pertain only to the extent there is not a Division 3 Section "Non-Metallic Non-Shrink Grouting" for grout or notes on the structural drawings addressing same. If so, these shall supersede this article.
- B. Work Included. Furnishing and installing grout for filling joints and setting and anchoring items to masonry and concrete.
- C. Reference Standards
 - 1. ASTM C109 - Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50 mm Cube Specimens).
 - 2. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
 - 3. ASTM C827 - Early Volume Change of Cementitious Mixtures.
- D. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Specifications include references to designated manufacturers to illustrate minimum acceptable requirements for products.
 - 2. Substitutions:
 - a. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

- E. Non-shrink Cement Grout
 - 1. Non-shrink, non-metallic cement based grout with a minimum compressive strength of 5,000 psi at 28 days when tested in accordance with ASTM C109, and with no shrinkage when tested in accordance with ASTM C827. Grout shall consist of premixed, prepackaged materials requiring only the addition of potable water. Grout shall meet the requirements of Embeco 153 Grout by Master Builders or Five Star Grout by U.S. Grout Corporation.
- F. Non-shrink Epoxy Grout
 - 1. Non-shrink, non-metallic epoxy-based grout with a minimum compressive strength of 10,000 psi at 28 days when tested in accordance with ASTM C109, and with no shrinkage when tested in accordance with ASTM C827. Grout shall be pourable, 100% solids epoxy system consisting of three premeasured, prepackaged components. Grout shall meet the requirements of Five Star Grout as manufactured by U.S. Grout Corporation.

PART 3 EXECUTION

3.01 FIRE SUPPRESSION DEMOLITION

- A. Disconnect, demolish, and remove fire suppression systems, equipment, and components indicated to be removed and as appropriate to reconfiguration of system.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and as appropriate to reconfiguration of system; cap or plug remaining piping with same or compatible piping material. Demolish any existing associated wall sleeves except as noted below.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or comparable and compatible piping material.
 - 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 - 6. Whenever piping, equipment, and appurtenances are indicated to be removed, resulting in a hole, opening, void, or other discontinuity in the adjacent architectural features, these features shall be infilled and restored to a continuous appearance and function as indicated or to match existing materials of construction. Waterproofing is to be repaired, where it existed before, or where indicated. If the resulting hole is indicated or suitable to be reused, any required wall sleeve shall be replaced unless in excellent condition.
- B. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
- C. Disconnect, demolish, and remove Work as needed for reconfiguration of systems.
- D. If pipe or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.
- E. Accessible Work: Remove indicated exposed pipe and equipment in its entirety.

COMMON WORK RESULTS FOR FIRE SUPPRESSION

- F. Work Abandoned in Place: Cut and remove underground pipe a minimum of 2 inches beyond face of adjacent construction. Cap and patch surface to match existing finish. Do not abandon work in place unless unavoidable or drawings specifically state this is required.
- G. Removal: Remove indicated equipment from Project site.
- H. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and foreign material, from inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

- A. Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13.
- B. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- C. Install piping to conserve building space, to not interfere with use of space and other work.
- D. Group piping whenever practical at common elevations.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Piping that is a "combined service main", serving both fire protection and domestic water service, is to be installed under Division 21. Such piping is typically ductile iron pipe or stainless steel pipe as required by Section 221116 Domestic Water.
- G. Piping Applications:

- 1. Wet Type System Piping

Pipe Size	Pipe Type	Fitting Type
2" and Smaller	Steel: ASTM A795 Schedule 40, Black	Threaded Fittings
2-1/2" and Larger	Steel: ASTM A795 Schedule 40, Black	Grooved Fittings

- 2. Standpipe System Piping

Pipe Size	Pipe Type	Fitting Type
2" and Smaller	Steel: ASTM A795 Schedule 40, Black	Threaded Fittings
2-1/2" and Larger	Steel: ASTM A795 Schedule 40, Black	Grooved Fittings

- H. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- I. Pipe Hangers and Supports:

1. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 2. Place hangers within 12 inches of each horizontal elbow.
 3. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 4. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 6. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- J. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- K. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welding. Coordinate exposed piping painting with the requirements of Division 9.
- L. Cutting, notching and boring holes of steel floor / roof decking shall be as prescribed by the registered design professional.
- M. Do not penetrate building structural members unless indicated.
- N. Locate flexible expansion loops at or near the building seismic joint.
- O. Install escutcheons for penetrations of walls, ceilings, and floors according to the following. For new piping use one-piece designs. For existing piping use split-casting designs. Additional escutcheon requirements for both new and existing piping follow:
1. Piping with Fitting or Sleeve Protruding from Wall: Deep-pattern type.
 2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Cast-brass type with polished chrome-plated finish.
 3. Bare Piping at Ceiling Penetrations in Finished Spaces: Cast-brass type with polished chrome-plated finish.
 4. Bare Piping in Unfinished Service Spaces: Cast-brass type with polished chrome-plated finish.
 5. Bare Piping in Equipment Rooms: Cast-brass type.
 6. Bare Piping at Floor Penetrations in Equipment Rooms: Floor-plate type.
- P. Sleeve pipe passing through concrete and masonry walls, gypsum-board partitions, elevated floors, and roof penetrations.
1. When installed as part of a UL-listed fire rated assembly, the sleeve shall meet the requirements of listing.
 2. Position pipe in center of sleeve.
 3. Cut sleeves to length for mounting flush with both surfaces. While not required by this Section, it is preferred that sleeves extend 1/2" beyond the wall on each side to the extent not conflicting with escutcheon installations.
 - a. Exception: For elevated floors of mechanical equipment areas, parking garages, commercial kitchens, janitors closets, spaces that can anticipate washdown, and other wet areas, extend sleeves 2 inches above finished floor level to inhibit water on floor from passing to level below.

4. Install sleeves in new walls and elevated floors as new walls and slabs are constructed. Securely fasten sleeves to the assemblies penetrated. Space outside sleeve perimeter is to be filled as follows.
 - a. Use grout for any portion installed thru existing concrete or CMU walls or concrete floors. Surface to be flush and continuous with existing wall and floor surfaces.
 - b. Use materials in compliance with UL-listed fire rated assembly and as required based upon adjacent materials of construction.
5. Contractor to determine means and methods to install sleeves in existing walls and partitions. Coring concrete and masonry walls would be one possible method. Where multiple sleeves are required in a tight area, contractor may desire to remove a rectangular section of the wall or slab, and to then reconstruct the section with the sleeves, matching existing materials and finishes. In that case, inquire with the architect and/or structural engineer via the RFI process and furnish a multi-trade coordinated and dimensioned sketch and intended approach to infill wall, to confirm each such location and approach is acceptable. Determination will be based, in part, if existing wall is load-bearing.
6. Install sleeves for interior wall and floor pipe penetrations that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Any pipe insulation is to be continuous through sleeve, unless not permissible where installed as part of a UL-listed fire rated assembly.
 - a. For interior wall and floor pipe penetrations, use the following sleeve materials:
 - 1) Steel Pipe Sleeves: For pipes smaller than NPS 6 and for all exposed floor pipe penetrations.
 - 2) Steel Sheet Sleeves: For pipes NPS 6 and larger, except exposed floor pipe penetrations. Where installed thru masonry or concrete wall, to be 12 ga (minimum,) with caution taken not to damage sleeve, especially when installing masonry, mortar, and grout. Steel pipe sleeves specified will be permitted.
 - 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 above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
 - b. For interior wall and floor pipe penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Use materials in compliance with UL-listed fire rated assembly where required. Refer to Division 7 Section "Joint Sealants" for materials and installation.
7. Permanent sleeves are not required in bare concrete walls for suitably sized core-drilled or formed holes with smooth concrete bore, unless a sleeve is required by UL-listed fire rated assembly. These holes may be formed by removable PE sleeves. Concrete walls that are part of a wall assembly (such as combined with insulation, brick, metal studs, gypsum wall board, etc.) require a sleeve extending thru the entire assembly.
8. Underground and aboveground pipe penetrations thru exterior-walls into a building or structure: Seal penetrations using specified steel pipe sleeves and mechanical sleeve seals installed per manufacturer's written instructions. Select sleeve size in accordance with the Mechanical Sleeve Seal manufacturer's Engineering Manual. Generally, the annular clear space expected between the pipe OD and sleeve ID for installing

COMMON WORK RESULTS FOR FIRE
SUPPRESSION

mechanical sleeve seals as follows: For most pipes 6" and smaller expect annular space from approximately 9/16" to 1", and for most pipes 8" and larger expect annular space from approximately 1-5/8" to 2". Any pipe penetration thru exterior-walls subject to plumbing code jurisdiction shall comply with International Plumbing Code requirement (305.3) for pipe sleeve to be two pipe sizes greater than the pipe passing through the wall. Install steel pipe sleeve with not greater than seven (7) degrees angular misalignment to pipe, preferably less.

- a. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material, design temperature, and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
 - b. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
 - c. For exterior wall installations both sleeve-to-wall and sleeve-to-pipe junctures shall be watertight.
- Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Penetration Firestopping" for requirements.
- R. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.
- S. Die cut threaded joints with full cut standard taper pipe threads with appropriate non-toxic pipe-joint compound applied to male (external) threads only.

3.04 CLEANLINESS CONTROL MEASURES

- A. Clean-Up: Frequently clean-up all waste, remove from site regularly, and legally dispose of offsite. Comply with further requirements of Division 1 Section in regard to construction waste management.
- B. During construction meet or exceed the minimum requirements of the recommended Control Measures of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, Second Edition, November 2007, Chapter 3 to help minimize contamination of a building from construction activities. These shall apply to new building construction as well, to the extent needed to similarly protect the HVAC systems. Below is a list and summary of these Control Measures. These include HVAC System Protection; Source Control; Pathway Interruption; Housekeeping; and Scheduling.
1. HVAC System Protection. Prevent construction dust and debris, moisture, and chemical vapors from entering the fire protection piping and equipment.
 2. Source Control. Achieved through the selection of low emission materials and finishes including paints, sealants, adhesives, carpeting, other furnishings, and cleaning products.
 3. Pathway Interruption. To prevent the migration of contaminants through a building during construction. Approaches can include ventilation using 100% outside air during installation of Volatile Organic Compound (VOC) emitting materials, preconditioning products which have significant VOC emissions in a offsite dry well ventilated space for

- sufficient period to dissipate emissions, erecting physical barriers between work areas and non-work areas, and temporary negative pressure zones.
4. Housekeeping. Frequent cleaning to remove construction dust and debris, immediate clean-up of any spills, removal of accumulated water, and other actions to keep work areas dry.
 5. Scheduling. The sequence of construction can minimize impact of dust and debris on mechanical systems.
- C. Comply with any additional requirements of a Construction IAQ Management Plan if required elsewhere in these specifications.
 - D. Keep equipment in a clean environment or protected from any type of unclean environment.
 - E. Operate equipment as recommended in the manufacturers' installation, operation, and maintenance manuals. Do not operate equipment when the adjacent area is unclean or when in a dusty or wet environment.

3.05 PERMIT REQUIRED CONFINED SPACES

- A. Where appropriate, work is to comply with Confined Spaces in Construction standard 29 CFR 1926 Subpart AA (the 1926.12xx-series) for "Permit Required Confined Spaces."

3.06 FIRESTOPPING

- A. The trade contractor is responsible for providing proper U.L. Listed firestopping and smokestopping for all pipe, controls conduit, and related electrical conduit installed by this trade contractor.
- B. The trade contractor shall utilize the latest fire and smoke protection materials and installation methods. The trade contractor shall guarantee that all materials installed are fire and smoke stopped per U.L. Listing, NFPA, building code requirements.
- C. The trade contractor shall utilize Architectural Life Safety Drawings to identify partition ratings. If the trade contractor is unsure of partition rating then he or she must inquire to Construction Manager.
- D. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078413.
- E. Fire stopping shall be provided to both be compatible with the piping and meet the requirements of ASTM E 814 or ULC CAN-S115 , "Fire Tests of Through-Penetration Firestops". Pipe insulations or fire resistive coating shall be removed where the pipe passes through a fire stop and, if required by the firestop manufacturer, for 3 inches beyond the firestop outside of the fire barrier.

END OF SECTION

SECTION 21 05 53
IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Pipe markers.
- D. Ceiling tacks.

1.02 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2007.
- B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2013.

1.03 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Product Data: Provide manufacturers catalog literature for each product required.
- E. Manufacturer's Installation Instructions: Indicate special procedures, and installation instructions.
- F. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

- A. Piping: Tags.
- B. Pumps: Nameplates.
- C. Relays: Tags.
- D. Small-sized Equipment: Tags.
- E. Valves: Nameplates and ceiling tacks where above lay-in ceilings.

2.02 NAMEPLATES

- A. Description: Laminated three-layer plastic with engraved letters.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/4 inch.
 - 3. Background Color: Black.
 - 4. Thickness: 1/8 inch.
 - 5. Plastic: Comply with ASTM D709.

2.03 TAGS

- A. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- B. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.04 PIPE MARKERS

- A. Color: Comply with ASME A13.1.
- B. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

- C. Underground Plastic Pipe Markers: Bright-colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil, 0.004 inch thick, manufactured for direct burial service.
- D. Color code as follows:
 - 1. Fire Quenching Fluids: Red with white letters.

2.05 CEILING TACKS

- A. Description: Steel with 3/4 inch diameter color coded head.

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION

- A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Install plastic pipe markers in accordance with manufacturer's instructions.
- D. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- E. Use tags on piping 3/4 inch diameter and smaller.
 - 1. Identify service, flow direction, and pressure.
 - 2. Install in clear view and align with axis of piping.
 - 3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
- F. Locate ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 22 05 00
PLUMBING GENERAL PROVISIONS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes Contract requirements and the following basic mechanical materials and methods to complement other Division 22 Sections.
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Concrete base construction requirements.
 - 4. Escutcheons.
 - 5. Dielectric fittings.
 - 6. Flexible connectors.
 - 7. Pipe sleeves
 - 8. Mechanical sleeve seals.
 - 9. Nonshrink grout for equipment and sleeve installations.
 - 10. Field-fabricated metal and wood equipment supports.
 - 11. Installation requirements common to equipment specification sections.
 - 12. Plumbing demolition.
 - 13. Cutting and patching.
 - 14. Touchup painting and finishing.
- B. Pipe and pipe fitting materials are specified in Division 22 piping system Sections.

1.03 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The use of the word "Provide": Whenever the word "Provide" is used in the specifications and/or on the drawings, it shall mean "furnish and install", "connect", "apply", "erect", "construct", or similar terms, unless otherwise indicated.
- G. The use of the word "Piping": "Piping" shall include but not be limited to, in addition to piping or mains, all fittings, flanges, unions, valves, strainers, drains, traps, insulation, vents, hangers and other accessories relative to such piping.
- H. The use of the word "Material": Whenever the word material is used in the specifications and/or on the drawings, it shall mean any "product", "equipment", "device", "assembly", or

- “item” required under the contract, as indicated by trade or brand name, manufacturer’s name, standard specification reference or other description.
- I. The term “Mechanical Contractor”, “HVAC Contractor”, “Plumbing Contractor” or “Contractor” refer to the Sub Contractor or his Sub Contractors responsible for the furnishing and installation of all work indicated on the Mechanical, HVAC, and/or Plumbing drawings and in the Mechanical, HVAC, and/or Plumbing Specifications.
 - J. The term “Accessible” indicates ease of access with or without the use of ladders and without requiring extensive removal of other equipment, such as ductwork, piping, conduit, etc to gain access. “accessible ceiling” indicates acoustical tile type hung ceilings. Concealed spline or gypsum board ceilings with access panes shall not be considered accessible ceilings.
 - K. The following are industry abbreviations for plastic materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.
 - 3. NP: Nylon plastic.
 - 4. PE: Polyethylene plastic.
 - 5. PVC: Polyvinyl chloride plastic.
 - L. The following are industry abbreviations for rubber materials:
 - 1. CR: Chlorosulfonated polyethylene synthetic rubber.
 - 2. EPDM: Ethylene propylene diene terpolymer rubber.

1.04 CODES, STANDARDS, REFERENCES, AND PERMITS

- A. All material and workmanship shall comply with all the currently adopted editions of all applicable Codes (to include the State Plumbing Code), Specifications, Local and State Ordinances, Industry Standards and Utility Company Regulations.
- B. In case of differences between the Building Codes, State Law, Local Ordinances, Industry Standards and Utility Company Regulations and the Contract Documents, the contractor shall promptly notify the Engineer in writing of any such difference.
- C. In case of conflict between the Contract Documents and the requirements of any Code or Authorities having jurisdiction, the most stringent requirements of the aforementioned shall govern for budgetary and bid purposes. However, no work will proceed until the Engineer determines the correct method of installation.
- D. Should the contractor perform any work that does not comply with the requirements of the applicable Building Codes, State Laws, Local Ordinances, Industry Standards and Utility Company Regulations, the contractor shall bear all costs arising in correcting the deficiencies, as approved by the Engineer.
- E. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials, installation, and testing unless a more stringent requirement is noted elsewhere.
- F. Certified to NSF 61, "Drinking Water System Components--Health Effects, Sections 1 through 9," for potable water installations. This shall apply to pipes, fittings, fixtures, valves and other products that come in contact with drinking water.
- G. Certified to ANSI/NSF 372 - Drinking Water System Components – Lead content. Low lead content product compliance for potable water installations. This shall apply to pipes, fittings, fixtures, valves and other products that come in contact with drinking water.

1.05 REGULATORY REQUIREMENTS

- A. Perform Work in accordance with currently adopted edition of the state plumbing code.
- B. Conform to applicable code for installation of backflow prevention devices.

1.06 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.

- B. Product Data: For the following:
 - 1. Transition fittings.
 - 2. Dielectric fittings.
 - 3. Pipe sleeves
 - 4. Mechanical sleeve seals.
 - 5. Escutcheons.
- C. Welding certificates.
- D. Coordination Drawings: Detail major elements, components, and systems of plumbing equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
 - 1. Planned piping layout, including valve and specialty locations and valve-stem movement.
 - 2. Clearances for installing and maintaining insulation.
 - 3. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
 - 4. Equipment and accessory service connections and support details.
 - 5. Exterior wall and foundation penetrations.
 - 6. Fire-rated wall and floor penetrations.
 - 7. Sizes and location of required concrete pads and bases.
 - 8. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
 - 9. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 - 10. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.
 - 11. For complete piping and controls systems installations with identification of seismic support systems.
- E. Prior to the purchasing of materials or the start of work, prepare a $\frac{1}{2}'' = 1'-0''$ scale coordination drawing showing size, size and location of plumbing pipes, equipment, and appurtenances, relative to other trades. Distribute drawing to other trades, and Submit drawing to Design Professional for review and approval. No demolition or new work shall proceed until all trades have indicated their respective services on the coordination drawing, and the Engineer has reviewed and approved the coordination drawings. Coordination drawings shall not be utilized as the final as built drawings required in this specification.
- F. Shop Drawings: Detail fabrication and installation for metal and wood supports and anchorage for plumbing materials and equipment.
- G. Samples: Of color, lettering style, and other graphic representation required for each identification material and device.
- H. Whenever the Division 22 Sections require preparation of a delegated design submittal it shall be prepared within the contractor's scope of work using the services of a licensed and qualified professional engineer and the following shall pertain. The professional engineer shall be licensed in the state in which the project is located and with minimum five years experience preparing similar designs. Shop Drawings, and other submittals related to the Work, designed, or certified by such professional engineer, if prepared by others, shall bear

such professional engineer's written approval when submitted. The professional engineer shall promptly inquire of the Engineer if the performance and design criteria are not clear and complete. The contractor is responsible for coordinating the work of the delegated design. The Engineer's review of all delegated design submittals shall be for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Engineer shall be entitled to rely upon, and shall not be responsible for, the adequacy and accuracy of the services, certifications, and approvals performed or provided by such professional engineers.

- I. Hydrostatic pressure piping test reports, each including a statement of pass/fail, and signed by the contractor, Construction Manager, and Clerk of the Works or other approved owner's representative.

1.07 QUALITY ASSURANCE

- A. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.
- B. Equipment Selection: Subject to compliance with individual Section requirements for equipment and other components for the project, available manufacturers whose products may be incorporated into the Work, other than the Basis of Design products noted, and proposed as a substitution shall: (1) Be submitted as a substitution to not only demonstrate product compliance with the requirements, but also demonstrate equivalency to the Basis of Design product. The mechanical, plumbing, and electrical designs are based upon the Basis of Design product. If other than the Basis of Design product is furnished and: (1) if the power requirements differ, the plumbing contractor shall coordinate all requirements with the electrical contractor including circuit breaker, conductor, and conduit sizes. In such case, the power shall still come from the same panel as currently designed. (2) if the piping connection locations or sizes differ, the plumbing contractor shall coordinate with affected trades and shall provide all required modifications to accommodate. The plumbing contractor is responsible for any additional cost to any trade as noted above and as required to coordinate installation and provide proper service clearances for other than the Basis of Design product. The plumbing contractor is responsible for paying any design fees associated with redesigning architectural, structural, or MEP systems to accommodate other than the Basis of Design product.
- C. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- D. Steel Pipe Welding and Copper Pipe Brazing: Given it is a requirement of ASME B31.9, qualify processes and operators according to ASME Boiler and Pressure Vessel Code (BPVC): Section IX, "Welding, Brazing and Fusing Qualifications."
 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.08 SYSTEM DESCRIPTION

- A. Furnish and install all materials in order to provide functioning systems, upon completion, in compliance with all applicable codes, authorities having jurisdiction, manufacturer's requirements, performance requirements specified, and any modifications resulting from reviewed shop drawings and the field coordination drawings.

1.09 SCOPE OF WORK

- A. The contractor is responsible for furnishing and installing all the devices and equipment shown indicated the Plumbing Drawings including materials and equipment required to create fully operational systems.
- B. The Plumbing contractor shall be responsible for reviewing the Architectural, Mechanical, Fire Protection, and Electrical Plans. In addition to all plumbing equipment, fixtures, and devices indicated on the Plumbing Plans, the Plumbing contractor is responsible for plumbing installation of all the plumbing equipment, fixtures, and devices shown on the Architectural, Mechanical, Fire Protection, and Electrical Plans.
- C. The contractor shall be responsible for reviewing the Architectural, Electrical, Mechanical, and Fire Protection Plans. Prior to bid, the contractor shall notify the Engineer of any discrepancies between the Plumbing plans and the Architectural, Electrical, Mechanical, and Fire Protection Plans regarding plumbing equipment and fixture locations, equipment quantities, pipe routing, device locations, light locations, chase locations, etc. otherwise it will be assumed the contractor is responsible for plumbing installation of all the equipment and devices shown on the Architectural Plans, Mechanical Plans, Fire Protection Plans and the Electrical Plans regardless of whether they are indicated on the Plumbing Plans.

1.10 DRAWING INTERPRETATION

- A. The project drawings are schematic in nature and indicate general arrangement of equipment. It is not the intent of the drawings to substitute for shop drawings. In many instances, equipment and devices are sized on one manufacturer's product. In the event of a field verification or coordination issue, report issue to the Construction Manager with copy to the Clerk of the Works or other approved owner's representative
- B. Piping plans are intended to show size, capacity, approximate location, direction and general relationship of one work phase to another, but not exact detail or arrangement. The drawings do not necessarily indicate all required offsets, details and accessories and equipment to be connected or encountered in the way of new work.
- C. Generally, layout pipelines requiring drainage first, followed by large pipe mains, air duct and electrical conduit. Follow this procedure for an orderly installation but not to establish precedence of one trade over another. It must be understood that pipe and duct hanger installations must comply with seismic bracing requirements. Minimizing hanger lengths (structure to equipment and crossbars) to 12" and under minimizes the requirement for seismic bracing.
- D. Install work as closely as possible to layouts shown on drawings. Modify work as necessary to meet job conditions and to clear other equipment. Offsets, transitions and changes of direction in all systems shall be made as required to maintain proper headroom and pitch of sloping lines, to avoid existing field conditions as well as to maintain clearances to equipment whether or not indicated on the drawings. The contractor shall provide all drains, traps and accessories as required for his work to effect these offsets, transitions and changes in direction. Consult Design Professional before making changes that effect the function or appearance of systems.
- E. Do not install equipment or piping in a non-code compliant fashion due to drawing interpretation. Provide modification of illustrated work in order to accommodate job conditions at no cost to Owner.
- F. In some cases, drawings are based on products of one or several manufacturers, as listed on the contract documents. The contractor shall be held responsible for modifications made necessary by substitution of products or other manufacturers.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.
- C. Protect flanges, fittings, and piping specialties from moisture and dirt.
- D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.12 COORDINATION

- A. Refer to Division 1 Section "Facilities Services Coordination" for additional coordination required, to include meetings, field survey, and preparation and submittal of coordination drawings and schedules.
- B. Do not install any part of a system until all critical components of the systems and related systems have been approved. Coordinate individual parts of systems.
- C. Coordinate contract work with other work specified in other Sections. Relocate work if required for proper installation and functioning of other systems, at no extra cost to the Owner.
- D. Install products in accordance with manufacturer's instructions. Notify Design Professional if Contract Documents conflict with manufacturer's instructions. Comply with Design Professional's interpretations.
- E. In general, air duct, heating and sprinkler piping, and drainage lines take precedence over water, gas, and electrical conduits. The design professional will make final decisions regarding the arrangement of work which cannot be agreed upon by the contractors.

1.13 SEQUENCING AND SCHEDULING

- A. Coordinate plumbing equipment installation with other building components.
- B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for plumbing installations.
- C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.
- D. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the work. Coordinate installation of large equipment requiring positioning before closing in building.
- E. Coordinate connection of plumbing systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- F. Coordinate requirements for access panels and doors if plumbing items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors."
- G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

1.14 "AS-BUILT" RECORD DRAWINGS

- A. Record daily progress on one set of construction documents. Utilize a permanent black or blue marking media. All progress of record drawings shall be provided in a neat and accurate fashion.

- B. As-built drawing reviews will be completed on a monthly basis by the engineer of record. Release of requisitions will be based on the regular progress of As-built drawings. The latest As-built drawings shall be submitted for review with each requisition for payment.
- C. Formal As-built drawings shall be submitted for review at the completion of each phase of the work. The as-built drawings shall be ¼" scale and created in electronic format utilizing current release of AutoCAD and/or Revit. At the completion of each phase of work, the plumbing contractor shall submit to the Engineer the original field progress as-built drawings and the electronic files of the formal as-built drawings. Once these have been reviewed by the Engineer, print and furnish one set of final as-built drawings to the Owner, plotted on 24" x 36" 'D' sized sheets. Final payment for the phase of work and the start of the next phase shall require acceptance of the as-built drawings.

1.15 GUARANTEE

- A. Provide written guarantee of all completed/installed work. Materials, equipment and workmanship shall be guaranteed for a minimum period of one year after Owners acceptance of work. Any failure due to defective material, equipment or workmanship shall be corrected at no additional cost to owner. This shall include damage completed to other areas of construction or facility resulting from this failure. Provide correction of any failure within an acceptable/reasonable time period.
- B. Provide all equipment and material manufacturers guarantees and/or warranties to owner after acceptance of installation.

1.16 OPERATING AND MAINTENANCE MANUALS

- A. Provide operating and maintenance information for all equipment, devices, systems, and materials. This shall include all maintenance and operations procedures, recommendations, and service requirements. All submitted data must include minimum equipment/device operations and maintenance requirements to fulfill manufacturers warranties.
- B. Submit all engineering selection and specification documentation with operating and maintenance information for all equipment, devices, systems, and materials.
- C. Submit all data media in a detailed, organized, and complete manner. Provide electronic copy to the Construction Manager with copy to the Clerk of the Works or other approved owner's representative for engineer/architect review.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Dielectric Flanges:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Co.
 - c. Epco Sales Inc.
 - d. Watts Industries, Inc.; Water Products Div.
 - e. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
 - 2. Dielectric-Flange Insulating Kits:
 - a. Calpico, Inc.
 - b. Central Plastics Co.

- c. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- 3. Dielectric Couplings:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
 - c. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- 4. Dielectric Nipples:
 - a. Grinnell Corp.; Grinnell Supply Sales Co.
 - b. Perfection Corp.
 - c. Victaulic Co. of America.
 - d. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- 5. Metal, Flexible Connectors:
 - a. ANAMET Industrial, Inc.
 - b. Flexicraft Industries.
 - c. Mercer Rubber Co.
 - d. Uniflex, Inc.
 - e. Metraflex Co.
 - f. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- 6. Rubber, Flexible Connectors:
 - a. General Rubber Corp.
 - b. Mercer Rubber Co.
 - c. Proco Products, Inc.
 - d. Uniflex, Inc.
 - e. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- 7. Mechanical Sleeve Seals:
 - a. Metra Seals by Metraflex Co.
 - b. Link-Seal by Garlock Pipeline Technologies (GPT) ~ an Enpro Industries Company
 - c. Innerlynx by Advance Products & Systems, Inc.
 - d. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

2.02 PIPE AND PIPE FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe and pipe fitting materials and joining methods.

2.03 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents. For other than AWWA pipe flanges, gaskets are to meet the requirements of Table in ASME B31.1 (pertinent items are summarized below for common Division 22 applications,) as well as the gasket manufacturer's recommendations.
 - 1. Where both Flange A and mating Flange B are either Class 150 steel or Class 150 ductile iron, furnish flat ring nonmetallic to ASME B16.5, Annex C, Group Ia, Table C1.
 - 2. Where both Flange A and mating Flange B are Class 300 steel, furnish flat ring nonmetallic to ASME B16.5, para 6.11 and Annex C, Group Ia material.

3. Where Flange A is Class 125 cast iron mating with Flange B Class 125 cast iron, Class 150 steel, or Class 150 ductile iron, furnish flat ring, nonmetallic gasket to ASME B16.21, Table 2. Both flange facings are to be flat (flat face.)
4. Where Flange A is Class 150 bronze or nonmetallic mating with Flange B Class 125 cast iron, Class 150 bronze, Class 150 steel, Class 150 ductile iron, or nonmetallic, furnish full face, nonmetallic gasket to ASME B16.21, Table 2. Both flange facings are to be flat (flat face.)
5. Where Flange A is Class 250 cast iron mating with Flange B Class 250 cast iron, Class 300 steel, or Class 300 ductile iron, furnish flat ring, nonmetallic gasket to ASME B16.21, Table 3.
6. Gaskets indicated above to be manufactured in accordance with ASME B16.21-2021 "Nonmetallic Flat Gaskets for Pipe Flanges" shall be nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated, and to suit ASME B16.5 flange designation. Refer to Division 23 pipe specifications for additional gasket requirements.
 - 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.
 - c. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
7. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Flexitallic (Basis of Design)
 - b. Leader Gasket, Eriks Company
 - c. Teadit
 - d. Garlock, Enpro Industries, Inc.
 - e. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- C. Flange bolts and nuts for plumbing pipe flanges are to be one of the following, as indicated in the Component Standards and Specifications Table of ASME B31.9, unless otherwise indicated or required:
 1. Bolts / Nuts: ASME B18.2.1, ASTM A307 Grade B carbon steel machine hex bolts with ASME B18.2.2, ASTM A563 Grade A carbon steel hex nuts.
 2. Bolts / Nuts (alternative higher strength option if above are not available): ASME B18.2.1, ASTM A193 Grade B7 alloy steel machine hex bolts with ASME B18.2.2, ASTM A194 Grade 2H carbon steel heavy hex nuts.
 3. Note that SAE J429 bolts are not listed in the table and will not be permitted.
 4. Threads as required to match valve.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer and as indicated in the Component Standards and Specifications Table (referenced ASTM standards) of ASME B31.9, unless otherwise indicated or required.
- E. Solder Filler Metals: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated. Given it is required by ASME B31.9, the soldering filler metal shall conform to the applicable ASTM specification.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAgl, silver alloy for refrigerant piping,

- unless otherwise indicated. Given it is required by ASME B31.9, the brazing filler metal shall conform to an applicable AWS classification.
- G. Welding Filler Metals: Given it is required by ASME B31.9, comply with the ASME Boiler and Pressure Vessel Code: Section II, Part C, for materials appropriate for pipe being welded. Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
 - H. No other copper or steel joint methods for piping, fittings, valves, or other piping system components (such as using grooved mechanical joints, associated mechanical couplings, or mechanical press seal joints) shall be permitted.
 - 1. Furnish a deductive alternate price for owners' consideration to furnish mechanical press seal joints and pressed ends, to the extent the contractor prefers to utilize such products in lieu of those specified. Mechanical press seal joints furnished shall be only ProPress as manufactured by Viega. No other manufacturer's products will be permitted. ProPress components shall be installed per manufacturer's written instructions and by trained and currently certified installers. Submittal of such training and manufacturer certification shall be required before the start of work.
 - I. Solvent Cements for Joining Plastic Piping:
 - 1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - 2. PVC to ABS Piping Transition: ASTM D 3138.

2.04 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
 - 1. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
 - 2. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
 - 3. Aboveground Pressure Piping: Pipe fitting.
- B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
- C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
- D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
- E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.05 DIELECTRIC FITTINGS

- A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion. Refer to piping Section for additional requirements.
- B. Dielectric unions: Dielectric unions are not acceptable.
- C. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.
- D. Insulating Material: Suitable for system fluid, pressure, and temperature.
- E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

- F. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure as required to suit system pressures.
- G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- H. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain or threaded ends; and 300-psig minimum working pressure at 225 deg F.

2.06 FLEXIBLE CONNECTORS

- A. General: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections. Entire flexible connector shall be assembled by the manufacturer or approved distributor at their shop, not in the contractor's shop nor in field by the Contractor. Include 250-psig minimum working-pressure rating, unless higher working pressure is indicated, and ends according to the following:
 - 1. 2-Inch NPS and Smaller: Threaded.
 - 2. 2-1/2-Inch NPS and Larger: Flanged.
- B. Bronze-Hose, Flexible Connectors: Corrugated, bronze, inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to hose.
- C. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.
- D. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.
- E. Rubber, Flexible Connectors: CR or EPDM elastomer rubber construction, with multiple plies of NP fabric, molded and cured in hydraulic presses. Include 125-psig minimum working-pressure rating at 220 deg F. Units may be straight or elbow type, unless otherwise indicated.

2.07 PIPE SLEEVES

- A. The following materials are for wall, partition, elevated floor, and roof penetrations:
- B. Galvanized-Steel Sheet: 0.0276-inch (24 gauge) minimum thickness; round tube closed with welded longitudinal joint.
- C. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 10 (minimum) pipe, galvanized, plain ends.
- D. Steel pipe sleeves, for use in conjunction with mechanical sleeve seals for underground pipe penetrations thru exterior-walls into a building or structure:
 - 1. ASTM A 53, Type E, Grade B, Schedule 10 (minimum) pipe, hot-dip galvanized according to ASTM A123, plain ends. Prior to hot-dip galvanizing, continuously weld both sides of an ASTM A36 carbon steel water stop plate, minimum 0.25 inch thick, to be located at center of concrete wall.
 - 2. Similar sleeve construction without galvanizing using materials below is acceptable.
 - a. Pipe, to be unannealed / hard:
 - 1) ASTM A312 GRADE TP304 (UNS S30400) or GRADE TP304L (UNS S30403)
 - 2) ASTM A778 GRADE T304L (UNS S30403); Spiral butt seam pipe will not be accepted.
 - b. ASTM A240 304 stainless steel or equal water stop plate.
- E. Steel pipe sleeves, for use in conjunction with mechanical sleeve seals for aboveground pipe penetrations thru exterior-walls into a building or structure:

1. ASTM A 53, Type E, Grade B, Schedule 10 (minimum) pipe, plain ends, hot-dip galvanized according to ASTM A123. Water stop plate not required.
2. Similar sleeve construction without galvanizing using one of the stainless pipe materials directly above is acceptable.
- F. Cast Iron will Not be permitted: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe.
- 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.
- H. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- I. PVC Pipe: ASTM D 1785, Schedule 40.
- J. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.08 MECHANICAL SLEEVE SEALS

- A. Furnish and install mechanical sleeve seals as listed in Article 2.1 above and as described below for underground and aboveground pipe penetrations thru exterior-walls into a building or structure.
- B. Mechanical Sleeve Seal assemblies shall be modular, mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening, and pressure rated to 20 psig.
 1. Complete Assembly is defined as a combined:
 - a. Wall Opening (sleeve, cored hole, or formed hole). The wall opening size and/or type shall be selected according to the Mechanical Sleeve Seal manufacturer's Engineering Manual.
 - b. Sufficient quantity and type of Mechanical Sleeve Seals required to effectively provide a hydrostatic and/or fire-rated seal.
 2. The elastomeric element shall be sized and selected per manufacturer's written recommendations and have the following properties as designated by ASTM. Refer to Part 3 for additional application requirements.
 - a. For Standard Service Applications (-40°F to 250°F) EPDM = ASTM D2000 M3 BA510 (black)
 - b. For Hydrocarbon Service Applications (-40°F to 210°F) NITRILE = ASTM D2000 M1BF510 (green)
 - c. For High Temperature or Fire Seal Applications (-67°F to 400°F) SILICONE = ASTM D2000 M1GE505 (gray)
 3. Bolts and Nuts: Type 316 Stainless Steel. Mechanical sleeve seals intended for temporary piping may utilize zinc plated carbon steel bolts and nuts.
 4. Pressure plates:
 - a. Reinforced nylon polymer (composite) for standard service applications.
 - b. Type 316 Stainless Steel for high temperature or fire seal applications.
 5. Utilize the selected Mechanical Sleeve Seal manufacturer's Engineering Manual sizing procedures and online sizing calculator (if available) for each selection.
 6. Piping shall be independently supported, internal to building or manhole, by a specified pipe hanger, such that pipe is concentric with cored penetration or sleeve opening. Mechanical Sleeve Seal assembly shall not be allowed to support weight of piping.
 7. Install two Mechanical Sleeve Seal assemblies for each below grade exterior wall penetration greater than 12" thick and where indicated on the drawings.

8. Do not exceed manufacturer's angular misalignment recommendation which varies. Typically this may be approximately 7 degrees. Consult manufacturer for details. Utilize Metraflex product below where a particular application does not meet Mechanical Sleeve Seal manufacturer's requirements.
- C. Seals for misaligned or eccentric underground and aboveground pipe penetrations thru exterior-walls into a building or structure which do not meet Mechanical Sleeve Seal manufacturer's requirements shall be Off Center Seal (Eccentric Seal) by Metraflex, or approved equal.
 1. Product materials, selection, and installation shall meet all the requirements above for Mechanical Sleeve Seals.
 2. This product shall not be used in exchange for preinsulated factory fabricated fittings, as may be indicated on drawings.

2.09 PIPING SPECIALTIES

- A. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type if required to conceal protruding fittings and sleeves.
 1. ID: Closely fit around pipe, tube, and insulation of insulated piping.
 2. OD: Completely cover opening.
 3. Cast Brass: Split casting, with set screw.
 - a. Finish: Rough brass.
 - b. Finish: Polished chrome-plate.

2.10 GROUT

- A. This article shall pertain only to the extent there is not a Division 3 Section "Non-Metallic Non-Shrink Grouting" for grout or notes on the structural drawings addressing same. If so, these shall supersede this article.
- B. Work Included. Furnishing and installing grout for filling joints and setting and anchoring items to masonry and concrete.
- C. Reference Standards
 1. ASTM C109 - Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50 mm Cube Specimens).
 2. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
 3. ASTM C827 - Early Volume Change of Cementitious Mixtures.
- D. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 1. Specifications include references to designated manufacturers to illustrate minimum acceptable requirements for products.
 2. Substitutions:
 - a. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- E. Non-shrink Cement Grout
 1. Non-shrink, non-metallic cement based grout with a minimum compressive strength of 5,000 psi at 28 days when tested in accordance with ASTM C109, and with no shrinkage when tested in accordance with ASTM C827. Grout shall consist of premixed, prepackaged materials requiring only the addition of potable water. Grout shall meet the requirements of Embeco 153 Grout by Master Builders or Five Star Grout by U.S. Grout Corporation.

F. Non-shrink Epoxy Grout

1. Non-shrink, non-metallic epoxy-based grout with a minimum compressive strength of 10,000 psi at 28 days when tested in accordance with ASTM C109, and with no shrinkage when tested in accordance with ASTM C827. Grout shall be pourable, 100% solids epoxy system consisting of three premeasured, prepackaged components. Grout shall meet the requirements of Five Star Grout as manufactured by U.S. Grout Corporation.

PART 3 EXECUTION

3.01 PLUMBING DEMOLITION

- A. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or comparable and compatible piping material. Demolish any existing associated wall sleeves except as noted below.
 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or comparable and compatible piping material.
 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 6. Whenever piping, equipment, and appurtenances are indicated to be removed, resulting in a hole, opening, void, or other discontinuity in the adjacent architectural features, these features shall be infilled and restored to a continuous appearance and function as indicated or to match existing materials of construction. Waterproofing is to be repaired, where it existed before, or where indicated. If the resulting hole is indicated to be reused, any required wall sleeve shall be replaced unless in excellent condition. Fireproofing is to be repaired, where it existed before if damaged, and where indicated.
- B. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
- C. Disconnect, demolish, and remove Work specified in Division 22 Drawings and Sections.
- D. If pipe, ductwork, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.
- E. Accessible Work: Remove indicated exposed pipe in its entirety.
- F. Work Abandoned in Place: Cut and remove underground pipe a minimum of 2 inches beyond face of adjacent construction. Cap and patch surface to match existing finish.
- G. Removal: Remove indicated equipment from Project site.
- H. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

3.02 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction

- loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
 - D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
 - E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
 - F. Install piping to permit valve servicing.
 - G. Install piping at indicated slopes.
 - H. Install piping free of sags and bends.
 - I. Install fittings for changes in direction and branch connections.
 - J. Install piping to allow application of insulation.
 - K. Select system components with pressure rating equal to or greater than system operating pressure.
 - L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following. For new piping use one-piece designs. For existing piping use split-casting designs. Additional escutcheon requirements for both new and existing piping follow:
 - 1. Piping with Fitting or Sleeve Protruding from Wall: Deep-pattern type.
 - 2. Chrome-Plated Piping: Cast-brass type with polished chrome-plated finish.
 - 3. Insulated Piping: One-piece stamped-steel type with spring clips for new piping. Split-plate, stamped-steel type with spring clips for existing piping.
 - 4. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Cast-brass type with polished chrome-plated finish.
 - 5. Bare Piping at Ceiling Penetrations in Finished Spaces: Cast-brass type with polished chrome-plated finish.
 - 6. Bare Piping in Unfinished Service Spaces: Cast-brass type with polished chrome-plated finish.
 - 7. Bare Piping in Equipment Rooms: Cast-brass type.
 - 8. Bare Piping at Floor Penetrations in Equipment Rooms: Floor-plate type.
 - M. Sleeve pipe passing through concrete and masonry walls, gypsum-board partitions, elevated floors, and roof penetrations.
 - 1. When installed as part of a UL-listed fire rated assembly, the sleeve shall meet the requirements of listing.
 - 2. Position pipe in center of sleeve.
 - 3. Cut sleeves to length for mounting flush with both surfaces. While not required by this Section, it is preferred that sleeves extend $\frac{1}{2}$ " beyond the wall on each side to the extent not conflicting with escutcheon installations.
 - a. Exception: For elevated floors of mechanical equipment areas, parking garages, commercial kitchens, janitors closets, spaces that can anticipate washdown, and other wet areas, extend sleeves 2 inches above finished floor level to inhibit water on floor from passing to level below.
 - 4. Install sleeves in new walls and elevated floors as new walls and slabs are constructed. Securely fasten sleeves to the assemblies penetrated. Space outside sleeve perimeter is to be filled as follows.
 - a. Use grout for any portion installed thru existing concrete or CMU walls or concrete floors. Surface to be flush and continuous with existing wall and floor surfaces.

- b. Use materials in compliance with UL-listed fire rated assembly and as required based upon adjacent materials of construction.
- 5. Contractor to determine means and methods to install sleeves in existing walls and partitions. Coring concrete and masonry walls would be one possible method. Where multiple sleeves are required in a tight area, contractor may desire to remove a rectangular section of the wall or slab, and to then reconstruct the section with the sleeves, matching existing materials and finishes. In that case, inquire with the architect and/or structural engineer via the RFI process and furnish a multi-trade coordinated and dimensioned sketch and intended approach to infill wall, to confirm each such location and approach is acceptable. Determination will be based, in part, if existing wall is load-bearing.
- 6. Install sleeves for interior wall and floor pipe penetrations that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Any pipe insulation is to be continuous through sleeve, unless not permissible where installed as part of a UL-listed fire rated assembly.
 - a. For interior wall and floor pipe penetrations, use the following sleeve materials:
 - 1) Steel Pipe Sleeves: For pipes smaller than NPS 6 and for all exposed floor pipe penetrations.
 - 2) Steel Sheet Sleeves: For pipes NPS 6 and larger, except exposed floor pipe penetrations. Where installed thru masonry or concrete wall, to be 12 ga (minimum,) with caution taken not to damage sleeve, especially when installing masonry, mortar, and grout. Steel pipe sleeves specified will be permitted.
 - 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 above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
 - b. For interior wall and floor pipe penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Use materials in compliance with UL-listed fire rated assembly where required. Refer to Division 7 Section "Joint Sealants" for materials and installation.
- 7. Permanent sleeves are not required in bare concrete walls for suitably sized core-drilled or formed holes with smooth concrete bore, unless a sleeve is required by UL-listed fire rated assembly. These holes may be formed by removable PE sleeves. Concrete walls that are part of a wall assembly (such as combined with insulation, brick, metal studs, gypsum wall board, etc.) require a sleeve extending thru the entire assembly.
- 8. Underground and aboveground pipe penetrations thru exterior-walls into a building or structure: Seal penetrations using specified steel pipe sleeves and mechanical sleeve seals installed per manufacturer's written instructions. Select sleeve size in accordance with the Mechanical Sleeve Seal manufacturer's Engineering Manual. Generally, the annular clear space expected between the pipe OD and sleeve ID for installing mechanical sleeve seals as follows: For most pipes 6" and smaller expect annular space from approximately 9/16" to 1", and for most pipes 8" and larger expect annular space from approximately 1-5/8" to 2". Any pipe penetration thru exterior-walls subject to plumbing code jurisdiction shall comply with International Plumbing Code requirement (305.3) for pipe sleeve to be two pipe sizes greater than the pipe passing through the

wall. Install steel pipe sleeve with not greater than seven (7) degrees angular misalignment to pipe, preferably less.

- a. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material, design temperature, and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
 - b. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
 - c. Underground pipe penetrations thru exterior-walls into a building or structure: Where it is apparent that an opening in the wall was previously saw cut or otherwise created, opening created for installation of this work shall not be smaller than former opening in the same location.
 - d. For exterior wall installations both sleeve-to-wall and sleeve-to-pipe junctures shall be watertight.
- N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Penetration Firestopping" for requirements.
- O. Verify final equipment locations for roughing-in.
- P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.03 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements, applicable codes, manufacturer's instructions, and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe that is to be butt welded.
- C. Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction protect open ends with temporary plugs or caps.
- D. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before and after assembly. Remove all dirt, scale and other foreign matter from inside the pipe by use of a pipe swab or pipe "pig" before connecting pipe sections, valves, equipment or fittings.
- E. Wherever tie-ins are made to existing steel piping, contractor shall first thoroughly clean end of existing pipe to remove dirt, scale, and other foreign matter from inside the pipe by use of a pipe swab or pipe "pig", and then shall measure pipe wall thickness. Corrosion allowance for all steel pipe Schedules on this project shall be 0.05" for sizes 1" and smaller, and 0.063" for pipes 1 1/4" and larger. Notify Design Engineer for direction where corrosion is in excess of this allowance. Connections to existing piping shall be in accordance with ASME B31.9, "Building Services Piping".
- F. Soldered Joints: Apply ASTM B 813, water-flushable lead-free flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 preparation and technique using lead-free solder alloy complying with ASTM B 32. Lead-free shall mean a chemical composition equal to or less than 0.2 percent lead.
- G. Brazed Joints: Construct joints according to Copper Tube Handbook of the Copper Development Association, using copper-phosphorus brazing filler metal complying with AWS A5.8.

- H. 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 pipe-joint compound to male (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.
- I. Welded Joints: Construct pipe joints according to AWS D1.1 or AWS D10.12 (select one for the project's pipe joints; contractor to determine and utilize the one that has the more stringent Welding Procedure Specifications - WPS's to be followed), using qualified processes and welding operators according to Part 1 "Quality Assurance" Article. Given it is a requirement of ASME B31.9, the pipe joint WPS's shall be prepared and qualified according to ASME Boiler and Pressure Vessel Code (BPVC): Section IX, "Welding, Brazing and Fusing Qualifications."
- J. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use lubricant recommended by gasket manufacturer on bolt and cap screw threads, and underside of nuts and cap screw heads. Torque flange bolts as recommended in writing by gasket manufacturer.
- K. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 - 3. PVC Nonpressure Piping: Join according to ASTM D 2855.
- L. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- M. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.04 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.05 FIELD TESTING

- A. Prepare plumbing piping according to ASME B31.9, "Building Services Piping," and as follows:
 - 1. Contractor is to perform all field testing in accordance with adopted plumbing code.
 - 2. Leave joints, including welds, uninsulated and exposed for examination during test.
 - 3. Isolate piping outside scope of this work. Do not subject to test pressure.
 - 4. Drainage systems are to receive a water test with not less than 10 feet head of water for not less than 15 minutes with no leakage, or as directed by adopted plumbing code. After the plumbing fixtures have been set and their traps filled with water, submit the entire drainage system to final test using smoke machine(s) at 1 inch w.c. for not less

- than 15 minutes with no leakage based upon visual observation in sufficient detail. Eliminate leaks by tightening, repairing, or replacing components and repeat drainage system tests until there are no leaks. Prepare written report of drainage system tests. The field testing procedures below do not pertain to drainage systems.
5. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 6. Flush system with clean water. Clean strainers.
 7. Isolate fixtures and equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install a blank at flanged joints to isolate equipment. Blanks shall be of adequate thickness to prevent deformation under anticipated pressures, typically not less than 3/8" thick plate steel. Utilize equation in ASME B31.9 to calculate minimum required thickness of blank based upon allowable stress of blank material.
 8. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following examination and test on plumbing piping:
1. ASME B31.9 mandates visual examination of all project pressure welds. These shall be performed by any trained and licensed journeyman or master pipefitter who is also a certified welder. The visual examination must be within the scope of his/her experience and he/she must be comfortable doing so.
 2. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used. Pneumatic testing is discouraged due to safety risks and requires justification. Pneumatic testing shall not be used for cast iron pipe, plastic pipe subject to brittle failure or where manufacturer prohibits (such as PVC), system containing soldered or solvent cement joints over NPS 2, or test pressures exceeding 150 psig. Any pneumatic testing must be done in compliance with requirements of ASME B31.9. In service testing, without a hydrostatic pressure test, will only be permitted for the short sections of plumbing piping connecting to equipment and to existing piping. Owner will not be obliged to fund the replacement any existing valves not shown on the drawings to be replaced and that are found to leak during testing. Contractor is to carry cost for testing means that resolves any such concerns.
 3. Use vents installed at high points to release trapped air while filling system with water.
 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design (working) pressure. Hydrostatic test pressure for ferrous and copper piping systems shall not be less than 150 psig. Review hydrostatic test pressure and methods for plastic piping systems with engineer in advance of testing; comply with manufacturer's test procedures. Test pressures shall not exceed maximum allowable pressure for any pipe, fitting, vessel, pump, valve, instrument, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength. Contractor is responsible for determining means and methods (to include necessary drains, vents, pipe anchors, etc.) to implement hydrostatic pressure tests, which are to include expansion joints to the extent feasible.

5. After hydrostatic test pressure has been applied for at least 2 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic pressure test until there are no leaks.
 6. Plumbing contractor shall determine location of testing caps and purge valves required for hydrostatic pressure testing.
 7. Where expansion joints are installed at the time of test, the plumbing contractor shall bear all costs of preparing and submitting the design of any required temporary pipe restraints. Such a design shall be prepared by a professional engineer licensed in the state where the project is located.
 8. Use low point drains and high point vents to completely remove liquid when testing is complete.
- C. Prepare written report of hydrostatic tests.

3.06 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Equipment storage prior to installation.
1. All building interior equipment is to be stored indoors prior to installation, protected from weather, precipitation, and construction dust and damage, and in accordance with the manufacturer's installation instructions. Storage of such equipment outdoors during adverse weather (rain, snow, etc.) shall require manufacturer's advance written approval or the owner reserves the right to reject the equipment that in their reasonable opinion has been damaged or suffered a reduction in lifespan by such storage and require the contractor to replace same with new at no additional expense to the owner nor change in construction schedule.
 2. All building exterior equipment may be stored outdoors if stored on dunnage in a high area with good drainage, and in accordance with the manufacturer's installation instructions. Piping connections and any other equipment openings shall be protected from the weather with caps, tarps, etc.
 3. Stored equipment is to be covered with either the original packaging and shipping protection or an equivalent or better protective covering. Repair any damaged packaging. Cap the open ends of pipe connections. In areas where painting, plastering, spraying, and/or other dust generating activities have not been completed, all due precautions must be taken to avoid physical damage to the equipment and contamination by foreign material. Corrosive environments must be avoided. Store equipment in an upright position. Examine equipment before installing, first removing any dirt or debris found in or on the equipment.
- B. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- D. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- E. Install equipment to allow right of way for piping installed at required slope.
- F. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.
- G. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

- H. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

3.07 CLEANLINESS CONTROL MEASURES

- A. Clean-Up: Frequently clean-up all waste, remove from site regularly, and legally dispose of offsite. Comply with further requirements of Division 1 Section in regard to construction waste management.
- B. During construction meet or exceed the minimum requirements of the recommended Control Measures of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, Second Edition, November 2007, Chapter 3 to help minimize contamination of a building from construction activities. These shall apply to new building construction as well, to the extent needed to similarly protect the HVAC systems. Below is a list and summary of these Control Measures. These include HVAC System Protection; Source Control; Pathway Interruption; Housekeeping; and Scheduling.
 - 1. HVAC System Protection. Prevent construction dust and debris, moisture, and chemical vapors from entering the ductwork, mechanical equipment, and other components. Isolate the return side of the HVAC system during heavy construction or demolition. If permanently installed air handlers and/or ductwork are permitted to be used during construction, filtration media with a Minimum Efficiency Reporting Value (MERV) of 13, as determined by ASHRAE 52.2-2017, shall be temporarily installed at each return air opening or grille until such time as construction is completed.
 - 2. Source Control. Achieved through the selection of low emission materials and finishes including paints, sealants, adhesives, carpeting, other furnishings, and cleaning products.
 - 3. Pathway Interruption. To prevent the migration of contaminants through a building during construction. Approaches can include ventilation using 100% outside air during installation of Volatile Organic Compound (VOC) emitting materials, preconditioning products which have significant VOC emissions in a offsite dry well ventilated space for sufficient period to dissipate emissions, erecting physical barriers between work areas and non-work areas, and temporary negative pressure zones.
 - 4. Housekeeping. Frequent cleaning to remove construction dust and debris, immediate clean-up of any spills, removal of accumulated water, and other actions to keep work areas dry.
 - 5. Scheduling. The sequence of construction can minimize impact of dust and debris on mechanical systems.
- C. Comply with any additional requirements of a Construction IAQ Management Plan if required elsewhere in these specifications.
- D. Keep equipment in a clean environment or protected from any type of unclean environment.
- E. Operate equipment as recommended in the manufacturers' installation, operation, and maintenance manuals. Do not operate equipment when the adjacent area is unclean or when in a dusty or wet environment.

3.08 PAINTING AND FINISHING

- A. Apply paint to exposed piping according to the following, unless otherwise indicated:
 - 1. Interior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
 - 2. Interior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.

3. Interior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
 4. Exterior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.
 5. Exterior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
 6. Exterior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.
- B. Coordinate exposed piping painting with the requirements of Division 9.
 - C. Do not paint piping specialties with factory-applied finish.
 - D. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.09 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit. Provide 3/4" chamfered edges on top of concrete pads. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete." Provide broom finish.

3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Refer to Division 5 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1, "Structural Welding Code--Steel."

3.11 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.12 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for plumbing installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair cut surfaces to match adjacent surfaces.
- C. Plumbing Contractor shall be responsible for any patching of existing partitions after removal of plumbing piping.

3.13 GROUTING

- A. Install nonmetallic, nonshrink, grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, anchors, and for sleeve installations where noted. Coordinate with requirements of structural drawings. Mix grout according to manufacturer's written instructions.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placing of grout.
- E. Place grout, completely filling equipment bases and space around sleeves.
- F. Place grout on concrete bases to provide smooth bearing surface for equipment.
- G. Place grout around anchor plates.

- H. Cure placed grout according to manufacturer's written instructions.

3.14 PERMIT REQUIRED CONFINED SPACES

- A. Where appropriate, work is to comply with Confined Spaces in Construction standard 29 CFR 1926 Subpart AA (the 1926.12xx-series) for "Permit Required Confined Spaces."

3.15 FIRESTOPPING

- A. The trade contractor is responsible for providing proper U.L. Listed firestopping and smokestopping for all pipe, controls conduit, and related electrical conduit installed by this trade contractor.
- B. The trade contractor shall utilize the latest fire and smoke protection materials and installation methods. The trade contractor shall guarantee that all materials installed are fire and smoke stopped per U.L. Listing, NFPA, building code requirements.
- C. The trade contractor shall utilize Architectural Life Safety Drawings to identify partition ratings. If the trade contractor is unsure of partition rating then he or she must inquire to Construction Manager.
- D. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078413.
- E. Fire stopping shall be provided to both be compatible with the piping and meet the requirements of ASTM E 814 or ULC CAN-S115 , "Fire Tests of Through-Penetration Firestops". Pipe insulations or fire resistive coating shall be removed where the pipe passes through a fire stop and, if required by the firestop manufacturer, for 3 inches beyond the firestop outside of the fire barrier.
- F. Where plastic pipes, such as polypropylene and PVC materials, penetrate fire rated walls, partitions, or elevated floors, furnish firestop collar meeting ASTM E 814 or ULC CAN-S115, installed per UL listing requirements to provide fire rating required.

END OF SECTION

SECTION 22 05 29
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Support and attachment components for equipment, piping, and other plumbing work.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 05 50 00 - Metal Fabrications.
- C. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.
- D. MSS SP-58-2018 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation which includes Amendment 1 Issued 10-17-2019.
- E. MSS SP-69-2003 - Pipe Hangers and Supports - Selection and Application.
- F. MSS SP-89-2003 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- G. MSS SP-90-2000 - Guidelines on Terminology for Pipe Hangers and Supports.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

1.05 PERFORMANCE REQUIREMENTS

- A. Design piping and equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- B. Delegated Design: Design Metal Channel (Strut) Framing Systems, metal fabrications, trapeze hangers (for pipe and ductwork), equipment supports, pipe stands, pipe anchors, pipe guides, and determining means of controlling thermal expansion of piping, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

- C. Structural Performance: Hangers and supports for piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE 10.
 - 1. Design supports for multiple pipes, including pipe stands and equipment 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 all components of supports for roof mounted equipment and ductwork to withstand wind and snow loads.
 - 4. Contractor shall provide a stamped letter from a professional engineer licensed in the state where the project is located stating that all Division 22 piping and equipment supports, including anchors and fasteners, are designed and installed to carry the required loads at all substrates where located.

1.06 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for the following:
 - 1. Pipe hangers and supports.
 - 2. Post-installed concrete and masonry anchors.
 - 3. Metal framing systems.
- C. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; Include Product Data for components:
 - 1. Trapeze hangers.
 - 2. Metal framing systems.
 - 3. Equipment supports.
 - 4. Application of saddles, inserts, and protection shields at pipe hangers for each pipe service, pipe material, range of pipe sizes, type of insulation, and type of hanger.
- D. Delegated-Design Submittal: For hangers and supports of plumbing equipment and piping, submit the following data indicating compliance with performance requirements and design criteria signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Design calculations and detail for fabrication and assembly of trapeze hangers, metal framing systems, equipment supports, pipe stands, pipe anchors, pipe guides, and determining means of controlling thermal expansion of piping. Show methods of attachment to building structure.
 - 2. Contractor shall provide a stamped letter from a professional engineer licensed in the state where the project is located stating that all Division 22 equipment and piping supports, including anchors and fasteners, are designed and installed to carry the required loads at all substrates where located.

1.07 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.
- C. Reference "Plumbing General Provisions" in Division 22 for additional Quality Assurance requirements.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Provide required hardware to hang or support piping, equipment, or fixtures with related accessories as necessary to complete installation of plumbing work.
- B. Provide hardware products listed, classified, and labeled as suitable for intended purpose.
- C. Materials for Metal Fabricated Supports: Comply with Section 05 50 00.
 - 1. Zinc-Plated Steel: Electroplated in accordance with ASTM B633 unless stated otherwise.
 - 2. Galvanized Steel: Hot-dip galvanized in accordance with ASTM A123/A123M or ASTM A153/A153M unless stated otherwise.
- D. Corrosion Resistance: Use corrosion-resistant metal-based materials fully compatible with exposed piping materials and suitable for the environment where installed.

2.02 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements.
- B. Comply with MSS SP-58, Types 1 through 58, factory-fabricated components. If type of hanger or support for a particular situation is not indicated in this Section, select appropriate type using MSS SP-58 recommendations. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- C. Comply with MSS SP-69, including for pipe hanger selections and applications that are not specified in piping system Sections.
- D. Comply with MSS SP-89.
- E. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 1.5. Include consideration for vibration, equipment operation, and shock loads where applicable.

2.03 STEEL PIPE HANGERS AND SUPPORTS

- A. This article was written for the support of steel and copper piping.
- B. This article is to also pertain to the support of uninsulated PVC piping and plastic piping that is insulated. No steel hangers are to be in direct contact with plastic piping other than PVC, which precludes some hanger types below.
- C. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Anvil, An ASC Engineered Solution
 - 2. B-Line Systems, Inc.; a division of Cooper Industries (Eaton).
 - 3. ERICO/Michigan Hanger Co.
 - 4. Globe Pipe Hanger Products, Inc.
 - 5. GS Metals Corp.
 - 6. PHD Manufacturing, Inc.
 - 7. PHS Industries, Inc.
 - 8. Piping Technology & Products, Inc.
 - 9. The Pipe Supports Group (including Bergen-Power Pipe Supports and Carpenter & Paterson, Inc)
 - 10. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- D. Galvanized, Metallic Coatings: Hot-dip galvanized according to ASTM A153 or ASTM A123. Required of all pipe hangers and support steel components (clevis, roller, guides, etc.) and

- related structural steel framing except products specified to be painted or furnished in stainless steel.
- E. Where pipe hangers and support steel components (clevis, roller, guides, etc.) and related structural steel framing are exposed to view by the building occupants: (1) in indoor finished spaces normally accessible by occupants, and (2) where specifically noted on the plumbing drawings that aesthetics are a concern, they are to be finished as follows, in lieu of hot-dip galvanized:
 - 1. Prime coat the related structural steel framing.
 - 2. Pipe support steel components (clevis, roller, guides, etc.) with plain finish or galvanized will be acceptable.
 - 3. Finish paint the pipe hangers and support steel components (clevis, roller, guides, etc.) and related structural steel framing per Division 9 Section "Painting."
 - 4. Finish paint color for these items to be selected by project architect and approved by the owner.
 - F. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
 - G. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.
 - H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable Clevis Hanger (MSS Type 1): For suspension of stationary pipes, NPS 1/2 to NPS 30. These hangers are permitted only where no movement is expected.
 - 2. Where noted on drawings, for suspension of plastic pipe such as polypropylene and PEXa, use the clevis hanger specified, except with vee bottom, in conjunction with a continuous vee channel such as Eaton B-Line series B3106 or equal pipe support and pipe/socket clamp.
 - 3. Single Pipe Roll (MSS Type 41): For support of pipes, NPS 3/4 to NPS 30, from two (2) threaded rods if longitudinal movement caused by expansion and contraction might occur.
 - 4. Adjustable Steel Yoke Pipe Roll (MSS Type 43): For suspension of insulated pipe sizes NPS 2 1/2 to NPS 24, from one (1) threaded rod if longitudinal movement caused by expansion and contraction might occur.
 - 5. Split Ring Hangers, such as MSS Type 12, will be permitted only to support the short vertical runs to plumbing fixtures. Further use, on an exception basis, requires advance written approval by engineer.
 - I. 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 20.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
 - J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 - 2. Threaded Rods: For dry interior and temporary installations, use ASTM F1554, Grade 36, manufactured from ASTM A36 low carbon steel, standard threaded rods, hot-dip galvanized according to ASTM A153. Such low carbon steel threaded rods shall never be

- plain finish. For exterior, damp, and wet locations utilize ASTM A276, Type 316 stainless steel threaded rods. Rod couplings shall match threaded rod material and finish.
3. Nuts: For dry interior and temporary installations, use ASME B18.2.2, ASTM A563, Grade A, Heavy Hex, carbon steel nuts only on threaded rods, sizes 1½" and smaller, and hot-dip galvanized according to ASTM A153. ASTM A563 nuts shall never be plain finish. For exterior, damp, and wet locations utilize ASTM A194, Grade 8M (Type 316 stainless steel) Heavy Hex nuts.
 4. Washers: For dry interior and temporary installations, use ASTM F 844, steel, flat washers, and hot-dip galvanized according to ASTM A153. ASTM F 844 washers shall never be plain finish. For exterior, damp, and wet locations utilize Type 316 stainless steel washers.
- K. Structure Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Welded-Steel Brackets: For support of pipes from above or below. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
- L. Insulated Piping: Comply with the following:
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 according to ASME B31.9.
- M. Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Protection Shields for pipe (MSS SP-58, Type 40):
 - a. Applications:
 - 1) Use where insulated piping NPS 2-1/2 and larger is indicated.
 - 2) Use where any insulated pipe is supported by a pipe roller.
 - 3) Use where insulated pipe NPS 2 and smaller is supported directly on a Prefabricated Trapeze-Framed Metal Strut System or trapeze hanger.
 - b. Of length recommended in writing by insert (pipe insulation) manufacturer to prevent more than 5% compression of the pipe insulation. Protection Shields shall span an arc of 180 degrees. Protection Shield dimensions (based upon the NPS "hanger sizes" noted below, that is, the pipe insulation outside diameter) shall be not less than the following:
 - 1) NPS 5 and smaller: 12 inches long and 0.048 inch thick (18 gauge)
 - 2) NPS 6 and NPS 8: 12 inches long and 0.06 inch thick (16 gauge)
 - 3) NPS 10: 18 inches long and 0.06 inch thick (16 gauge)
 - 4) MSS SP-58 requires Protection Shield gages listed above to be for use with clevis hangers only. For "point loading", the Protection Shield thickness and possibly length shall be increased. "Point loading" shall be interpreted to be the following support conditions. Demonstrate compliance in the submittal.

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- (a) Any insulated pipe supported by a pipe roller.
 - (b) Pipe size NPS 2 and smaller where insulated and supported directly on a Prefabricated Trapeze-Framed Metal Strut System or trapeze hanger.
- c. Pipes NPS 2-1/2 and larger shall include Polyisocyanurate Fabricated Pipe Insulation or Calcium Silicate Fabricated Pipe Insulation inserts meeting requirements found in Section 220719 Plumbing Pipe Insulation. Insert material shall span an arc of 180 degrees at the lower half of the pipe, shall be at least as long as Protection Shield where vapor barrier is not indicated, shall extend two inches beyond each end of Protection Shield where vapor barrier is indicated, and be comprised of a singular piece of clamshell rigid molded pipe insulation.
- 2. As an alternative to Protection Shields where required above, Thermal-Hanger & Support Shield Inserts as specified further below may be used: For supporting insulated pipe; with same insulation thickness as piping insulation.
- N. Spring Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
- O. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- P. Use mechanical expansion anchors or adhesive anchors instead of building attachments where required in concrete construction.

2.04 MATERIALS FOR METAL FABRICATED SUPPORTS: COMPLY WITH SECTION 05 50 00.

- A. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
- B. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - 2. Thomas & Betts Corporation: www.tnb.com/#sle.
 - 3. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
 - 4. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- C. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
- D. Strut Channel or Bracket Material:
 - 1. Indoor Dry Locations: Use galvanized steel.
 - 2. Outdoor and Damp or Wet Indoor Locations: Use stainless steel.
- E. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
- F. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.

2.05 TRAPEZE HANGERS

- A. Description: MSS SP-69, Type 59 prefabricated back-to-back channel assembly, or alternatively shop- or field-fabricated pipe-support assembly of a similar format and function fabricated from structural carbon-steel shapes as specified under Miscellaneous Material in this Section.

- B. Except where arrangement justifies otherwise, trapeze hangers are to be installed with hanger-rod attachments (threaded rods, nuts, washers, and steel turnbuckles where appropriate) as specified in this Section.
- C. Metal Trapeze Hanger Installation for piping systems: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-assembled trapeze hangers.
 - 1. Pipes of Various Sizes: Support together and space trapeze hangers for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Select for loads being supported. Brace trapeze hanger if required due to pipe thermal expansion forces.
 - 3. Piping shall be supported from Trapeze Hangers and/or Prefabricated Trapeze-Framed Metal Strut Systems using only Horizontal-Piping Hangers and Supports (Adjustable Clevis Hangers, Single Pipe Roll, Adjustable Steel Yoke Pipe Roll, etc.) indicated in this Section, along with guides and independent anchors as needed.
 - a. Alternatively, at contractor discretion, insulated piping NPS 2 and smaller only may rest on Trapeze Hangers and/or Prefabricated Trapeze-Framed Metal Strut Systems if furnished with Protection Shields and guided with either U-Bolts or spider guides. U-Bolts are to be either MSS Type 24 or U-bolts may be field or shop fabricated from similar diameter threaded rod as specified in this Section.

2.06 THERMAL-HANGER & SUPPORT SHIELD INSERTS

- A. Description: 95-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Carpenter & Paterson, Inc.
 - 2. ERICO/Michigan Hanger Co.
 - 3. PHS Industries, Inc.
 - 4. Pipe Shields, Inc.
 - 5. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- C. Insulation-Insert Material:
 - 1. Polyisocyanurate Fabricated Pipe Insulation or Calcium Silicate Fabricated Pipe Insulation inserts meeting requirements found in Section 220719 Plumbing Pipe Insulation.
 - 2. ASTM C 552, Type II cellular glass similarly fabricated pipe insulation may be an acceptable alternate.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.
- F. Thermal-Hanger & Support Shield Installation: Install in pipe hanger or shield for insulated piping.
- G. Field install mastic or coating over insulation, notably at perimeter of Thermal-Hanger & Support Shield Inserts, to provide a protective barrier where vapor barrier is not required. Field install vapor barrier mastic or coating over insulation, notably at perimeter of Thermal-

Hanger & Support Shield Inserts, to provide a vapor barrier and protective barrier where vapor barrier is required.

2.07 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.08 MISCELLANEOUS MATERIALS

- A. This article shall pertain to structural steel framing and supports necessary to support piping and equipment only to the extent there is not a Division 5 Section "Metal Fabrications" or notes on the structural drawings addressing same. If so, these shall supersede this article.
- B. All structural steel shall conform to the latest issue of the American Institute of Steel Construction specifications for the design, fabrication, and erection of structural steel for buildings (AISC-360) and Structural Welding Code – Steel (AWS D1.1.) Structural steel shall be hot-dip galvanized according to ASTM A123 (Coating Grade 100 – 3.94 mils minimum) except areas to receive field welds. Apply ZRC cold galvanizing compound to field weld areas. Refer also to structural drawings and specifications such as for requirements for column base plate anchor bolts.
- C. Material for Structural Steel Shapes, to include plates, bars, channels and angles shall be carbon steel conforming to ASTM A36.
- D. Material for Structural Steel Wide Flange Beam Shapes shall be carbon steel conforming to ASTM A992.
- E. Material for Hollow Structural Sections (HSS) shall be carbon steel, cold formed, rectangular, yield strength 46 ksi minimum, conforming to ASTM A500, Grade B.
- F. Structural Steel bolted connection shall conform to the following:
 - 1. Structural Bolts: ASTM A325, Type 1, heavy hex steel, hot-dip galvanized according to ASTM A153, Class C.
 - 2. Nuts: ASTM A563, heavy hex carbon-steel, hot-dip galvanized according to ASTM A153, Grade C. Retap nuts in accordance with ASTM A385.
 - 3. Washers: ASTM F436 hardened carbon-steel, hot-dip galvanized according to ASTM A153, Class C.
- G. Refer to structural drawings and specifications for fastening systems such as mechanical expansion anchors and adhesive anchors.
- H. See Division 22 "Plumbing General Provisions" for grout.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- E. Cutting, notching and boring holes of steel floor / roof decking shall be as prescribed by the registered design professional.
- F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

- G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- H. Secure fasteners according to manufacturer's recommended torque settings.
- I. Remove temporary supports.
- J. Metal Channel (Strut) Framing Systems: Install per the MFMA published "Guidelines for the use of Metal Framing, latest edition."

3.02 HANGER AND SUPPORT INSTALLATION

- A. Install hangers and supports complete with necessary inserts, bolts, threaded rods, nuts, washers, shims, and other accessories.
- B. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- C. 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.
- D. For drain piping installed near the floor inside buildings, the piping shall be supported as follows:
 - 1. Preference is to support piping from above using a premanufactured Welded-Steel Bracket or similar, in accordance with this Division 22 Section, secured to wall.
 - 2. Alternatively, piping may be supported from the floor if using only stainless steel support products within three inches (3") of the floor.
- E. Install lateral bracing with pipe hangers and supports to prevent swaying.
- F. Install structure attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- G. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 are not exceeded.
- I. Refer to specific plumbing piping Sections for hanger spacing maximum and threaded rod minimum size requirements.
- J. Secure slide base plates to steel frames provided for such purpose by welding.
- K. Contractor shall be responsible for coordination of structural steel frames and supports necessary to properly support piping hangers and supports.

3.03 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 smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.04 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for pipe supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 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 contours of welded surfaces match adjacent contours.

3.05 ADJUSTING

- A. Support Adjustments: Adjust supports to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.06 PAINTING

- A. Touch Up: 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 A 780.
- C. Coatings: All pipe supports and secondary steel that are hot-dip galvanized carbon steel - The galvanizing shall be ground back to a depth of one to four inches prior to welding. A high zinc dust paint shall be used for touch-up after installation in accordance with MIL-P-21035

END OF SECTION

SECTION 22 05 53
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Pipe markers.
- D. Ceiling tacks.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2007.
- B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2013.

1.04 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Schedules:
 - 1. Submit plumbing component identification schedule listing equipment, piping, and valves.
 - 2. Detail proposed component identification data in terms of of wording, symbols, letter size, and color coding to be applied to corresponding product.
 - 3. Valve Data Format: Include id-number, location, function, and model number.
- C. Product Data: Provide manufacturers catalog literature for each product required.
- D. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
- E. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.01 PLUMBING COMPONENT IDENTIFICATION GUIDELINE

- A. Valves: Tags and ceiling tacks where located above lay-in ceiling.
- B. Tanks: Nameplates.
- C. Pumps: Nameplates.
- D. Pipe Markers: 3/4 inch diameter and higher.

2.02 NAMEPLATES

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Brimar Industries, Inc; _____: www.pipemarker.com/#sle.
 - 2. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 3. Seton Identification Products: www.seton.com/#sle.
 - 4. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Description: Laminated piece with up to three lines of text.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/4 inch.
 - 3. Background Color: Black.
 - 4. Nameplate Material:
 - a. Flexible: Vinyl with adhesive backing per ASTM D709.

2.03 TAGS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Advanced Graphic Engraving: www.advancedgraphicengraving.com/#sle.
 - 2. Brady Corporation: www.bradycorp.com/#sle.
 - 3. Brimar Industries, Inc; _____: www.pipemarker.com/#sle.
 - 4. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 5. Seton Identification Products: www.seton.com/#sle.
 - 6. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Metal: Brass, 19 gauge 1-1/2 inch in diameter with smooth edges, stamped and black filled, and corrosion-resistant ball chain. Up to three lines of text.
- C. Valve Tag Chart: Typewritten 12-point letter size list in anodized aluminum frame.

2.04 PIPE MARKERS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Brady Corporation: www.bradycorp.com/#sle.
 - 2. Brimar Industries, Inc; _____: www.pipemarker.com/#sle.
 - 3. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 4. Seton Identification Products: www.seton.com/#sle.
 - 5. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Color: Comply with ASME A13.1.
- C. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- D. Flexible Tape Pipe Markers: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.
- E. Underground Plastic Pipe Markers: Bright-colored continuously printed ribbon tape, minimum 6 inches wide by 4 mil, 0.004 inch thick, manufactured for direct burial service.
- F. Identification Scheme, ASME A13.1:
 - 1. Primary: External Pipe Diameter, Uninsulated or Insulated.
 - 2. Secondary: Color scheme per fluid service.
 - a. Water; Potable, Cooling, Boiler Feed, and Other: White text on green background.

2.05 CEILING TACKS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 - 2. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Description: Steel with 3/4 inch diameter color coded head.
- C. Color code as follows:
 - 1. Plumbing Equipment: Yellow.
 - 2. Plumbing Valves: Green.

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive identification products.

3.02 INSTALLATION

- A. Install flexible nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags in clear view and align with axis of piping
- C. Install plastic pipe markers in accordance with manufacturer's instructions.
- D. Install plastic tape pipe marker around pipe in accordance with manufacturer's instructions.
- E. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 22 07 19
PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping insulation.
- B. Glass fiber insulation.
- C. Calcium silicate fabricated pipe insulation.
- D. Elastomeric insulation.
- E. Weather barrier coatings.
- F. Jackets and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 07 8413 - Penetration Firestopping: Through-penetration firestop systems.
- B. Section 22 1116 - Domestic Water Piping: Placement of hangers and hanger inserts.
- C. Section 22 0529 - Hangers and Supports for Plumbing Piping and Equipment: Placement of hangers and hanger inserts.
- D. Section 22 1413 - Storm Drainage Piping: Placement of hangers and hanger inserts.
- E. Section 22 4000 - Plumbing Fixtures: ADA Compliant Under-sink / Under-lavatory Piping Covers.

1.03 REFERENCE STANDARDS

- A. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.
- B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2013.
- C. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2013).
- D. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2013).
- E. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2010.
- F. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2013.
- G. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2014.
- H. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2015.
- I. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing; 2010.
- J. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation; 2015.
- K. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2013).
- L. ASTM D1056 - Standard Specification for Flexible Cellular Materials--Sponge or Expanded Rubber; 2014.
- M. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics; 2012.
- N. ASTM D5590 - Standard Test Method for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay; 2017.

- O. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- P. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2014.
- Q. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.
- D. Armacell Qualified Installer Program (AQIP) training certifications or equal by actual flexible elastomeric cellular product manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum three years of experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.07 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, UL 723, ASTM E84, or UL 723.

2.02 GLASS FIBER, RIGID

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. CertainTeed Corporation; _____: www.certainteed.com/#sle.
 - 2. Johns Manville Corporation: www.jm.com/#sle.
 - 3. Knauf Insulation: www.knaufinsulation.com/#sle.
 - 4. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
 - 5. Manson Insulation: www.imanson.com.
 - 6. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Insulation: ASTM C547; rigid molded, noncombustible.
 - 1. Heavy-density, one-piece insulation made from inorganic glass fibers bonded with a thermosetting resin.
 - 2. Materials to comply with ASTM C 547, Type I, Grade A, 850°F or ASTM C 547, Type IV, 1,000°F.
 - 3. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
 - 4. Furnish with factory-applied ASJ jacket.

5. Complete, integrated system to meet maximum 25/50 flame-spread/smoke-developed indexes per ASTM E84.
 6. Thermal Conductivity (k Values): 0.23 BTU-in/hr-sq.ft.-°F at 75 deg F per ASTM C335.
 7. Service Temperature Range not less than 0 to 850°F.
 8. Moisture Sorption after 96 hours @120°F, 95%RH, ASTM C1104.
 - a. Fiberglass products: <5% by weight.
 9. Water Vapor Transmission: Jacket water vapor permeance of 0.02 perms or less per ASTM E96.
- C. Provide Hamfab Type 1000°, as manufactured by ICA Insulation, or approved equal, preformed (molded under heat and pressure with thermo-setting resin) fiberglass or mineral wool pipe fitting insulation in two matching half sections. Routed, mitered, or segmented fitting insulation made from blocks, boards, or pipe insulation shall not be accepted. Mitered or segmented fitting insulation made from pipe insulation will be accepted in lieu of specified Hamfab product for pipe sizes 2" and under only. Where "Hamfab" is mentioned below, it shall include these mitered or segmented fittings 2" and under. Fitting insulation shall be 4-10 lb per cu.ft. density and shall also comply with the glass fiber insulation properties directly above, except furnish fitting insulation unfaced from the factory.
1. For Hamfab pipe fittings, install PVC fitting covers (except where aluminum fitting covers are specifically indicated, that is, for exterior pipe fittings and for heat traced pipe fittings.)
 2. Where PVC covers are not molded or otherwise commercially available, such as for valves and some joints, install glass cloth or 100% cotton canvas, 6–8 oz., with mastic or coating over fitting insulation to provide a protective barrier. Canvas shall be as manufactured by GLT Products, Chas. Harmon & Company, Inc., or approved equal. Glass cloth shall be rewettable fiberglass cloth Ami-Glas Cloth style no. RGL1450 as manufactured by Auburn Manufacturing, Inc. (14.5 oz/sq.yd. minimum, 0.027" thickness minimum) or approved equal.
 3. Install all per manufacturers' written instructions.
 4. PVC fitting covers with fiberglass inserts will not be permitted.
 5. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- D. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
- E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- F. Vapor Barrier Lap Adhesive: Compatible with insulation.
- G. Indoor Vapor Barrier Finish:
1. Vinyl emulsion type acrylic, compatible with insulation, black color.
- H. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

2.03 CALCIUM SILICATE FABRICATED PIPE INSULATION

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
1. Johns Manville Corporation; Thermo-1200® pipe insulation:
www.jm.com/#sle. (Alternate product for inserts beneath Protection Shields; refer to Section 220529 Hangers and Supports for additional insert requirements.)

2. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Insulation: ASTM C533 Type 1, ASTM C585, and ASTM C795; rigid molded, noncombustible, asbestos free, gold color.
 1. Factory fabricate shapes according to ASTM C450 and ASTM C585. Pipe insulation shapes are required in two matching half sections (180 degree single pieces thru 24" diameter size.) Routed, mitered, or segmented pipe insulation made from blocks or boards shall not be accepted
 2. Complete, integrated system to meet 0/0 flame-spread/smoke-developed indexes per ASTM E84.
 3. Thermal Conductivity (k Values): 0.344 BTU-in/hr-sq.ft.-°F at 100°F mean temperature per ASTM C335 (Pipe.)
 4. ASTM C165 Compressive Strength: >100psi, 5% compression.
 5. ASTM C447 Maximum Service Temperature: 1,200 degrees F.
 6. ASTM C302 Density (dry) average: <15 pcf.
 7. Water resistant, engineered to withstand a heavy rainfall (1¼" of rain/hour) for up to 20 minutes without absorbing more than 15% of its weight in water.
 8. Proprietary corrosion inhibitor, called XOX Corrosion Inhibitor®, is integral to the chemical makeup and helps protect against corrosion under insulation (CUI) to the outside surfaces of carbon steel and stainless steel pipe.
 9. Field install mastic or coating over insulation, notably at perimeter of shield, to provide a protective barrier where vapor barrier is not required. Field install vapor barrier mastic or coating over insulation, notably at perimeter of shield, to provide a vapor barrier and protective barrier where vapor barrier is required.
- C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- D. Insulating Cement: ASTM C449.

2.04 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 1. Aeroflex USA, Inc; Aerocel Stay-Seal with Protape (SSPT): www.aeroflexusa.com/#sle (sub-paragraph B.2 below)
 2. Armacell LLC; AP Armaflex, 1-1/2" through 2" wall: www.armacell.us/#sle (sub-paragraph B.2 below)
 3. Armacell LLC; AP Armaflex, 3/8" through 1" wall: www.armacell.us/#sle (sub-paragraph B.1 below)
 4. K-Flex USA LLC; K-Flex Titan: www.kflexusa.com/#sle (sub-paragraph B.1 below)
 5. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Comply with one of the following, in accordance with sub-paragraph D below:
 1. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Type 1, Grade 1; use molded tubular material wherever possible.
 - a. Material: Closed-cell expanded rubber or NBR/PVC (Nitrile Butadiene Rubber) polymeric blend.
 - b. Minimum Service Temperature: -70 degrees F.
 - c. Maximum Continuous Service Temperature: 220 degrees F.

- d. Thermal Conductivity (k Values): 0.245 (or 0.23) BTU-in/hr-sq.ft.-°F at 75°F per ASTM C 177 or C 518.
 - e. Connection: Waterproof vapor barrier adhesive.
 - 2. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Type 1, Grade 1; use molded tubular material wherever possible.
 - a. Material: Closed-cell EPDM-based rubber.
 - b. Minimum Service Temperature: -320 degrees F.
 - c. Maximum Continuous Service Temperature: 257 degrees F.
 - d. Thermal Conductivity (k Values): 0.28 BTU-in/hr-sq.ft.-°F at 75°F per ASTM C 177 or C 518.
 - e. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.
- D. PEX tubing for domestic water applications, that is scheduled to be insulated with flexible elastomeric cellular insulation, in horizontal, vertical, and inverted installations to be supported from insulation clamps / clips as specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment" to maintain continuous insulation of piping system. Comply with manufacturer's installation instructions.
- E. Flexible elastomeric cellular components shall be installed per manufacturer's written instructions and by trained and currently certified installers under Armacell Qualified Installer Program (AQIP), or equal by actual product manufacturer. Submittal of such training and manufacturer certification shall be required before the start of work.

2.05 WEATHER BARRIER COATINGS

- A. Weather-Resistive Barrier Coating: Fire-resistive, UV resistant, water-based mastic for use over closed cell polyethylene and polyurethane foam insulation; applied with glass fiber or synthetic reinforcing mesh.
 - 1. Manufacturers:
 - a. H.B. Fuller Construction Products, Inc; Childers - CP Series Weather Barrier Coating: www.fosterproducts.com/#sle.
 - 2. Surface Burning Characteristics: Flame spread index of 25 or less, smoke developed index of 450 or less, Class A, when tested in accordance with ASTM E84.
 - 3. Water Vapor Permeance: Greater than 1.0 perm in accordance with ASTM E96/E96M.
 - 4. Resistance to Fungal Growth: No growth when tested in accordance with ASTM D5590.

2.06 JACKETING AND ACCESSORIES

- A. PVC Plastic Jacket:
 - 1. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Johns Manville Corporation; Zeston 2000 Series White PVC: www.jm.com/#sle.
 - b. Proto Corp.; LoSmoke PVC Fitting Covers: www.protocorporation.com.
 - c. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
 - 2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 20 mil.

- e. Connections: Brush on welding adhesive.
 - f. Containing UV inhibitor.
- 3. Covering Adhesive Mastic: Compatible with insulation.
- B. Aluminum Jacket:
 - 1. Thickness: 0.020 inch sheet.
 - 2. Finish: Smooth.
 - 3. Joining: Longitudinal slip joints and 2 inch laps.
 - 4. Fittings: 0.024 inch thick die shaped fitting covers with factory attached protective liner.
 - 5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with North American Insulation Manufacturers Association (NAIMA) National Insulation Standards.
- C. Exposed Piping: Locate insulation and cover seams in least visible locations.
- D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, _____, and expansion joints.
- E. Glass fiber insulated pipes conveying fluids below ambient temperature:
 - 1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic. Insulation shall have a complete and continuous vapor barrier with no openings at valve stems, pipe hangers, etc.
 - 2. Insulate fittings with insulation noted above. Insulate joints and valves with molded insulation of like material and thickness as adjoining pipe. Finish each fitting, joint, and valve with one of the following depending on the application:
 - a. Where PVC covers are indicated, but are not molded or otherwise commercially available, such as for valves and some joints, install glass cloth or 100% cotton canvas, as specified above, with vapor barrier mastic or coating over insulation to provide a protective barrier.
 - b. On exterior systems and for heat traced systems install aluminum covers.
 - c. For other systems, install PVC covers.
- F. For hot piping conveying fluids 110 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- G. For hot piping conveying fluids over 110 degrees F, insulate flanges and unions at equipment.
- H. Glass fiber insulated pipes conveying fluids above ambient temperature:
 - 1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples.
 - 2. Insulate fittings with insulation noted above. Insulate joints and valves with molded insulation of like material and thickness as adjoining pipe. Finish each fitting, joint, and valve with one of the following depending on the application:

- a. Where PVC covers are indicated, but are not molded or otherwise commercially available, such as for valves and some joints, install glass cloth or 100% cotton canvas, as specified above, with mastic or coating over insulation to provide a protective barrier.
 - b. On exterior systems and for heat traced systems install aluminum covers.
 - c. For other systems, install PVC covers.
- I. Inserts and Shields:
 1. Application: Piping 1 inches diameter and larger.
 2. Furnish insulation shields with or without inserts for NPS 1 thru NPS 2 insulated pipe supports, because these smaller pipe sizes are unlikely to significantly compress the pipe insulation. Furnish Polyisocyanurate Fabricated Pipe Insulation or Calcium Silicate Fabricated Pipe Insulation as an insert in addition to insulation shields for NPS 2-1/2 and larger insulated plumbing pipe supports. Furnish same thickness insert as adjacent insulation. Using wood, high density molded fiberglass, or other insert materials not meeting this Section will not be accepted.
 3. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 4. Insert Location: Between support shield and piping and under the finish jacket.
 5. Insert Configuration: Insert material shall be at least as long as protective shield, of same thickness and contour as adjoining insulation, and factory fabricated.
 6. Insert Material: Polyisocyanurate insulation or Calcium silicate insulation.
 7. Refer to also inserts and shields requirements in Division 23 Section "Hangers and Supports for Plumbing Piping and Equipment."
- J. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 078400.
- K. Insulated pipe exposed in kitchens, bathrooms, walkin coolers, food processing areas, and other sanitary finished spaces where regular cleaning of piping is required, as well as where exposed indoors in a location that is potentially subject to damage: Cover such pipe, fittings, joints, and valves with PVC jacket, locate seams on bottom side of horizontal piping. Overlap radial joints to shed water for vertical piping. PVC jacket in these areas shall be installed as a redundant vapor barrier, where installed over the factory-applied ASJ jacket, and all PVC jacket joints shall be sealed with mastic or coating to provide vapor barrier and protective barrier suitable for hose washdown when needed.
- L. Exterior applications, walkin freezers (since heat traced), and parking garages: Provide vapor barrier jacket. Insulate pipe and fittings with insulation noted above. Insulate joints and valves with molded insulation of like material and thickness as adjoining pipe. Cover such pipe, fittings, joints, and valves with aluminum jacket, locate seams on bottom side of horizontal piping. Overlap radial joints to shed water for vertical piping.
- M. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.
- N. Where plastic pipe and fittings, such as those for sanitary waste and vent and storm with PVC jacket material, are to be installed within an air distribution plenum, they shall be insulated with specified pipe insulation, field installed.
 1. The pipe insulation shall meet the requirements of CAN/ULC-S102.2-2018 or ASTM E84.
 2. The system shall have a Flame Spread Classification of less than 25 and Smoke Development rating of less than 50.

3.03 SCHEDULES

A. Plumbing Systems.

Service	Size	Insulation Thickness	Insulation Type
Domestic Cold Water	3/4" and Smaller	1/2"	Glass Fiber
Domestic Cold Water	1" and Larger	1"	Glass Fiber
Domestic Hot Water	1-1/4" and Smaller	1"	Glass Fiber
Domestic Hot Water	1-1/2" and Larger	1-1/2"	Glass Fiber
Domestic Hot Water Recirc.	1-1/4" and Smaller	1"	Glass Fiber
Domestic Hot Water Recirc.	1-1/2" and Larger	1-1/2"	Glass Fiber
Isolation Valves, Control Valves, Specialties, Strainers, Automatic Flow Control Valves, and Calibrated Balance Valves	All Sizes	Match Pipe Insulation Thickness	Glass Fiber
Roof Drains	All Sizes	1"	Flexible Elastomeric Cellular Insulation
Rain Water Conductors (Horizontal & Vertical)	All Sizes	1"	Glass Fiber
Condensate Drains	All Sizes	1/2"	Glass Fiber

END OF SECTION

SECTION 22 10 08
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 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes soil and waste, sanitary drainage and vent, and corrosive waste piping piping inside the building and to locations indicated.
- B. This Division 22 Section shall apply in every respect to temporary piping shown on drawings. Temporary piping shall be removed and areas restored to pre-existing conditions after Commissioning of permanent piping systems, unless otherwise indicated on the drawings.

1.03 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with the following minimum design (working) pressure ratings, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 20-foot head of water.
 - 2. Sanitary Sewer, Force-Main Piping: 100 psig.
 - 3. Corrosive Waste Piping: 30-foot head of water.

1.04 REFERENCE STANDARDS

- A. ASME B31.9 - Building Services Piping; 2020.
- B. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2013a.
- C. ASTM A888- Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2021.
- D. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2012.
- E. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2013.
- F. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2012.
- G. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings; 1996 (Reapproved 2010).
- H. ASTM D3311 - Standard Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns; 2017
- I. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe; 2010.
- J. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 1992 (Reapproved 2008).
- K. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications; Cast Iron Soil Pipe Institute; 2018.
- L. 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; Cast Iron Soil Pipe Institute; 2011
- M. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2013.
- N. MSS SP-58-2018 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation which includes Amendment 1 Issued 10-17-2019.

- O. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.
- P. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.

1.05 RELATED SECTIONS

- A. Division 7 Section "Penetration Firestopping" for through-penetration firestop systems.
- B. Division 8 Section "Access Doors and Panels."
- C. Division 22 Section "Plumbing General Provisions" for additional quality assurance requirements, joining materials, field testing requirements, and more.
- D. Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment".

1.06 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: For pipe, tube, fittings, and couplings. Provide manufacturers catalogue information.
- C. Firestopping materials.
- D. Shop Drawings: For drainage system, include plans, elevations, sections, and details.
- E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- F. Project Record Documents: Field survey and document actual locations and sizes of sanitary waste and vent piping, corrosive waste and vent piping, transitions, pipe fittings, cleanouts, fixtures, etc. Record changes in pipe location and additional fittings used. Record drawings are to be contractor-prepared by modifying the source digital files (typically AutoCAD and/or Revit to be furnished by the Design Engineer.) Submit both the modified digital files as well as Adobe PDF format record drawings. Refer to Division 22 Section "Plumbing General Provisions" and the Division 1 specifications for additional record drawing requirements.

1.07 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Reference Division 22 Section "Plumbing General Provisions" for additional Quality Assurance requirements.
- C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials and installation.
- D. Installer Qualifications: Company specializing in performing work of the type specified in this section, with minimum 3 years of experience.

1.08 FIELD CONDITIONS

- A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Flexible Transition Couplings for Underground Nonpressure Piping: ASTM C 1173 with elastomeric sleeve. Include ends of same sizes as piping to be joined and include corrosion-resistant metal band on each end.

2.02 PVC PIPE AND FITTINGS, BURIED WITHIN 5 FEET OF THE BUILDING

- A. Solid-Wall PVC Pipe: ASTM D 2665, Schedule 40, drain, waste, and vent.
 - 1. PVC Joints: Solvent welded, with ASTM D 2564 solvent cement, ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

2. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Charlotte Pipe and Foundry Company (Basis of Design)
 - b. North American Pipe
 - c. Spears Manufacturing Co.
 - d. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Solid-Wall PVC Pipe: ASTM D 2665, Schedule 40 or ASTM D3034 SDR 35.
 1. PVC Joints: Push-on, using ASTM F477 elastomeric gaskets.
 2. Not permissible for use with force-main piping.
 3. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Charlotte Pipe and Foundry Company (Basis of Design)
 - b. North American Pipe
 - c. Spears Manufacturing Co.
 - d. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

2.03 PVC PIPE AND FITTINGS, ABOVE GRADE

- A. Solid-Wall PVC Pipe: ASTM D 2665, Schedule 40, drain, waste, and vent.
 1. PVC Joints: Solvent welded, with ASTM D 2564 solvent cement, ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
 2. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Charlotte Pipe and Foundry Company (Basis of Design)
 - b. North American Pipe
 - c. Spears Manufacturing Co.
 - d. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

2.04 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A888 or CISPI 301. All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF International.
 1. Heavy-Duty, FM-Approved Couplings: ASTM A 666, Type 304, stainless-steel housing; stainless-steel bands; and sleeve.
 - a. NPS 1-1/2 to NPS 4: 3-inch wide housing with 4 bands.
 - b. NPS 5 to NPS 10: 4-inch wide housing with 6 bands.
 2. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Charlotte Pipe and Foundry Company (Basis of Design)
 - b. Tyler Pipe and Foundry
 - c. AB&I Foundry
 - d. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

PART 3 EXECUTION

3.01 EXCAVATION

- A. Refer to Division 31 Section "Site Earthwork" for excavating, trenching, and backfilling.

3.02 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.
- B. Aboveground, Soil, Waste, and Vent Piping, to include condensate from equipment, and Aboveground, Kitchen Grease Waste and Vent Piping: Use the following piping materials:
 - 1. NPS 3/4 and larger: No-hub cast iron pipe with matching fittings and heavy duty couplings.
 - 2. For fire resistance rated wall penetrations, penetrations through horizontal assemblies, etc. use firestopping with ratings determined by ASTM E814 or UL1479 for use with plastic piping.
- C. Underground, Soil, Waste, and Vent Piping, and Underground, Kitchen Grease Waste and Vent Piping: Use the either or both of the following piping materials:
 - 1. NPS 1-1/2 and larger: Solid Wall PVC Piping, Schedule 40, with solvent welded joints.
 - 2. NPS 1-1/2 and larger: Solid Wall PVC Piping, Schedule 40 or SDR 35, with push on joints.
 - 3. If both products are used, contractor shall select a size demarcation (say, all NPS 1-1/2 to NPS 4 is solvent welded joints, and all NPS 6 and larger is push joints.)

3.03 PIPING INSTALLATION

- A. Refer to Division 22 Section "Plumbing General Provisions" for basic piping installation.
- B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- C. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.
- D. Sleeve pipe passing through partitions, walls and floors. When installed as part of a UL-listed fire rated assembly, the sleeve shall meet the requirements of listing. Refer to Division 22 Section "Plumbing General Provisions" for additional sleeve and mechanical sleeve seal requirements.
- E. Firestopping: Install per requirements found in Division 22 Section "Plumbing General Provisions."
- F. 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 2 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.
- G. 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.
- H. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Sanitary Drain: 1/4" per 1'-0" to the extent possible. Otherwise, 1/8" per 1'-0" may be acceptable where necessary; confirm with plumbing engineer via RFI before

- installing any piping at 1/8" per 1'-0". Confirm site tie-in invert elevation requirements with civil engineer prior to installation.
2. Horizontal Sanitary Drainage Piping: 1/8" per 1'-0" to the extent possible. Otherwise, 1/8" per 1'-0" may be acceptable for sizes 3" and above, where necessary; confirm with plumbing engineer via RFI before installing any piping at 1/8" per 1'-0". Confirm site tie-in invert elevation requirements with civil engineer prior to installation.
 3. Vent Piping: 1/4" per 1'-0" to the extent possible. Otherwise, 1/8" per 1'-0" may be acceptable where necessary; confirm with plumbing engineer via RFI before installing any piping at 1/8" per 1'-0".
- I. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
 - J. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
 - K. Install underground PVC soil and waste drainage piping according to ASTM D 2321. Where beneath slab-on-grade, bury pipes with not less than 12" of cover, including the slab-on-grade thickness. In other locations, furnish at least 24 inches depth of cover. Give special attention to the selection, placement, and compaction of backfill material around shallow buried flexible pipe (such as PVC pipe), especially where beneath a road or similar surface, to prevent cracking of the surface materials. All bedding and backfill shall comply with the requirements of the currently adopted Plumbing Code
 - L. Select system components with pressure rating equal to or greater than system design (working) pressure.
 - M. Provide access where cleanouts and valves are not exposed. Coordinate size and location of access doors with Section 083113.

3.04 JOINT CONSTRUCTION

- A. Refer to Division 22 Section "Plumbing General Provisions" for basic piping joint construction.
- B. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.
 2. Hubless Joints: Make with heavy duty rubber gasket and sleeve or clamp couplings
- C. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.05 VALVE INSTALLATION

- A. Refer to Division 22 Section "Plumbing Valves" for general-duty valves.
- B. Shutoff Valves: Install shutoff valve on each sewage pump discharge.
 1. Use full-port ball valve for piping NPS 3 and smaller.
 2. Use gate valve for piping NPS 4 and larger.
- C. Check Valves: Install swing check valve, downstream from shutoff valve, on each sewage pump discharge.
- D. Backwater Valves: Install backwater valves in piping subject to sewage backflow.
 1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
 2. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.
 3. Install backwater valves in accessible locations.
 4. Refer to Division 22 Section "Plumbing Specialties" for backwater valves.

3.06 HANGER AND SUPPORT INSTALLATION

- A. Install pipe hanger and support devices in accordance with Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
 1. Vertical Piping: MSS Type 8 or Type 42, clamps.

2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install in accordance with ASME B31.9, MSS SP-58, MSS SP-69, and MSS SP-89.
- C. Support vertical piping and tubing at base and at each floor. Piping 2" and smaller shall be installed with mid-story guides. Support riser piping independently of connected horizontal piping.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install supports for vertical cast-iron soil piping every 15 feet.
- F. Install hangers for horizontal PVC piping with maximum spacing of 4 feet.
- G. Install supports for vertical PVC piping with maximum spacing of 10 feet. For sizes 2 inch and under, a guide shall be installed between required vertical supports. Such guides shall prevent pipe movement in a direction perpendicular to the axis of the pipe.
- H. Support piping and tubing not listed above according to MSS SP-69, manufacturer's written instructions, ASME B31.9, and plumbing code.
- I. Place hangers within 12 inches of each horizontal elbow.
- J. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

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. Refer to Division 22 Section "Plumbing Fixtures."
 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. Refer to Division 22 Section "Plumbing Piping Specialties."
 4. 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 and larger.
- D. Connect force-main piping to the following:
 1. Sanitary Sewer: To exterior force main or sanitary manhole.

3.08 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 and corrosive waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. 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. 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. 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.

3.09 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION

SECTION 22 10 10
PLUMBING SPECIALTIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following plumbing specialties:
 - 1. Water hammer arrestors.
 - 2. Balancing valves.
 - 3. Point of use thermostatic mixing valves.
 - 4. Strainers.
 - 5. Key-operation hydrants.
 - 6. Trap seal primer valves.
 - 7. Drain valves.
 - 8. Miscellaneous piping specialties.
 - 9. Sleeve penetration systems.
 - 10. Flashing materials.
 - 11. Cleanouts.
 - 12. Floor drains.
 - 13. Roof drains.
 - 14. Relief Valves.
- B. Related Sections include the following:
 - 1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers and pressure gages.
 - 2. Division 22 Section "Domestic Water Piping" for water meters.

1.03 DEFINITIONS

- A. The following are industry abbreviations for plastic piping materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. PE: Polyethylene plastic.
 - 3. PVC: Polyvinyl chloride plastic.

1.04 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:
 - 1. Domestic Water Piping: 125 psig.
 - 2. Sanitary Waste and Vent Piping: 10-foot head of water.
 - 3. Storm Drainage Piping: 10-foot head of water.
 - 4. Force-Main Piping: 100 psig.

1.05 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Include rated capacities and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections for the following:
 - 1. Backflow preventers and water regulators.
 - 2. Balancing valves, water filters, and strainers.

3. Digitally-controlled, thermostatic master mixing valves, thermostatic water mixing valves, water tempering valves, and point of use thermostatic mixing valves.
 4. Individual shower and tub-shower combination valves.
 5. Water hammer arresters, air vents, and trap seal primer valves and systems.
 6. Drain valves, hose bibbs, hydrants, and hose stations.
 7. Washing machine boxes and valves.
 8. Backwater valves, cleanouts, floor drains, open receptors, trench drains, and roof drains.
 9. Air-admittance valves, vent caps, vent terminals, and roof flashing assemblies.
 10. Grease interceptors, grease recovery units, oil interceptors, and solids interceptors.
 11. Sleeve penetration systems.
- C. Certificates: Certify that grease interceptors meet or exceed specified requirements.
- D. Shop Drawings: Diagram power, signal, and control wiring.
- E. Field test reports.
- F. Maintenance Data: For plumbing specialties to include in maintenance manuals. Include the following:
1. Backflow preventers and water regulators.
 2. Water filters.
 3. Digitally-controlled, thermostatic master mixing valves, thermostatic water mixing valves, water tempering valves, and point of use thermostatic mixing valves.
 4. Individual shower and tub-shower combination valves.
 5. Trap seal primer valves and systems.
 6. Hose stations and hydrants.
 7. Grease interceptors, grease recovery units, oil interceptors, and solids interceptors.

1.06 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of plumbing specialties and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- B. Plumbing specialties shall bear label, stamp, or other markings of specified testing agency.
- C. 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.
- D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials and installation.
- E. Certified to NSF 61, "Drinking Water System Components--Health Effects, Sections 1 through 9," for potable domestic water plumbing specialties.
- F. Certified to ANSI/NSF 372 - Drinking Water System Components – Lead content. Low lead content product compliance for potable domestic water plumbing specialties.

1.07 REGULATORY REQUIREMENTS

- A. Perform Work in accordance with state adopted plumbing code and any municipality requirements.
- B. Conform to applicable code for installation of backflow prevention devices.

1.08 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. Water Filter Cartridges: Equal to 200 percent of amount installed for each type and size indicated.

2. Operating Key Handles: Equal to 100 percent of amount installed for each key-operated hose bibb and hydrant installed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Products shall be as scheduled on the plumbing drawings. Any substitution shall be equivalent to the make and model scheduled. Acceptance of equivalency shall rest solely with the Engineer of Record and will be based on compliance with the specification and drawing schedule requirements, physical dimensions, product performance, materials of construction, maintenance requirements, and compliance with ADA Accessibility Guidelines and national standards.

2.02 WATER HAMMER ARRESTORS

- A. Water Hammer Arrestors: ASSE 1010 certified, NSF/ANSI 61 certified, copper barrel construction, piston type. Sizes indicated are based on ASSE 1010 or PDI-WH 201, Sizes A through F. Sized in accordance with PDI-WH 201. Max static pressure 250 PSI. Max spike pressure 400 PSI.
 1. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Josam Co.
 - b. Smith, Jay R. Mfg. Co.
 - c. Watts
 - d. Zurn Industries, Inc.; Specification Drainage Operation.
 - e. Precision Plumbing Products: www.pppinc.net (Basis of Design)
 - f. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
 2. Install water hammer arrestor on each individual DCW drop to water closet and flush valve.
 3. Install water hammer arrestor on each individual DCW & DHW drop to lavatory with foot pedal controls.
 4. Install water hammer arrestor on each individual DCW & DHW drop to scrub sink with knee valve control.

2.03 BALANCING VALVES

- A. Calibrated Balancing Valves: Adjustable, with two readout ports and memory setting indicator. Suitable for potable water applications. Include manufacturer's standard hoses, fittings, valves, differential pressure meter, and carrying case.
 1. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Nibco Inc. T-1810-LF (female NPT threaded ends - preferred) or S-1810-LF (solder ends.) DZR (dezincification resistant.) Basis of Design.
 - b. Victaulic Company. TA (Tour and Andersson) Series 790 (female NPT threaded ends.)
 - c. Macon Balancing. LL-STV (female NPT threaded ends - preferred) or LL-STVL (solder ends.)
 - d. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

2. NPS 2 and Smaller: Brass valve body and bonnet, adjustment knob/handwheel, positive shutoff, and calibrated nameplate.
3. 300 psi non-shock cold working pressure to 160°F, maximum temperature 260°F @ 150 psi. NSF/ANSI 61, NSF/ANSI 372.
4. Provide with two integral ports that can be used in field to measure pressure. Separate Pete's plug is required for temperature readings.
5. End connections: Threaded (preferred) or soldered. Pressed and grooved valve ends will not be accepted.
 - a. Furnish a deductive alternate price for owners' consideration to furnish mechanical press seal joints and pressed ends, to the extent the contractor prefers to utilize such products in lieu of those specified. Mechanical press seal joints furnished shall be only ProPress as manufactured by Viega. No other manufacturer's products will be permitted. ProPress components shall be installed per manufacturer's written instructions and by trained and currently certified installers. Submittal of such training and manufacturer certification shall be required before the start of work.
6. Ball valves are not permitted in lieu of these balancing valves.
7. Install per manufacturer's instructions; integral ports should not be facing down as they may collect dirt and debris and foul up, resulting in readout errors.

2.04 POINT OF USE THERMOSTATIC MIXING VALVES

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 1. Leonard Valve Company, 170A-LF (Basis of Design to supply one sensor faucet or one two handle manual faucet.)
 2. Symmons Industries, Inc., MaxLine TMV model 8210CK.
 3. Powers, A Watts Brand, LFG480
 4. Chicago Faucets.
 5. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. General: ASSE 1070 thermostatic water mixing valve with brass body, suitable to supply one sensor faucet or one two handle manual faucet.
 1. Operation and pressure rating 125 psig minimum, lead free.
 2. Integral inlet checks and stainless steel screens.
 3. 3/8" compression rough bronze finish, suitable for 3/8" tubing or flex hose installation. 1/2" NPT connections will only be acceptable if minimum flow required below is met.
 4. Manually adjustable temperature setting, vandal resistant locknut to prevent accidental adjustment.
 5. Minimum flow: 0.25 gpm certified to ASSE. Capacity at least 4 gpm @ 45psi differential.
 6. Certified to ASSE 1070. Certified to NSF 61.
 7. Furnish with mounting bracket (shipped loose.)
 8. Furnish with cold water bypass option (a tee fitting shipped loose) for use with two handle manual faucets, or provide similar cold water piping configuration as part of field installation.

2.05 STRAINERS

- A. Strainers: Y-pattern, unless otherwise indicated, and full size of connecting piping. Include ASTM A 666, Type 304, stainless-steel screens with 3/64-inch round perforations, unless otherwise indicated.

1. Pressure Rating: 125-psig minimum steam working pressure, unless otherwise indicated.
 2. NPS 2 and Smaller: Bronze body, with female threaded ends.
 3. NPS 2-1/2 and Larger: Cast-iron body, with interior AWWA C550 or FDA-approved, epoxy coating and flanged ends.
 4. Y-Pattern Strainers: Screwed screen retainer with centered blowdown.
 - a. Drain: Factory- or field-installed, hose-end drain valve.
 5. T-Pattern Strainers: Malleable-iron or ductile-iron body; access end cap with drain plug and access coupling with rubber gasket.
 6. Basket Strainers: Bolted flange or clamp cover, and basket with lift-out handle.
 - a. Type: Duplex with bronze or stainless-steel diverter valve and two baskets.
 - b. Drain: Factory- or field-installed, hose-end drain valve.
- B. Drainage Basket Strainers: Non-pressure-rated, cast-iron or coated-steel body; with bolted flange or clamp cover and drain with plug.
1. Basket: Bronze or stainless steel with 1/8- or 3/16-inch diameter holes and lift-out handle.
 2. Female threaded ends for NPS 2 and smaller, and flanged ends for NPS 2-1/2 and larger.

2.06 KEY-OPERATION HYDRANTS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
1. Josam Co.
 2. Simmons Manufacturing Co.
 3. Tyler Pipe; Wade Div.
 4. Watts Industries, Inc.; Drainage Products Div.
 5. Woodford Manufacturing Co.
 6. Zurn Industries, Inc.; Specification Drainage Operation.
 7. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. General: ASME A112.21.3M, key-operation hydrant with pressure rating of 125 psig.
1. Inlet: NPS 3/4 or NPS 1 threaded or solder joint.
 2. Outlet: ASME B1.20.7, garden-hose threads.
 3. Operating Keys: Two with each key-operation hydrant.
- C. Nonfreeze Exposed-Outlet Wall Hydrants: ASSE 1019, self-drainable with integral nonremovable hose-connection vacuum breaker or backflow preventer, casing and operating rod to match wall thickness, projecting outlet, and wall clamp.
1. Classification: Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
 2. Nozzle and Wall Plate Finish: Polished nickel bronze.
- D. Nonfreeze Concealed-Outlet Wall Hydrants: ASSE 1019, self-drainable with flush-mounting box with cover, integral nonremovable hose-connection vacuum breaker or backflow preventer, casing and operating rod to match wall thickness, concealed outlet, and wall clamp.
1. Classification: Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
 2. Box and Cover Finish: Polished nickel bronze.
- E. Hot and Cold, Nonfreeze Concealed-Outlet Wall Hydrants: With deep flush-mounting box with cover; hot- and cold-water casings and operating rods to match wall thickness;

concealed outlet; wall clamps; and factory- or field-installed, nonremovable and manual drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.

1. Box and Cover Finish: Polished chrome plate.

2.07 TRAP SEAL PRIMER VALVES

- A. Supply-Type Trap Seal Primer Valves: ASSE 1018, water-supply-fed type, with the following characteristics:

1. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. E & S Valves.
 - b. Josam Co.
 - c. Smith, Jay R. Mfg. Co.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Industries, Inc.; Water Products Div.
 - f. Zurn Industries, Inc.; Specification Drainage Operation.
 - g. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
2. 125-psig minimum working pressure.
3. Bronze body with atmospheric-vented drain chamber.
4. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
5. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
6. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

2.08 DRAIN VALVES

- A. Hose-End Drain Valves: MSS SP-110, NPS 3/4 ball valve, rated for 400-psig minimum CWP. Include two-piece, copper-alloy body with standard port, chrome-plated brass ball, replaceable seats and seals, blowout-proof stem, and vinyl-covered steel handle.

1. Inlet: Threaded or solder joint.
2. Outlet: Short-threaded nipple with ASME B1.20.7, garden-hose threads and cap.

2.09 CLEANOUTS

- A. Cleanouts, Comply with ASME A112.36.2M.

1. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Josam Co
 - b. Smith, Jay R. Mfg. Co.
 - c. Zurn Industries, Inc., Specification Drainage Operation
 - d. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
2. Body or Ferrule Material: Cast iron.
3. Clamping Device: Required.
4. Closure: Brass plug with straight threads and gasket.
5. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
6. Frame and Cover Shape: Round.
7. Top Loading Classification: Heavy Duty.

2.10 FLOOR DRAINS

- A. Floor Drains, Comply with ASME A112.21.1M with ASME A112.14.1, backwater valve.
 - 1. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Josam Co.
 - b. Smith, Jay R. Mfg. Co.
 - c. Zurn Industries, Inc.
 - d. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
 - 2. Body Material: See Plumbing Schedule on drawing.
 - 3. Clamping Device: Required.
 - 4. Trap Primer Connection: Required
 - 5. Interior Finish: See Plumbing Schedule on drawings.
 - 6. Top or Strainer Material: See Plumbing Schedule on drawings.
 - 7. Top of Body and Strainer Finish: See Plumbing Schedule on drawings.

2.11 ROOF DRAINS

- A. Roof Drains: Comply with ASME A112.21.2M.
 - 1. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Josam Co.
 - b. Smith, Jay R. Mfg. Co.
 - c. Zurn Industries, Inc.
 - d. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
 - 2. Body Material: Cast iron.
 - 3. Dome Material: Stainless steel.
 - 4. Underdeck Clamp: Required.

2.12 RELIEF VALVES

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Apollo Valves: www.apollovalves.com/#sle, Series 18C-500 (Basis of design T&P relief valve that meets ASME Section IV.) 3/4" to 2" bronze automatic temperature and pressure relief valve for protection of commercial hot water heaters and storage tanks. Coated elements for 3/4" and 1", SS elements for 1-1/2" and 2".
 - 2. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled for domestic water service intended. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.
 - 1. ASME Section IV: Heating Boilers.
- C. See Part 3 below for additional requirements.

2.13 MISCELLANEOUS PIPING SPECIALTIES

- A. Water Hammer Arresters: ASSE 1010 or PDI-WH 201, metal-bellows type with pressurized metal cushioning chamber. Sizes indicated are based on ASSE 1010 or PDI-WH 201, Sizes A through F.
 - 1. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Josam Co.
 - b. Smith, Jay R. Mfg. Co.
 - c. Tyler Pipe; Wade Div.
 - d. Zurn Industries, Inc.; Specification Drainage Operation.
 - e. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Hose Bibbs: Bronze body with replaceable seat disc complying with ASME A112.18.1M for compression-type faucets. Include NPS 1/2 or NPS 3/4 threaded or solder-joint inlet, of design suitable for pressure of at least 125 psig; integral, nonremovable, drainable hose-connection vacuum breaker; and garden-hose threads complying with ASME B1.20.7 on outlet.
 - 1. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
 - 2. Finish for Service Areas: Chrome or nickel plated.
 - 3. Finish for Finished Rooms: Chrome or nickel plated.
 - 4. Operation for Equipment Rooms: Wheel handle or operating key.
 - 5. Operation for Service Areas: Operating key.
 - 6. Operation for Finished Rooms: Wheel handle.
 - 7. Include operating key with each operating-key hose bibb.
 - 8. Include integral wall flange with each chrome- or nickel-plated hose bibb.
- C. Air Vents: Float type for automatic air venting.
 - 1. Bolted Construction: Bronze body with replaceable, corrosion-resistant metal float and stainless-steel mechanism and seat; threaded NPS 1/2 minimum inlet; 125-psig minimum pressure rating at 140 deg F; and threaded vent outlet.
 - 2. Welded Construction: Stainless-steel body with corrosion-resistant metal float, stainless-steel mechanism and seat, threaded NPS 3/8 minimum inlet, 150-psig minimum pressure rating, and threaded vent outlet.
- D. Roof Flashing Assemblies: Manufactured assembly made of 6-lb/sq. ft. .0938-inch thick, lead flashing collar and skirt extending at least 10 inches from pipe with galvanized steel boot reinforcement, and counterflashing fitting.
 - 1. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Acorn Engineering Company; Elmdor/Stoneman Div.
 - b. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
 - 2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
 - 3. Extended Vent Cap: With field-installed, vandal-proof vent cap.
- E. Open Drains: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting, joined with ASTM C 564, rubber gaskets.

- F. Deep-Seal Traps: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap seal primer valve connection.
 - 1. NPS 2: 4-inch minimum water seal.
 - 2. NPS 2-1/2 and Larger: 5-inch minimum water seal.
- G. Floor-Drain Inlet Fittings: Cast iron, with threaded inlet and threaded or spigot outlet, and trap seal primer valve connection.
- H. Fixed Air-Gap Fittings: Manufactured cast-iron or bronze drainage fitting with semiopen top with threads or device to secure drainage inlet piping in top and bottom spigot or threaded outlet larger than top inlet. Include design complying with ASME A112.1.2 that will provide fixed air gap between installed inlet and outlet piping.
- I. Stack Flashing Fittings: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
- J. Vent Caps: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and set-screws to secure to vent pipe.
- K. Vent Terminals: Commercially manufactured, shop- or field-fabricated, frost-proof assembly constructed of galvanized steel, copper, or lead-coated copper. Size to provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.
- L. Expansion Joints: ASME A112.21.2M, assembly with cast-iron body with bronze sleeve, packing gland, and packing; of size and end types corresponding to connected piping.
- M. Downspout Boots: ASTM A 48, gray-iron casting, with NPS 4 outlet; shop-applied bituminous coating; and inlet size to match downspout.
- N. Downspout Boots: ASTM A 74, Service class, hub-and-spigot, cast-iron soil pipe.

2.14 SLEEVE PENETRATION SYSTEMS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. ProSet Systems, Inc.
 - 2. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Description: UL 1479, through-penetration firestop assembly consisting of sleeve and stack fitting with firestopping plug.
 - 1. 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.
 - 2. Stack Fitting: ASTM A 48, gray-iron, hubless-pattern, wye-branch stack fitting with neoprene O-ring at base and gray-iron plug in thermal-release harness in branch. Include PVC protective cap for plug.
 - a. Special Coating: Include corrosion-resistant interior coating on fittings for plastic chemical waste and vent stacks.

2.15 FLASHING MATERIALS

- A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
 - 1. General Use: 4-lb/sq. ft., 0.0625-inch thickness.
 - 2. Vent Pipe Flashing: 3-lb/sq. ft., 0.0469-inch thickness.
 - 3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.
- B. Copper Sheet: ASTM B 152, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft..
2. Vent Pipe Flashing: 8 oz./sq. ft..
- C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
- D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- E. Fasteners: Metal compatible with material and substrate being fastened.
- F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- G. Solder: ASTM B 32, lead-free alloy.
- H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Refer to Division 22 Section "Plumbing General Provisions" for piping joining materials, joint construction, and basic installation requirements.
- B. 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 not acceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- C. Relief Valve Capacity and Installation:
 1. Install relief valve to protect each pressure vessel and elsewhere as required by ASME Boiler and Pressure Vessel Code. Comply with ASME Boiler and Pressure Vessel Code: Section IV and Section VIII, Division 1, for installation requirements. Select equipment relief valve capacity to exceed rating of connected equipment.
 2. Install relief valve discharge (vent) piping without valves. Pipe relief valve discharge as noted on drawings. If not indicated on drawings, pipe domestic water discharge to nearest suitable floor drain or indirect waste drain.
 3. Pipe relief valve discharge serving different equipment independently, even though relief valves piped to a common discharge header is not prohibited by any code.
- D. Install pressure regulators with inlet and outlet shutoff valves and balance valve bypass. Install pressure gages on inlet and outlet.
- E. Install strainers on supply side of each control valve, pressure regulator, and solenoid valve.
- F. Install trap seal primer valve and piping for each floor drain. All floor drains shall be fitted with trap seal priming systems. Trap primer to be connected to frequently used source.
- G. Install trap seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- H. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

- I. Install expansion joints on vertical risers, stacks, and conductors if indicated.
- J. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- K. Install cleanout deck plates with top flush with finished floor, for floor cleanouts for piping below floors.
- L. Install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.
- M. Install flashing flange and clamping device with each stack and cleanout passing through floors with waterproof membrane.
- N. Install vent flashing sleeves on stacks passing through roof. Secure over stack flashing according to manufacturer's written instructions.
- O. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- P. 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. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 - 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.
- Q. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.
 - 1. Install roof-drain flashing collar or flange so no leakage occurs between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
 - 2. Position roof drains for easy access and maintenance.
- R. Fasten wall-hanging plumbing specialties securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated.
- S. Fasten recessed-type plumbing specialties to reinforcement built into walls.
- T. Install wood-blocking reinforcement for wall-mounting and recessed-type plumbing specialties.
- U. Install individual shutoff valve in each water supply to plumbing specialties. Use ball, gate, or globe valve if specific valve is not indicated. Install shutoff valves in accessible locations. Refer to Division 22 Section "Plumbing Valves" for general-duty ball, butterfly, check, gate, and globe valves.

- V. Install air vents at piping high points. Include ball, gate, or globe valve in inlet and drain piping from outlet to floor drain.
- W. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- X. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.
- Y. Per the IPC (International Plumbing Code), Chapter 4, install point of use ASSE 1070 thermostatic mixing valve to provide tempered water for public hand washing facilities (lavatory faucets and group wash fixtures located in public toilet facilities provided for customers, patrons, and visitors.) The IPC, Chapter 2 Definitions, says Public or Public Utilization applies to fixtures in general toilet rooms of schools, gymnasiums, hotels, airports, bus and railroad stations, public buildings, bars, public comfort stations, office buildings, stadiums, stores, restaurants, and other installations where a number of fixtures are installed so that their utilization is similarly unrestricted. Per the IPC, provide ASSE 1070 thermostatic mixing valve also for footbaths and pedicure bath fixtures, bidets fittings, bathtub and whirlpool bathtub valves, and head shampoo sink faucets.
- Z. Install ASSE 1071 thermostatic tempering valve ahead of emergency equipment, such as emergency eyewash and emergency shower.
- AA. Install ASSE 1016 individual shower and tub-shower combination valves for such fixtures.

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. Connect plumbing specialties to piping specified in other Division 22 Sections.
- D. Ground equipment.
- E. 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.
- F. Connect plumbing specialties and devices that require power according to Division 26 Sections.

3.03 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of lead sheets 6-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4-lb/sq. ft., 0.0625-inch thickness or thinner.
 - 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.

- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 7 Section "Sheet Metal Flashing and Trim."
- F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.04 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each backflow preventer, thermostatic water mixing valve, and water tempering valve.
 - 1. Text: 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.
 - 2. Refer to Division 22 Section "Identification for Plumbing Piping and Equipment" for nameplates and signs.

3.05 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of each day.

END OF SECTION

SECTION 22 10 20 PLUMBING VALVES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Bronze Check Valves
 - 2. Bronze Spring Check Valves
 - 3. Bronze Ball Valves

1.02 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: For each type of valve indicated.

1.03 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials and installation.
- C. Certified to NSF 61, "Drinking Water System Components--Health Effects, Sections 1 through 9," for potable domestic water plumbing valves.
- D. Certified to ANSI/NSF 372 - Drinking Water System Components – Lead content. Low lead content product compliance for potable domestic water plumbing valves.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

- A. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
 - 1. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures:
 - 2. Boiler Feed Water Piping:
 - a. Design (Working) Pressure/Temperature 375 psig/270°F
 - b. Normal Operating Pressure/Temperature 300 psig/270°F
 - 3. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
- B. Valve Sizes: Same as upstream piping unless otherwise indicated.
- C. Valve Actuator Types:
 - 1. Handwheel: For valves other than quarter-turn types.
 - 2. 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.
- D. Valves in Piping: With 2-inch stem extensions and the following features:
 - 1. Ball Valves: With extended operating handle, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
- E. Valve-End Connections:
 - 1. Solder Joint: With sockets according to ASME B16.18.
 - 2. Threaded: With threads according to ASME B1.20.1.

2.02 BRONZE CHECK VALVES

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Crane Co.; Crane Valve Group; Crane Valves.
 - 2. Crane Co.; Crane Valve Group; Jenkins Valves.
 - 3. Hammond Valve.
 - 4. Kitz Corporation.
 - 5. Watts Industries, Inc.; Water Products Div.
 - 6. Milwaukee Valve Company
 - 7. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Description:
 - 1. Bronze swing check valves with bronze disc and seat for potable water
 - 2. Standard: MSS SP-80, Type 3.
 - 3. NPS 3/4 to NPS 3
 - 4. 300 psig WOG (2" and under), 200 psig WOG (2-1/2" - 3")
 - 5. Body Design: Horizontal flow.
 - 6. Body/Cap/Disc/Lever Material: ASTM B584 C89833, bronze. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc shall not be permitted. Bronze ASTM specs that are less than 10 percent zinc are B61, B62, and B584 alloys C84400, C89833, and C89836 and will be accepted if provided with certifications below.
 - 7. End connections: Threaded. Pressed and grooved valve ends will not be accepted.
 - a. Furnish a deductive alternate price for owners' consideration to furnish mechanical press seal joints and pressed ends, to the extent the contractor prefers to utilize such products in lieu of those specified. Mechanical press seal joints furnished shall be only ProPress as manufactured by Viega. No other manufacturer's products will be permitted. ProPress components shall be installed per manufacturer's written instructions and by trained and currently certified installers. Submittal of such training and manufacturer certification shall be required before the start of work.
 - 8. Basis of Design: Milwaukee Valve #UP509 (threaded)

2.03 BRONZE SPRING CHECK VALVES

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Crane Co.; Crane Valve Group; Crane Valves.
 - 2. Crane Co.; Crane Valve Group; Jenkins Valves.
 - 3. Hammond Valve.
 - 4. Kitz Corporation.
 - 5. Watts Industries, Inc.; Water Products Div.
 - 6. Milwaukee Valve Company
 - 7. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Description:
 - 1. Bronze spring check valves with bronze disc holder and PTFE disk for potable water
 - 2. NPS 3/8 to NPS 2
 - 3. 250 psig WOG

4. Body Design: Check Valves may be installed in both the horizontal and vertical lines with upward flow or in any intermediate position.
5. Body/Cap/Disc/Lever Material: ASTM B584 C89833, bronze. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc shall not be permitted. Bronze ASTM specs that are less than 10 percent zinc are B61, B62, and B584 alloys C84400, C89833, and C89836 and will be accepted if provided with certifications below.
6. End connections: Threaded. Pressed and grooved valve ends will not be accepted.
 - a. Furnish a deductive alternate price for owners' consideration to furnish mechanical press seal joints and pressed ends, to the extent the contractor prefers to utilize such products in lieu of those specified. Mechanical press seal joints furnished shall be only ProPress as manufactured by Viega. No other manufacturer's products will be permitted. ProPress components shall be installed per manufacturer's written instructions and by trained and currently certified installers. Submittal of such training and manufacturer certification shall be required before the start of work.
7. Basis of Design, subject to compliance with above: Milwaukee Valve #UP548T (threaded). Alternate: Hammond Valve #UP943 (threaded.)

2.04 BRONZE BALL VALVES

- A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim ("Non-critical" ball valve as noted in Article 3.04):
 1. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Apollo Valves, Aalberts Integrated Piping Systems.
 - b. Hammond Valve.
 - c. Jomar International, LTD.
 - d. Kitz Corporation.
 - e. Milwaukee Valve Company.
 - f. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
 2. Description:
 - a. Standard: MSS SP-110.
 - b. 600 psig WOG.
 - c. Body Design: Two piece.
 - d. Body Material: ASTM B584 C89833, bronze. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc shall not be permitted. Bronze ASTM specs that are less than 10 percent zinc are B61, B62, and B584 alloys C84400, C89833, and C89836 and will be accepted if provided with certifications below.
 - e. End connections: Threaded or soldered. Pressed and grooved valve ends will not be accepted.
 - 1) Furnish a deductive alternate price for owners' consideration to furnish mechanical press seal joints and pressed ends, to the extent the contractor prefers to utilize such products in lieu of those specified. Mechanical press seal joints furnished shall be only ProPress as manufactured by Viega. No other manufacturer's products will be permitted. ProPress components shall be installed per manufacturer's written instructions and by trained and currently certified installers. Submittal of such training and manufacturer certification shall be required before the start of work.

- f. Seats: PTFE or TFE.
 - g. Stem: Bronze preferred. Brass acceptable.
 - h. Ball: Hard chrome-plated bronze preferred. Hard chrome-plated brass acceptable.
 - i. Port: Full.
 - j. Handle: Steel with zinc plating. Stem extension.
 - k. Certified to NSF/ANSI 61 and NSF/ANSI 372. These require the wetted surface of this product (in any material combination) contacted by consumable water shall contain less than one quarter of one percent (0.25%) of lead by weight.
 - l. Basis of Design: Milwaukee Valve Ultra Pure # UPBA400 (threaded)
- B. Three-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim ("Critical" ball valve as noted in Article 3.04):
 - 1. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Apollo Valves, Aalberts Integrated Piping Systems.
 - b. Jomar International, LTD.
 - c. Kitz Corporation.
 - d. Milwaukee Valve Company.
 - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - f. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. 600 psig WOG.
 - c. Body Design: Three piece.
 - d. Body Material: ASTM B584 C89833, bronze. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc shall not be permitted. Bronze ASTM specs that are less than 10 percent zinc are B61, B62, and B584 alloys C84400, C89833, and C89836 and will be accepted if provided with certifications below.
 - e. End connections: Threaded or soldered. Pressed and grooved valve ends will not be accepted.
 - 1) Furnish a deductive alternate price for owners' consideration to furnish mechanical press seal joints and pressed ends, to the extent the contractor prefers to utilize such products in lieu of those specified. Mechanical press seal joints furnished shall be only ProPress as manufactured by Viega. No other manufacturer's products will be permitted. ProPress components shall be installed per manufacturer's written instructions and by trained and currently certified installers. Submittal of such training and manufacturer certification shall be required before the start of work.
 - f. Seats: PTFE or TFE.
 - g. Stem: 316 Stainless steel.
 - h. Ball: 316 Stainless steel, vented.
 - i. Port: Full.
 - j. Handle: Steel with zinc plating. Stem extension.
 - k. Certified to NSF/ANSI 61 and NSF/ANSI 372. These require the wetted surface of this product (in any material combination) contacted by consumable water shall contain less than one quarter of one percent (0.25%) of lead by weight.

- I. Basis of Design: Milwaukee Valve Ultra Pure # UPBA300S (threaded)
- C. Safety-Exhaust, Bronze body, brass trim:
 - 1. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Apollo Valves, Aalberts Integrated Piping Systems.
 - b. DynaQuip Controls.
 - c. Grinnell Corporation.
 - d. Hammond Valve.
 - e. Jamesbury, Inc.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
 - h. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
 - 2. Safety-Exhaust, Copper-Alloy Ball Valves: Two-piece bronze body with exhaust vent opening, chrome-plated ball with vent, blowout-proof stem, locking handle, and working pressure rating for compressed air of at least 600-psig CWP.
- D. MSS SP-110 - Ball Valves Threaded, Solder Joint; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2010.

2.05 CHAINWHEELS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Babbitt Steam Specialty Co. (Basis of design)
 - 2. Roto Hammer Industries.
 - 3. Rotork Gears
 - 4. Trumbull Industries.
 - 5. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- 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 valve handwheels or stems. Zinc plated carbon steel attachment set for clamping to the handwheel.
 - 3. Sprocket Rim with Chain Guides: Ductile iron chainwheel, of type and size required for valve.
 - 4. Chain: Hot-dip galvanized steel weldless chain , 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.
- F. Protect valves against corrosion during shipping and storage. Store in a dry and heated environment. Comply with all requirements to maintain manufacturer's warranty.

3.02 VALVE INSTALLATION

- A. Install shutoff duty / isolation valve close to water main on each branch connection. Install shutoff duty / isolation valve at connection to each end-user (fixture, faucet, hose bibb, tool, equipment, etc.) that does not have supply stops arranged to allow service, maintenance, and end-user removal without system shutdown, unless only one end-user is connected to the branch line. All end-users must have isolation valves or supply stops.
- 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. Provide gate, globe, and swing check valves indicated in Products section.
- F. Install chainwheels on operators for valves NPS 6 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
- G. Install gear operators for all butterfly valves 4" and larger.
- H. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- I. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Lift Check Valves: With stem upright and plumb.
- J. Install check valves on all showers, mop sinks, scrub sinks, and any other fixtures with restricted discharge or secondary flow control. Such check valves to be spring loaded type.
- K. Check valves on water heaters supplies to be spring loaded type.

3.03 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- B. Select valves for domestic water (including combined service mains, domestic water service, and domestic water distribution,) and non-potable water with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Use bronze ball valves, Threaded or soldered-joint valve-ends.
 - 2. For Ductile Iron Pipe and Stainless Steel Pipe, NPS 2-1/2 and Larger: Use lug or flanged valves.
- C. Critical" valves for domestic water (including combined service mains, domestic water service, and domestic water distribution,) and non-potable water shall be as follows:
 - 1. Those ball valves used to isolate more than one end-user (fixture, faucet, hose bibb, tool, equipment, etc.), or
 - 2. The first ball valve NPS 2½ and smaller located in a branch when connected to header larger than NPS 2½.
 - 3. Drain valve NPS 3 and smaller connected to header larger than NPS 2½.

4. Unless noted otherwise, sub-paragraphs "1" and "2" above shall not apply where the largest pipe main in the entire domestic water system is NPS 2½ and smaller; that is, these valves need not be "Critical" valves. All valves which are not "Critical" shall be "Non-critical".
- D. Domestic water (including combined service mains, domestic water service, and hot and cold domestic water distribution,) hot and cold non-potable water valve schedule
 1. Pipe NPS 2 and Smaller:
 - a. Bronze Valves.
 - 1) "Critical" Ball Valves: Three piece, full port, bronze with stainless-steel trim, and steel handle with zinc plating.
 - 2) "Non-critical" Ball Valves: Two piece, full port, bronze with bronze trim, and steel handle with zinc plating

3.05 JOINT CONSTRUCTION

- A. Refer to Division 22 Section "Plumbing General Provisions" for basic piping joint construction.
- B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

END OF SECTION

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 domestic water piping inside the building.
- B. This Division 22 Section shall apply in every respect to temporary piping shown on drawings. Temporary piping shall be removed and areas restored to pre-existing conditions after Commissioning of permanent piping systems, unless otherwise indicated on the drawings.
- C. Related Sections include the following:
 - 1. Division 33 Section "Water Systems" for water-service piping outside the building from source to the point where water-service piping enters the building.
 - 2. Division 7 Section "Penetration Firestopping" for through-penetration firestop systems.
 - 3. Division 8 Section "Access Doors and Panels."
 - 4. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and fittings.
 - 5. Division 22 Section "Plumbing General Provisions" for additional quality assurance requirements, joining materials, field testing requirements, and more.
 - 6. Division 22 Section "Plumbing Valves."
 - 7. Division 22 Section "Expansion Fittings and Loops for Plumbing Piping ."
 - 8. Division 22 Section "Plumbing Specialties" for water distribution piping specialties.
 - 9. Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
 - 10. Division 22 Section "Plumbing Equipment."

1.03 REFERENCE STANDARDS

- A. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
- B. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.
- C. ASME B16.24 - Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves: Classes 150, 300, 600, 900, 1500, and 2500; 2016.
- D. ASME B31.9 - Building Services Piping; 2020.
- E. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).
- F. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2016.
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2021a.
- H. MSS SP-58-2018 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation which includes Amendment 1 Issued 10-17-2019.
- I. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.
- J. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.
- K. NSF/ANSI 14 - Plastic Piping System Components and Related Materials.

1.04 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing water piping systems with the following minimum design (working) pressure ratings, unless otherwise indicated:
 - 1. Domestic Water Service Piping and Domestic Water Distribution Piping: 150 psig

2. Domestic Water Distribution Piping: 125 psig (only where downstream of a pressure regulator.)

1.05 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data:
 1. Include data on pipe and tube materials, pipe fittings, flanges, joining materials, couplings, valves, water meters, and accessories.
 2. Provide manufacturers catalogue information.
 3. Provide valve data and ratings.
- C. Firestopping materials.
- D. Water Samples: Specified in Part 3 "Cleaning" Article.
- E. Field quality-control test reports.
- F. All submittals of Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment," to include Delegated-Design requirements.
- G. Shop Drawings: Detail, 1/2 inch equals 1 foot scale, fabrication of pipe anchors, pipe support frames, hangers, pipe, multiple pipes, alignment guides, and expansion loops, offsets, swing joints, and their attachment to the building structure. Detail locations of anchors, alignment guides, expansion loops, offsets, and swing joints.
- H. Project Record Documents: Field survey and document actual locations and sizes of domestic water piping, meters, regulators, backflow preventers, transitions, pipe fittings, fixtures, etc. Record changes in pipe location and additional fittings used. Record drawings are to be contractor-prepared by modifying the source digital files (typically AutoCAD and/or Revit to be furnished by the Design Engineer.) Submit both the modified digital files as well as Adobe PDF format record drawings. Refer to Division 22 Section "Plumbing General Provisions" and the Division 1 specifications for additional record drawing requirements.

1.06 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Reference Division 22 Section "Plumbing General Provisions" for additional Quality Assurance requirements.
- C. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.
- D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials and installation.
- E. Certified to ANSI/NSF 372 - Drinking Water System Components – Lead content. Low lead content product compliance for potable domestic water piping and components.
- F. Installer Qualifications: Company specializing in performing work of the type specified in this section, with minimum 3 years of experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
- C. Care and handle plastic piping in accordance with manufacturers written instructions.

1.08 FIELD CONDITIONS

- A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 PIPING MATERIALS

- A. Refer to Part 3 "Pipe and Fitting Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.02 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.
 - 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Threaded or soldered valves and hydronic specialties. Furnish wrought-copper fittings unless indicated otherwise. No other copper joint methods or fittings (such as with grooved mechanical joints, associated mechanical couplings, or mechanical press seal joints) shall be permitted.
 - a. Furnish a deductive alternate price for owners' consideration to furnish mechanical press seal joints and pressed ends, to the extent the contractor prefers to utilize such products in lieu of those specified. Mechanical press seal joints furnished shall be only ProPress as manufactured by Viega. No other manufacturer's products will be permitted. ProPress components shall be installed per manufacturer's written instructions and by trained and currently certified installers. Submittal of such training and manufacturer certification shall be required before the start of work.
 - 2. Bronze Flanges: ASME B16.24, ANSI Class 150, with solder-joint or threaded ends. Furnish ANSI Class 300 flanges if required to match piping.
 - 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.03 VALVES

- A. Bronze valves are specified in Division 22 Section "Plumbing Valves."
- B. Balancing and drain valves are specified in Division 22 Section "Plumbing Specialties."

PART 3 EXECUTION

3.01 EXCAVATION

- A. Excavating, trenching, and backfilling are specified in Division 31 Section "Site Earthwork."

3.02 PIPE AND FITTING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
- B. Flanges may be used on aboveground piping, unless otherwise indicated.
- C. Aboveground Domestic Water Piping: Use the following piping materials for each size range:
 - 1. NPS 2 and Smaller: Hard copper tube, Type L; copper pressure fittings; and soldered joints.

3.03 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use copper alloy ball for piping NPS 2 and smaller.
 - 2. Throttling Duty: Use copper alloy ball or globe valves for piping NPS 2 and smaller. Use cast iron butterfly valves with flanged ends for piping NPS 2-1/2 and larger.
 - 3. Hot-Water-Piping, Balancing Duty: Calibrated balancing valves.
 - 4. Drain Duty: Hose-end drain valves.

- B. Install shutoff duty / isolation valve close to water main on each branch connection. Install shutoff duty / isolation valve at connection to each end-user (fixture, faucet, hose bibb, tool, equipment, etc.) that does not have supply stops, arranged to allow service, maintenance, and end-user removal without system shutdown. Where only one end-user is connected to a branch line, only the shutoff duty valve at the branch connection is required. Each end-user must have an individual shutoff valve or supply stop.
- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
 - 1. Install hose-end drain valves at low points in water mains, risers, and branches.
 - 2. Install stop-and-waste drain valves where indicated. Stop-and-waste drain valves not required on 2 ½" or smaller pipe.
- D. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Calibrated balancing valves are specified in Division 22 Section "Plumbing Specialties."
- E. Install valves with stems upright or horizontal, not inverted.

3.04 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 22 Section "Plumbing General Provisions."
- B. Install under-building-slab copper tubing according to Copper Development Association's "Copper Tube Handbook."
- C. Sleeve pipe passing through partitions, walls and floors. When installed as part of a UL-listed fire rated assembly, the sleeve shall meet the requirements of listing. Refer to Division 22 Section "Plumbing General Provisions" for additional sleeve and mechanical sleeve seal requirements.
- D. Firestopping: Install per requirements found in Division 22 Section "Plumbing General Provisions" and Division 7 Section "Penetration Firestopping."
- E. Install piping to allow for thermal expansion and contraction without stressing pipe, joints, or connected fixtures and equipment. Install pipe expansion loops, offsets, swing joints, anchors, supports, and pipe alignment guides as indicated on drawings and as determined necessary by delegated design. Refer to Section 22 "Expansion Fittings and Loops for Plumbing Piping" for additional requirements.
- F. Inserts:
 - 1. Refer to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for Steel or Malleable Concrete Inserts (MSS Type 18) requirements.
 - 2. Provide inserts for placement in concrete formwork.
 - 3. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 4. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- G. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Pressure gages are specified in Division 22 Section "Meters and Gages for Plumbing Piping," and drain valves and strainers are specified in Division 22 Section "Plumbing Specialties."
- H. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

- I. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- J. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- K. Select system components with pressure rating equal to or greater than system design (working) pressure.
- L. Wherever water pressure from the street main or other source of supply is insufficient to provide flow pressure at fixture outlets as required under Table 604.3 of the adopted IPC, a water pressure booster system conforming to Section 606.5 of the adopted IPC shall be installed on the building water supply system.
- M. Provide access where valves are not exposed. Coordinate size and location of access doors with Section 083113.

3.05 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Plumbing General Provisions".
- B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated. Given it is required by ASME B31.9, the soldering filler metal shall conform to the applicable ASTM specification.
- C. Grooved mechanical joints, associated mechanical couplings, and mechanical press seal joints will not be accepted.
 - 1. Furnish a deductive alternate price for owners' consideration to furnish mechanical press seal joints and pressed ends, to the extent the contractor prefers to utilize such products in lieu of those specified. Mechanical press seal joints furnished shall be only ProPress as manufactured by Viega. No other manufacturer's products will be permitted. ProPress components shall be installed per manufacturer's written instructions and by trained and currently certified installers. Submittal of such training and manufacturer certification shall be required before the start of work.

3.06 HANGER AND SUPPORT INSTALLATION

- A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Install pipe hanger and support devices in accordance with Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet: MSS Type 49, spring cushion rolls, if indicated.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install in accordance with ASME B31.9, MSS SP-58, MSS SP-69, and MSS SP-89.
- D. Support vertical piping and tubing at base and at each floor. Piping 2" and smaller shall be installed with mid-story guides. Support riser piping independently of connected horizontal piping.
- E. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.
- F. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
- G. Install supports for vertical copper tubing every 10 feet.
- H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.
- I. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- J. Place hangers within 12 inches of each horizontal elbow.
- K. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
- L. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- M. Provide copper plated hangers and supports for copper piping.
- N. For domestic hot water, arrange piping and supports suitable to accommodate thermal expansion and comply with Division 22 Section "Expansion Fittings and Loops for Plumbing Piping."
- O. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Division 22 Section "Plumbing Piping Insulation."

3.07 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow 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, and extend and connect to the following:
1. Water Heaters: Cold-water supply and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections. All domestic water piping connections to water heaters including the ASSE 1017 thermostatic mixing valve and the full port cold water shut off valve shall be rigidly supported using code compliant metallic piping. Metallic piping must extend a minimum of three feet or greater from both the hot and cold-water connection points of the water heater.
 2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Fixtures."
 3. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections.
 4. For equipment, including water heaters, provide shutoff valve and union for each connection. For pumps provide shutoff valve on each side and at least one union or flange. Use flanges instead of unions for NPS 2-1/2 and larger. Install valves with unions or flanges at each equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

3.08 FIELD QUALITY CONTROL

- A. Inspect domestic water piping as follows:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 2. 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:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- B. Test domestic water piping as follows:
1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 2. 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.
 3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 4. Cap and subject piping to hydrostatic pressure test at 50 psig above minimum design (working) pressure ratings without exceeding pressure rating of piping system materials, valves, fixtures, or equipment. Isolate test source and allow to stand with hydrostatic test pressure for four hours. Examine piping, joints, and connections for leakage. Leaks constitute defects that must be repaired. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic pressure test until there are no leaks.
 - a. Domestic Water Service Piping and Domestic Water Distribution Piping: 200 psig hydrostatic pressure test.
 - b. Domestic Water Distribution Piping: 175 psig hydrostatic pressure test (only where downstream of a pressure regulator.)
 5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
 6. Prepare reports for tests and required corrective action.

3.09 ADJUSTING

- A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
 2. Open shutoff valves to fully open position.
 3. Open throttling valves to proper setting.
 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 5. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.

7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
 1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Prepare and submit reports of purging and disinfecting activities.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION 22 11 16

**SECTION 22 30 00
PLUMBING EQUIPMENT**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Residential electric water heaters.
- B. Commercial electric water heaters.
- C. Domestic hot water storage tanks.
- D. Expansion tanks.
- E. Water filters.
- F. In-line circulator pumps.
- G. Sump pumps.
- H. Condensate removal pumps.
- I. Sanitary sewage pumps.
- J. Thermostatic mixing valves.

1.02 RELATED REQUIREMENTS

- A. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
- B. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; 2013, Including All Amendments and Errata.
- B. ICC (IPC) - International Plumbing Code; 2012.
- C. NEMA MG 00001 - Motors and Generators; 2024.
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. NSF 61 - Drinking Water System Components - Health Effects; 2024.
- F. UL 174 - Standard for Household Electric Storage Tank Water Heaters; Current Edition, Including All Revisions.
- G. UL 778 - Standard for Motor-Operated Water Pumps; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data:
 - 1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
 - 2. Indicate pump type, capacity, power requirements.
 - 3. Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
 - 4. Provide electrical characteristics and connection requirements.
- C. Shop Drawings:
 - 1. Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, tappings, and drains.
- D. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
- E. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Certifications:
 - 1. Water Heaters: NSF approved.
 - 2. Electric Water Heaters: UL listed and labeled to UL 174.
 - 3. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.
- C. Identification: Provide pumps with manufacturer's name, model number, and rating/capacity identified by permanently attached label.
- D. Performance: Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

1.06 CERTIFICATIONS

- A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for plumbing equipment and installation.
- B. Certified to NSF 61, "Drinking Water System Components--Health Effects, Sections 1 through 9," for potable domestic water equipment.
- C. Certified to ANSI/NSF 372 - Drinking Water System Components – Lead content. Low lead content product compliance for potable domestic water equipment.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.
- B. Protect motors, shafts, and bearings from weather and construction dust.

1.08 WARRANTY

- A. Provide five year manufacturer warranty for domestic water heaters.

PART 2 PRODUCTS

2.01 WATER HEATERS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. A.O. Smith Water Products Co; _____: www.hotwater.com/#sle.
 - 2. State Water Heaters.
 - 3. Rheem Manufacturing Company; _____: www.rheem.com/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Residential/Light Commercial Electric Water Heaters:
 - 1. Type: Automatic, electric, vertical storage.
 - 2. Minimum Efficiency Required: ASHRAE Std 90.1 I-P.
 - 3. Tank: Glass lined welded steel, thermally insulated with one inch thick glass fiber; encased in corrosion-resistant steel jacket; baked-on enamel finish.
 - 4. Controls: Automatic water thermostat with externally adjustable temperature range from 120 to 170 degrees F, flanged or screw-in nichrome elements, enclosed controls and electrical junction box and operating light. Wire double element units so elements do not operate simultaneously.
 - 5. Accessories:
 - a. Water Connections: Brass.
 - b. Dip Tube: Brass.

- c. Drain valve.
 - d. Anode: Magnesium.
 - e. Temperature and Pressure Relief Valve: ASME labeled.
- C. Commercial Electric Water Heaters:
 - 1. Type: Factory-assembled and wired, electric, vertical storage.
 - 2. Minimum Efficiency Required: ASHRAE Std 90.1 I-P.
 - 3. Controls: Automatic immersion water thermostat; externally adjustable temperature range from 60 to 180 degrees F, flanged or screw-in nichrome elements, high temperature limit thermostat.
 - 4. Tank: Welded steel ASME labeled pressure vessel; glass lining, mounted on steel channel base with lifting lugs, insulated with 2 inch glass fiber; enclosed with 16 gauge, 0.0598 inch steel jacket; baked enamel finish.
 - 5. Controls: Ventilated control cabinet, factory-wired with solid state progressive sequencing step controller, fuses, magnetic contactors, control transformer, pilot lights indicating main power and heating steps, control circuit toggle switch, electronic low-water (probe-type) cut-off, high temperature limit thermostat, flush-mounted temperature and pressure gauges.
 - 6. Heating Elements: Flange-mounted immersion elements; individual elements sheathed with Incoloy corrosion-resistant metal alloy, rated less than 75 W/sq in.

2.02 DOMESTIC HOT WATER STORAGE TANKS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. A.O. Smith Water Products Co: www.hotwater.com/#sle.
 - 2. Bradford White Corporation; Jacketed Storage Tank: www.bradfordwhite.com/#sle.
 - 3. State Water Heaters: www.statewaterheaters.com
 - 4. HTP Products
 - 5. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Tank: Welded steel, ASME labeled for working pressure of 125 psig, steel support saddles, tappings for accessories, threaded connections of stainless steel, access manhole.
- C. Openings: Up to 3 inches, copper-silicone threaded; over 4 inches, flanged; flanged collar for heat exchanger; manway fitting.

2.03 EXPANSION TANKS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Amtrol Inc: www.amtrol.com/#sle. Basis of design.
 - 2. Bell & Gossett, a brand of Xylem, Inc: www.bellgossett.com/#sle.
 - 3. Taco, Inc: www.taco-hvac.com/#sle.
 - 4. Grundfos Pumps Corporation.
 - 5. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Maximum Rated Working Pressure: 150 psi.
- C. Maximum Allowable Service Temperature: 200 degrees F.

- D. Construction: Welded steel with flexible heavy duty butyl diaphragm sealed into tank, lined with polypropylene or antimicrobial coating, and steel legs or saddles. Stainless steel connection. Appliance quality paint finish.
- E. Certified to NSF/ANSI Standard 61 Domestic Hot.
- F. Sizing to be based on water heater recovery from 40F, water supply pressure of 60 psig, and relief valve set at 150 psig unless otherwise noted on drawings.
- G. Accessories: Pressure gauge and air-charging fitting, tank drain; precharge to 40 psig, or 50 psig if permissible per tank ratings.

2.04 WATER FILTERS

- A. Commercial:
 - 1. Filter Media: 0.05 micron particulate.
 - 2. Glassfiber reinforced plastic tank with valve, 30 gpm.
 - 3. Provide capped backwash, carbon refill, and sediment removal access.
 - 4. Potable Water Service: NSF 61 certified.
 - 5. Drinking Water Service: NSF 61 certified in compliance with ICC (IPC).
- B. Service Pressure: 20 to 120 psi.
- C. Service Temperature: 40 to 110 degrees F.

2.05 IN-LINE CIRCULATOR PUMPS

- A. Available Manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated into the Work include only those listed below. The following shall occur for any manufacturer's series, other than the Basis of Design manufacturer's series noted below and on the drawings, to be proposed as a substitution: (1) A bidder RFI shall be submitted by the vendor or plumbing contractor expressing such desire. For Engineer of Record review, furnish a preliminary submittal including any additional requested supporting documentation not later than one week in advance of the RFI deadline (to allow additional time for the review.) The vendor or plumbing contractor's desire shall not be carried by any bidder unless approved via Addendum. (2) Be submitted as a substitution to not only demonstrate manufacturer's series compliance with the requirements, but also demonstrate equivalency to the Basis of Design series. The mechanical, plumbing, and electrical designs are based upon the Basis of Design manufacturer's series equipment. If other than the Basis of Design manufacturer's series is furnished and: (a) if the power requirements differ, the plumbing contractor shall coordinate all requirements with the electrical contractor including circuit breaker, conductor, and conduit sizes. In such a case, the power shall still come from the same panel as currently designed. (b) if the piping connections locations or sizes differ, the plumbing contractor shall coordinate with affected trades and shall provide all required modifications to accommodate. The plumbing contractor is responsible for any additional cost to any trade as noted above and as required to coordinate installation and provide proper service clearances for other than the Basis of Design manufacturer's series. The plumbing contractor is responsible for paying any design fees associated with redesigning architectural, structural, or MEP systems to accommodate other than the Basis of Design manufacturer's series.
 - 1. Grundfos Pumps Corporation: www.grundfos.com.
 - 2. Taco Inc.
 - 3. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Casing: Low lead Bronze or Stainless Steel, rated for 125 psig working pressure, with stainless steel rotor assembly.

- C. Impeller: Bronze or stainless steel.
- D. Shaft: Alloy steel with integral thrust collar and two oil lubricated bronze sleeve bearings.
- E. Seal: Carbon rotating against a stationary ceramic seat.
- F. Drive: Flexible coupling or direct.

2.06 CONDENSATE REMOVAL PUMPS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Little Giant Pumps.
 - 2. Axiom.
 - 3. Franklin Electric Company: www.franklin-electric.com/#sle.
 - 4. Liberty Pumps Inc: www.libertypumps.com/#sle.
 - 5. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Construction: Commercial grade, nonferrous pump with stainless steel shaft, integral discharge check valve, integral float switch, safety switch, thermoplastic reservoir, motor assembly, and power cord with ground.
- C. Safety: UL 778.

2.07 THERMOSTATIC MIXING VALVES

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Watts/Powers, Basis of design
 - 2. Leonard Valve Company
 - 3. Lawler Manufacturing Co., Inc.
 - 4. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Listed to ASSE 1017 Standard.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.
- B. Coordinate with plumbing piping and related fuel piping work to achieve operating system.
- C. Domestic Water Storage Tanks:
 - 1. Provide steel pipe support, independent of building structural framing members.
 - 2. Clean and flush prior to delivery to site. Seal until pipe connections are made.
- D. Pumps:
 - 1. Provide line sized isolating valve and strainer on suction and line sized soft seated check valve and balancing valve on discharge.
 - 2. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
 - 3. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- E. Expansion Tanks

1. Install on cold water supply, between backflow preventer, check valve, or pressure regulator and the domestic hot water tank. Verify and adjust tank precharge pressure in advance of placing tank in service. Tank precharge pressure should equal the anticipated water pressure at the tank location; consult installation instructions.

END OF SECTION

SECTION 22 40 00
PLUMBING FIXTURES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes plumbing fixtures and related components.
- B. Related Sections include the following:
 - 1. Division 22 Section "Plumbing Specialties" for backflow preventers and specialty fixtures not in this Section.

1.03 DEFINITIONS

- A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Fitting: Device that controls flow of water into or out of plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

1.04 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports and indicate materials and finishes, dimensions, construction details, and flow-control rates for each type of fixture indicated.
- C. Maintenance Data: For plumbing fixtures to include in maintenance manuals specified in Division 1.
- D. Documentation indicating flow and water consumption requirements

1.05 DRAWING INTERPRETATION

- A. The project drawings are schematic in nature and indicate general arrangement of equipment. It is not the intent of the drawings to substitute for shop drawings. In many instances, equipment and devices are sized on one manufacturers product. In the event of a field verification or coordination issue, report issue to Owners construction supervisor.
- B. Piping and air duct plans are intended to show size, capacity, approximate location, direction and general relationship of one work phase to another, but not exact detail or arrangement.
- C. Do not install equipment, duct work or piping in a non code compliant fashion due to drawing interpretation. Provide modification of illustrated work in order to accommodate job conditions at no cost to Owner.
- D. Generally, layout pipelines requiring drainage first, followed by large pipe mains, air duct and electrical conduit. Follow this procedure for an orderly installation but not to establish precedence of one trade over another.
- E. Install work as closely as possible to layouts shown on drawings. Modify work as necessary to meet job conditions and to clear other equipment. Consult Design Professional before making changes which effect the function or appearance of systems.
- F. In some cases, drawings are based on products of one or several manufacturers, as listed on the contract documents. The contractor shall be held responsible for modifications made necessary by substitution of products or other manufacturers
- G. Architectural drawings take precedence for equipment layout and locations.

1.06 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
 - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; about plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements in U.S. Architectural & Transportation Barriers Compliance Board's "Uniform Federal Accessibility Standards (UFAS), 1985-494-187" about plumbing fixtures for people with disabilities.
- E. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- F. Regulatory Requirements: Certified to ANSI/NSF 372 - Drinking Water System Components – Lead content. Low lead content product compliance for plumbing fixture materials that will be in contact with potable water.
- G. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- H. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- I. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
 - 1. Hand Sinks: NSF 2 construction.
 - 2. Plastic Bathtubs: ANSI Z124.1.
 - 3. Plastic Laundry Trays: ANSI Z124.6.
 - 4. Plastic Mop-Service Basins: ANSI Z124.6.
 - 5. Plastic Shower Enclosures: ANSI Z124.2.
 - 6. Slip-Resistant Bathing Surfaces: ASTM F 462.
 - 7. Stainless-Steel Fixtures Other Than Service Sinks: ASME A112.19.3.
 - 8. Vitreous-China Fixtures: ASME A112.19.2.
 - a. Lavatories;
 - b. Sinks;
 - c. Urinals;
 - d. Water Closets.
 - 9. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
 - 10. Water-Closet, Flushometer Tank Trim: ASSE 1037.
- J. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
 - 1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
 - 2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
 - 3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
 - 4. Faucet Hose: ASTM D 3901.
 - 5. Faucets: ASME A112.18.1M.

6. Hose-Connection Vacuum Breakers: ASSE 1011.
 7. Hose-Coupling Threads: ASME B1.20.7.
 8. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 9. NSF Materials: NSF 61.
 10. Pipe Threads: ASME B1.20.1.
 11. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
 12. Supply and Drain Fittings: ASME A112.18.1M.
- K. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
1. Atmospheric Vacuum Breakers: ASSE 1001.
 2. Brass and Copper Supplies: ASME A112.18.1M.
 3. Manual-Operation Flushometers: ASSE 1037.
 4. Plastic Tubular Fittings and Piping: ASTM F 409.
 5. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
 6. Tubular Brass Drainage Fittings and Piping: ASME A112.18.1M.
- L. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Disposers: ASSE 1008 and UL 430.
 2. Floor Drains: ASME A112.21.1M.
 3. Grab Bars: ASTM F 446.
 4. Hose-Coupling Threads: ASME B1.20.7.
 5. Hot-Water Dispensers: ASSE 1023 and UL 499.
 6. Off-Floor Fixture Supports: ASME A112.6.1M.
 7. Pipe Threads: ASME B1.20.1.
 8. Plastic Shower Receptors: ANSI Z124.2.
 9. Plastic Toilet Seats: ANSI Z124.5.
 10. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.07 COORDINATION

- A. Coordinate roughing-in and final plumbing fixture locations, and verify that fixtures can be installed to comply with original design and referenced standards.

1.08 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. Faucet Washers and O-Rings: Not less than 10 percent of amount of each type and size installed.
 2. Faucet Cartridges and O-Rings: Not less than 5 percent of amount of each type and size installed.
 3. Faucet, Laminar-Flow Fittings: Not less than 10 percent of amount of each type and size installed, but not less than 2 of each type and size.
 4. Faucet, Flow-Control Fittings: Not less than 10 percent of amount of each type and size installed.
 5. Supply, Flow-Control Fittings: Not less than 5 percent of amount of each type and size installed.
 6. Shower, Flow-Control Fittings: Not less than 5 percent of amount of each type and size installed.
 7. Flushometer Valve, Repair Kits: Not less than 25 percent of amount of each type installed, minimum 2 of each type.

8. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.
9. Water-Closet Tank, Repair Kits: Not less than 5 percent of amount of each type installed.
10. Toilet Seats: Not less than 5 percent of amount of each type installed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Products shall be as scheduled on the plumbing drawings. Any substitution shall be equivalent to the make and model scheduled. Acceptance of equivalency shall rest solely with the Engineer of Record and will be based on compliance with the specification and drawing schedule requirements, physical dimensions, product performance, materials of construction, maintenance requirements, and compliance with ADA Accessibility Guidelines and national standards.
- B. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

2.02 WATER CLOSETS

- A. Description Accessible, floor mounted, floor-outlet, vitreous-china fixture designed for dual flush tank operation.
 1. Seat: See Plumbing Schedule on drawing P5.01
 2. Style: One piece
 3. Design Consumption: 1.6 gal./flush / 1.0 gal./flush
 4. Water Hammer Arrestor: Furnish and install Zurn Shoktrol water hammer arrestor for each individual flush valve and water closet.

2.03 FLUSHOMETERS

- A. Description: Flushometer for water-closet-type fixture. Dual-flush, push-button type. Include brass body with corrosion-resistant internal components, push-button non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.
 1. Consumption: 1.0 gal./flush for liquids and 1.6 gal./flush for solids

2.04 LAVATORIES

- A. Lavatories: Vitreous china, cast iron wall hangers with lag screw through anchor holes.
 1. Supply Pipes: 3/8" flexible tube risers, loose key stops, escutcheons
 2. Waste: 1 1/2" tail piece, adjustable p-trap, 17 gauge tubing waste to wall and escutcheon.
 3. Carrier System: Concealed arms. See Plumbing Schedule on drawing P5.01
- B. ADA-compliant Under-sink / Under-lavatory Piping Covers.
 1. Wall hung sinks and lavatories indicated to be in compliance with ADA requiring front approach are to have under-sink / under-lavatory piping covers installed for protection on the waste and supply piping. These are to be durable, attractive, and ADA-compliant per ADA article 4.19.4. Made of molded vinyl, 1/8" wall, virtually indestructible, internal tear lines for custom trimming. Product is to be designed with builtin fasteners for installation without tools, and antimicrobial molded vinyl with an internal rib design for cushioning.
 2. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. IPS Corporation - Truebro Lav Guard 2E-Z Series (basis of design.)

- b. Plumberex, Inc. - Pro-Extreme. Made in USA.
- c. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

2.05 LAVATORY FAUCETS

- A. Description: Single-control mixing valve. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
 - 1. Maximum Flow Rate: 0.5 GPM

2.06 KITCHEN SINKS

- A. Service Sinks: Stainless Steel, sizes as specified on the drawings
 - 1. Supply Pipes: ½" loose key stops, escutcheons
 - 2. Waste: 1 ½" tail piece, adjustable p-trap, 17 gauge tubing waste to wall and escutcheon

2.07 KITCHEN SINK FAUCETS

- A. Description: Kitchen faucet without spray. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
 - 1. Maximum Flow Rate: 2.2 GPM

2.08 SERVICE SINKS

- A. Service Sinks: Cast Iron or Stainless Steel, sizes as specified on the drawings
 - 1. Supply Pipes: ½" loose key stops, escutcheons
 - 2. Waste: 1 ½" tail piece, adjustable p-trap, 17 gauge tubing waste to wall and escutcheon
 - 3. Fixtures: All laboratory fixtures shall include a vacuum breaker
 - 4. Water Hammer Arrestor: Furnish and install Zurn Shoktrol water hammer arrestor on DCW and DHW for each service sink with knee valve control.

2.09 MOP SINKS

- A. Service Sinks: Compression molded stone composite molded under high temperature and pressure; one-piece of uniform thickness; ribbed support underneath unit.
 - 1. Size: 24" x 24"
 - 2. Supply Pipes: ½" loose key stops, escutcheons
 - 3. Waste: 1 ½" tail piece, adjustable p-trap, 17 gauge tubing waste to wall and escutcheon

2.10 MOP SINK FAUCETS

- A. Description: Service sink faucet with stops in shanks, vacuum breaker, hose-thread outlet, and pail hook. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
 - 1. Maximum Flow Rate: 2.2 GPM

2.11 WATER COOLERS

- A. Electric water coolers shall have compressors, insulated tank, piping and heat exchanger, stainless steel bowl and cabinet. Water piping shall be copper.
 - 1. Cooler shall be air cooled with hermetically sealed compressors. Refrigerant piping shall be copper. Tanks, piping and heat exchanger shall be insulated. Compressor motors shall be 120v single phase 60 hz.
 - 2. Provide cold water supply connection with shut off valve, and waste connection with p-trap and accessible cleanout. Insulate trap and waste piping between unit and trap.
 - 3. Fountains shall have a stainless steel top with self closing bubbler, and flow regulating valve. Cabinet finish shall be satin stainless steel.

2.12 FIXTURE CARRIERS

- A. Water Closets (Wall mounted): provide chair carrier suited for fixture, location wall thickness, and material. Exposed arms shall have white porcelain finish
- B. Lavatories: provide concealed arms carrier suited for fixture, location wall thickness, and material.
- C. Service Sinks: Short foot or block supports to support fixture independent of wall. With fixture bolts, bearing plates, steel pipe uprights, and chrome plated trim.
- D. Flushing Rim Sinks: Support system with connection fitting, adjustable faceplate and upper support plate. Height to suit fixture.

2.13 PLUMBING FIXTURE TRIM

- A. General: All fittings, faucets and similar devices shall be as manufactured by Chicago Faucet Company or approved equal in Watersaver or Wolverine Brass
- B. Water Fittings - General: Water fittings shall be provided with a renewable unit containing all operating parts which are subject to wear. The renewable unit shall contain an integral slow compression volume control device and all faucets shall be capable of being readily converted from compression to self-closing, without disturbing the faucet or fitting body proper.
Provide 4-arm forged brass handles containing plastic screw-on type colored service index buttons.
- C. Remote Control Valves: All valves for remote control use shall be as previously specified, but shall be complete with brass extension rods, escutcheon plates, brass forged handles and screw-on type colored service index button.
- D. Tank Nipples: Tank nipples shall be provided with locking nut and washer for all fixtures where fittings are anchored to equipment.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in for water soil and for waste piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated, before plumbing fixture installation. Use manufacturer's roughing-in data if roughing-in data are not indicated.
- B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 FIXTURE INSTALLATION

- A. Assemble fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. For wall-hanging fixtures, install off-floor supports affixed to building substrate.
 - 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 - 2. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-hanging fixtures onto waste fitting seals and attach to supports.
- D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- E. Install wall-hanging fixtures with tubular waste piping attached to supports.
- F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.
- G. Install counter-mounting fixtures in and attached to casework.
- H. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.

- I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
 - 1. Exception: Use ball, gate, or globe valve if stops are not specified with fixture. Refer to Division 22 Section "Plumbing Valves" for general-duty valves.
- J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- L. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- M. Install toilet seats on water closets.
- N. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- O. Install water-supply, flow-control fittings with specified flow rates in fixture supplies at stop valves.
- P. Install faucet, flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- Q. Install shower, flow-control fittings with specified maximum flow rates in shower arms.
- R. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- S. Install disposer in outlet of sinks indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.
- T. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Refer to Division 22 Section "Plumbing General Provisions" for escutcheons.
- U. Set shower receptors, and service basins in leveling bed of cement grout. Refer to Division 22 Section "Plumbing General Provisions" for grout.
- V. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Refer to Division 7 Section "Joint Sealants" for sealant and installation requirements.

3.03 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect water supplies from water distribution piping to fixtures.
- C. Connect drain piping from fixtures to drainage piping.
- D. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.
- E. Supply and Waste Connections to Fixtures and Equipment Specified in Other Sections: Connect fixtures and equipment with water supplies, stops, risers, traps, and waste piping specified. Use size fittings required to match fixtures and equipment. Connect to plumbing piping.
- F. Ground equipment.

1. 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.

3.04 FIELD QUALITY CONTROL

- A. Verify that installed fixtures are categories and types specified for locations where installed.
- B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
- E. Install fresh batteries in sensor-operated mechanisms.

3.05 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Adjust water pressure at faucets, shower valves, and flushometer valves to produce proper flow and stream.
- C. Replace washers and seals of leaking and dripping faucets and stops.

3.06 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 2. Remove sediment and debris from drains.

3.07 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 23 05 00
MECHANICAL GENERAL PROVISIONS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes Contract requirements and the following basic mechanical materials and methods to complement other Division and 23 Sections.
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Concrete base construction requirements.
 - 4. Escutcheons.
 - 5. Dielectric fittings.
 - 6. Flexible connectors.
 - 7. Pipe sleeves
 - 8. Mechanical sleeve seals.
 - 9. Equipment nameplate data requirements.
 - 10. Labeling and identifying mechanical systems and equipment is specified in Division 23 Section "Identification for HVAC Piping and Equipment."
 - 11. Nonshrink grout for equipment and sleeve installations.
 - 12. Field-fabricated metal and wood equipment supports.
 - 13. Installation requirements common to equipment specification sections.
 - 14. Mechanical demolition.
 - 15. Cutting and patching.
 - 16. Touchup painting and finishing.
- B. Pipe and pipe fitting materials are specified in Division 23 piping system Sections.

1.03 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The use of the word "Provide": Whenever the word "Provide" is used in the specifications and/or on the drawings, it shall mean "furnish and install", "connect", "apply", "erect", "construct", or similar terms, unless otherwise indicated.
- G. The use of the word "Piping": "Piping" shall include but not be limited to, in addition to piping or mains, all fittings, flanges, unions, valves, strainers, drains, traps, insulation, vents, hangers and other accessories relative to such piping.

- H. The use of the word "Material": Whenever the word material is used in the specifications and/or on the drawings, it shall mean any "product", "equipment", "device", "assembly", or "item" required under the contract, as indicated by trade or brand name, manufacturer's name, standard specification reference or other description.
- I. The term "Mechanical Contractor", "HVAC Contractor", "Plumbing Contractor" or "Contractor" refer to the Sub Contractor or his Sub Contractors responsible for the furnishing and installation of all work indicated on the Mechanical, HVAC, and/or Plumbing drawings and in the Mechanical, HVAC, and/or Plumbing Specifications.
- J. The term "Accessible" indicates ease of access with or without the use of ladders and without requiring extensive removal of other equipment, such as ductwork, piping, conduit, etc to gain access. "accessible ceiling" indicates acoustical tile type hung ceilings. Concealed spline or gypsum board ceilings with access panes shall not be considered accessible ceilings.
- K. The following are industry abbreviations for plastic materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.
 - 3. NP: Nylon plastic.
 - 4. PE: Polyethylene plastic.
 - 5. PVC: Polyvinyl chloride plastic.
- L. The following are industry abbreviations for rubber materials:
 - 1. CR: Chlorosulfonated polyethylene synthetic rubber.
 - 2. EPDM: Ethylene propylene diene terpolymer rubber.

1.04 CODES, STANDARDS, REFERENCES, AND PERMITS

- A. All material and workmanship shall comply with all the currently adopted editions of all applicable Codes, Specifications, Local and State Ordinances, Industry Standards and Utility Company Regulations.
- B. In case of differences between the Building Codes, State Law, Local Ordinances, Industry Standards and Utility Company Regulations and the Contract Documents, the contractor shall promptly notify the Engineer in writing of any such difference.
- C. In case of conflict between the Contract Documents and the requirements of any Code or Authorities having jurisdiction, the most stringent requirements of the aforementioned shall govern for budgetary and bid purposes. However, no work will proceed until the Engineer determines the correct method of installation.
- D. Should the contractor perform any work that does not comply with the requirements of the applicable Building Codes, State Laws, Local Ordinances, Industry Standards and Utility Company Regulations, the contractor shall bear all costs arising in correcting the deficiencies, as approved by the Engineer.
- E. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials, installation, and testing unless a more stringent requirement is noted elsewhere.

1.05 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: For the following:
 - 1. Transition fittings.
 - 2. Dielectric fittings.
 - 3. Pipe sleeves
 - 4. Mechanical sleeve seals.
 - 5. Escutcheons.
- C. Welding certificates.

- D. Coordination Drawings: Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
1. Planned piping layout, including valve and specialty locations and valve-stem movement.
 2. Clearances for installing and maintaining insulation.
 3. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
 4. Equipment and accessory service connections and support details.
 5. Exterior wall and foundation penetrations.
 6. Fire-rated wall and floor penetrations.
 7. Sizes and location of required concrete pads and bases.
 8. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
 9. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 10. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.
 11. For complete piping, air ducting, and controls systems installations with identification of seismic support systems.
- E. Prior to the purchasing of materials or the start of work, prepare a $\frac{1}{2}'' = 1'-0''$ scale coordination drawing showing size, size and location of mechanical pipes, ducts, equipment, and appurtenances, relative to other trades. Distribute drawing to other trades, and Submit drawing to Design Professional for review and approval. No demolition or new work shall proceed until all trades have indicated their respective services on the coordination drawing, and the Engineer has reviewed and approved the coordination drawings. Coordination drawings shall not be utilized as the final as built drawings required in this specification.
- F. Shop Drawings: Detail fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.
- G. Samples: Of color, lettering style, and other graphic representation required for each identification material and device.
- H. Whenever the Division 23 Sections require preparation of a delegated design submittal it shall be prepared within the contractor's scope of work using the services of a licensed and qualified professional engineer and the following shall pertain. The professional engineer shall be licensed in the state in which the project is located and with minimum five years experience preparing similar designs. Shop Drawings, and other submittals related to the Work, designed, or certified by such professional engineer, if prepared by others, shall bear such professional engineer's written approval when submitted. The professional engineer shall promptly inquire of the Engineer if the performance and design criteria are not clear and complete. The contractor is responsible for coordinating the work of the delegated design. The Engineer's review of all delegated design submittals shall be for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Engineer shall be entitled to rely upon, and shall not be responsible

for, the adequacy and accuracy of the services, certifications, and approvals performed or provided by such professional engineers.

- I. Hydrostatic pressure piping test reports and duct leakage test reports, each including a statement of pass/fail, and signed by the Construction Manager and Clerk of the Works or other approved owner's representative.

1.06 QUALITY ASSURANCE

- A. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.
- B. Equipment Selection: Subject to compliance with individual Section requirements for equipment and other components for the project, available manufacturers whose products may be incorporated into the Work, other than the Basis of Design products noted, and proposed as a substitution shall: (1) Be submitted as a substitution to not only demonstrate product compliance with the requirements, but also demonstrate equivalency to the Basis of Design product. The mechanical, plumbing, and electrical designs are based upon the Basis of Design product. If other than the Basis of Design product is furnished and: (1) if the power requirements differ, the mechanical contractor shall coordinate all requirements with the electrical contractor including circuit breaker, conductor, and conduit sizes. In such case, the power shall still come from the same panel as currently designed. (2) if the piping or duct connections locations or sizes differ, the mechanical contractor shall coordinate with affected trades and shall provide all required modifications to accommodate. The mechanical contractor is responsible for any additional cost to any trade as noted above and as required to coordinate installation and provide proper service clearances for other than the Basis of Design product. The mechanical contractor is responsible for paying any design fees associated with redesigning architectural, structural, or MEP systems to accommodate other than the Basis of Design product.
- C. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- D. Steel Pipe Welding and Copper Pipe Brazing: Given it is a requirement of ASME B31.9, qualify processes and operators according to ASME Boiler and Pressure Vessel Code (BPVC): Section IX, "Welding, Brazing and Fusing Qualifications."
 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.07 SYSTEM DESCRIPTION

- A. Furnish and install all materials in order to provide functioning systems, upon completion, in compliance with all applicable codes, authorities having jurisdiction, manufacturer's requirements, performance requirements specified, and any modifications resulting from reviewed shop drawings and the field coordination drawings.

1.08 SCOPE OF WORK

- A. The contractor is responsible for furnishing and installing all the devices and equipment shown indicated the Mechanical Drawings including materials and equipment required to create fully operational systems.
- B. The Mechanical contractor shall be responsible for reviewing the Architectural, Plumbing, Fire Protection, and Electrical Plans. In addition to all mechanical equipment and devices indicated on the Mechanical Plans, the Mechanical contractor is responsible for mechanical installation of all the mechanical equipment and devices shown on the Architectural, Plumbing, Fire Protection, and Electrical Plans.

- C. The contractor shall be responsible for reviewing the Architectural, Electrical, and Fire Protection Plans. Prior to bid, the contractor shall notify the Engineer of any discrepancies between the Architectural, Electrical, Mechanical, and Fire Protection Plans regarding equipment locations, equipment quantities, piping and duct work routing, device locations, light locations, chase locations, etc. otherwise it will be assumed the contractor is responsible for mechanical installation of all the equipment and devices shown on the Architectural Plans, Mechanical Plans, Plumbing Plans, Fire Protection Plans and the Electrical Plans regardless of whether they are indicated on the Mechanical Plans.

1.09 DRAWING INTERPRETATION

- A. The project drawings are schematic in nature and indicate general arrangement of equipment. It is not the intent of the drawings to substitute for shop drawings. In many instances, equipment and devices are sized on one manufacturer's product. In the event of a field verification or coordination issue, report issue to the Construction Manager with copy to the Clerk of the Works or other approved owner's representative.
- B. Piping and air duct plans are intended to show size, capacity, approximate location, direction and general relationship of one work phase to another, but not exact detail or arrangement. The drawings do not necessarily indicate all required offsets, details and accessories and equipment to be connected or encountered in the way of new work.
- C. Generally, layout pipelines requiring drainage first, followed by large pipe mains, air duct and electrical conduit. Follow this procedure for an orderly installation but not to establish precedence of one trade over another. It must be understood that pipe and duct hanger installations must comply with seismic bracing requirements. Minimizing hanger lengths (structure to equipment and crossbars) to 12" and under minimizes the requirement for seismic bracing.
- D. Install work as closely as possible to layouts shown on drawings. Modify work as necessary to meet job conditions and to clear other equipment. Offsets, transitions and changes of direction in all systems shall be made as required to maintain proper headroom and pitch of sloping lines, to avoid existing field conditions as well as to maintain clearances to equipment whether or not indicated on the drawings. The contractor shall provide all drains, traps and accessories as required for his work to effect these offsets, transitions and changes in direction. Consult Design Professional before making changes that effect the function or appearance of systems.
- E. Do not install equipment, air ducting or piping in a non-code compliant fashion due to drawing interpretation. Provide modification of illustrated work in order to accommodate job conditions at no cost to Owner.
- F. In some cases, drawings are based on products of one or several manufacturers, as listed on the contract documents. The contractor shall be held responsible for modifications made necessary by substitution of products or other manufacturers.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.
- C. Protect flanges, fittings, and piping specialties from moisture and dirt.
- D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.11 COORDINATION

- A. Refer to Division 1 Section "Facilities Services Coordination" for additional coordination required, to include meetings, field survey, and preparation and submittal of coordination drawings and schedules.
- B. Do not install any part of a system until all critical components of the systems and related systems have been approved. Coordinate individual parts of systems.
- C. Coordinate contract work with other work specified in other Sections. Relocate work if required for proper installation and functioning of other systems, at no extra cost to the Owner.
- D. Install products in accordance with manufacturer's instructions. Notify Design Professional if Contract Documents conflict with manufacturer's instructions. Comply with Design Professional's interpretations,
- E. In general, air duct, heating and sprinkler piping, and drainage lines take precedence over water, gas, and electrical conduits. The design professional will make final decisions regarding the arrangement of work which cannot be agreed upon by the contractors.

1.12 SEQUENCING AND SCHEDULING

- A. Coordinate mechanical equipment installation with other building components.
- B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
- C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.
- D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Coordinate installation of large equipment requiring positioning before closing in building.
- E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- F. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors."
- G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

1.13 "AS-BUILT" RECORD DRAWINGS

- A. Record daily progress on one set of construction documents. Utilize a permanent black or blue marking media. All progress of record drawings shall be provided in a neat and accurate fashion.
- B. As-built drawing reviews will be completed on a monthly basis by the engineer of record. Release of requisitions will be based on the regular progress of As-built drawings. The latest As-built drawings shall be submitted for review with each requisition for payment.
- C. Formal As-built drawings shall be submitted for review at the completion of each phase of the work. The as-built drawings shall be 1/4" scale and created in electronic format utilizing current release of AutoCAD or Revit. At the completion of each phase of work, the mechanical contractor shall submit to the Engineer the original field progress as-built drawings and the electronic files of the formal as-built drawings. Once these have been reviewed by the Engineer, print and furnish one set of final as-built drawings to the Owner, plotted on 24" x

36" 'D' sized sheets. Final payment for the phase of work and the start of the next phase shall require acceptance of the as-built drawings.

1.14 GUARANTEE

- A. Provide written guarantee of all completed/installed work. Materials, equipment and workmanship shall be guaranteed for a minimum period of one year after Owners acceptance of work. Any failure due to defective material, equipment or workmanship shall be corrected at no additional cost to owner. This shall include damage completed to other areas of construction or facility resulting from this failure. Provide correction of any failure within an acceptable/reasonable time period.
- B. Provide all equipment and material manufacturers guarantees and/or warranties to owner after acceptance of installation.

1.15 OPERATING AND MAINTENANCE MANUALS

- A. Provide operating and maintenance information for all equipment, devices, systems, and materials. This shall include all maintenance and operations procedures, recommendations, and service requirements. All submitted data must include minimum equipment/device operations and maintenance requirements to fulfill manufacturers warranties.
- B. Submit all engineering selection and specification documentation with operating and maintenance information for all equipment, devices, systems, and materials.
- C. Submit all data media in a detailed, organized, and complete manner. Provide electronic copy to the Construction Manager with copy to the Clerk of the Works or other approved owner's representative for engineer/architect review.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Dielectric Flanges:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Co.
 - c. Epco Sales Inc.
 - d. Watts Industries, Inc.; Water Products Div.
 - e. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
 - 2. Dielectric-Flange Insulating Kits:
 - a. Calpico, Inc.
 - b. Central Plastics Co.
 - c. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
 - 3. Dielectric Couplings:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
 - c. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
 - 4. Dielectric Nipples:
 - a. Grinnell Corp.; Grinnell Supply Sales Co.
 - b. Perfection Corp.

- c. Victaulic Co. of America.
 - d. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- 5. Metal, Flexible Connectors:
 - a. ANAMET Industrial, Inc.
 - b. Flexicraft Industries.
 - c. Mercer Rubber Co.
 - d. Uniflex, Inc.
 - e. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- 6. Rubber, Flexible Connectors:
 - a. General Rubber Corp.
 - b. Mercer Rubber Co.
 - c. Proco Products, Inc.
 - d. Uniflex, Inc.
 - e. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- 7. Mechanical Sleeve Seals:
 - a. Metra Seals by Metraflex Co.
 - b. Link-Seal by Garlock Pipeline Technologies (GPT) ~ an Enpro Industries Company
 - c. Innerlynx by Advance Products & Systems, Inc.
 - d. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

2.02 PIPE AND PIPE FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe and pipe fitting materials and joining methods.

2.03 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents. Gaskets are to meet the requirements of Table in ASME B31.1 (pertinent items are summarized below for common Division 23 applications,) as well as the gasket manufacturer's recommendations.
 - 1. Where both Flange A and mating Flange B are either Class 150 steel or Class 150 ductile iron, furnish flat ring nonmetallic to ASME B16.5, Annex C, Group 1a, Table C1.
 - 2. Where both Flange A and mating Flange B are Class 300 steel, furnish flat ring nonmetallic to ASME B16.5, para 6.11 and Annex C, Group 1a material.
 - 3. Where Flange A is Class 125 cast iron mating with Flange B Class 125 cast iron, Class 150 steel, or Class 150 ductile iron, furnish flat ring, nonmetallic gasket to ASME B16.21, Table 2. Both flange facings are to be flat (flat face.)
 - 4. Where Flange A is Class 150 bronze or nonmetallic mating with Flange B Class 125 cast iron, Class 150 bronze, Class 150 steel, Class 150 ductile iron, or nonmetallic, furnish full face, nonmetallic gasket to ASME B16.21, Table 2. Both flange facings are to be flat (flat face.)
 - 5. Where Flange A is Class 250 cast iron mating with Flange B Class 250 cast iron, Class 300 steel, or Class 300 ductile iron, furnish flat ring, nonmetallic gasket to ASME B16.21, Table 3.

6. Gaskets indicated above to be manufactured in accordance with ASME B16.21-2021 "Nonmetallic Flat Gaskets for Pipe Flanges" shall be nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated, and to suit ASME B16.5 flange designation. Refer to Division 23 pipe specifications for additional gasket requirements.
 - 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.
7. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Flexitallic (Basis of Design)
 - b. Leader Gasket, Eriks Company
 - c. Teadit
 - d. Garlock, Enpro Industries, Inc.
 - e. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- C. Flange bolts and nuts are to be one of the following, as indicated in the Component Standards and Specifications Table of ASME B31.9, unless otherwise indicated or required:
 1. Bolts / Nuts: ASME B18.2.1, ASTM A307 Grade B carbon steel machine hex bolts with ASME B18.2.2, ASTM A563 Grade A carbon steel hex nuts.
 2. Bolts / Nuts (alternative higher strength option if above are not available): ASME B18.2.1, ASTM A193 Grade B7 alloy steel machine hex bolts with ASME B18.2.2, ASTM A194 Grade 2H carbon steel heavy hex nuts.
 3. Note that SAE J429 bolts are not listed in the table and will not be permitted.
 4. Threads as required to match valve.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer and as indicated in the Component Standards and Specifications Table (referenced ASTM standards) of ASME B31.9, unless otherwise indicated or required.
- E. Solder Filler Metals: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated. Given it is required by ASME B31.9, the soldering filler metal shall conform to the applicable ASTM specification.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated. Given it is required by ASME B31.9, the brazing filler metal shall conform to an applicable AWS classification.
- G. Welding Filler Metals: Given it is required by ASME B31.9, comply with the ASME Boiler and Pressure Vessel Code: Section II, Part C, for materials appropriate for pipe being welded. Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. No other copper or steel joint methods for piping, fittings, valves, or other piping system components (such as using grooved mechanical joints, associated mechanical couplings, or mechanical press seal joints) shall be permitted.
 1. Furnish a deductive alternate price for owners' consideration to furnish mechanical press seal joints and pressed ends, to the extent the contractor prefers to utilize such products in lieu of those specified. Mechanical press seal joints furnished shall be only ProPress as manufactured by Viega. No other manufacturer's products will be permitted. ProPress components shall be installed per manufacturer's written

instructions and by trained and currently certified installers. Submittal of such training and manufacturer certification shall be required before the start of work.

- I. Solvent Cements for Joining Plastic Piping:
 - 1. ABS Piping: ASTM D 2235.
 - 2. CPVC Piping: ASTM F 493.
 - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - 4. PVC to ABS Piping Transition: ASTM D 3138.
- J. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.04 DIELECTRIC FITTINGS

- A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion. Refer to piping Section for additional requirements.
- B. Dielectric unions: Dielectric unions are not acceptable.
- C. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.
- D. Insulating Material: Suitable for system fluid, pressure, and temperature.
- E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- F. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure as required to suit system pressures.
- G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- H. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain or threaded ends; and 300-psig minimum working pressure at 225 deg F.

2.05 FLEXIBLE CONNECTORS

- A. General: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections. Entire flexible connector shall be assembled by the manufacturer or approved distributor at their shop, not in the contractor's shop nor in field by the Contractor. Include 250-psig minimum working-pressure rating, unless higher working pressure is indicated, and ends according to the following:
 - 1. 2-Inch NPS and Smaller: Threaded.
 - 2. 2-1/2-Inch NPS and Larger: Flanged.
- B. Bronze-Hose, Flexible Connectors: Corrugated, bronze, inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to hose.
- C. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.
- D. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.
- E. Rubber, Flexible Connectors: CR or EPDM elastomer rubber construction, with multiple plies of NP fabric, molded and cured in hydraulic presses. Include 125-psig minimum working-pressure rating at 220 deg F. Units may be straight or elbow type, unless otherwise indicated.

2.06 PIPE SLEEVES

- A. The following materials are for wall, partition, elevated floor, and roof penetrations:

- B. Galvanized-Steel Sheet: 0.0276-inch (24 gauge) minimum thickness; round tube closed with welded longitudinal joint.
- C. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 10 (minimum) pipe, galvanized, plain ends.
- D. Steel pipe sleeves, for use in conjunction with mechanical sleeve seals for underground pipe penetrations thru exterior-walls into a building or structure:
 - 1. ASTM A 53, Type E, Grade B, Schedule 10 (minimum) pipe, hot-dip galvanized according to ASTM A123, plain ends. Prior to hot-dip galvanizing, continuously weld both sides of an ASTM A36 carbon steel water stop plate, minimum 0.25 inch thick, to be located at center of concrete wall.
 - 2. Similar sleeve construction without galvanizing using materials below is acceptable.
 - a. Pipe, to be unannealed / hard:
 - 1) ASTM A312 GRADE TP304 (UNS S30400) or GRADE TP304L (UNS S30403)
 - 2) ASTM A778 GRADE T304L (UNS S30403); Spiral butt seam pipe will not be accepted.
 - b. ASTM A240 304 stainless steel or equal water stop plate.
- E. Steel pipe sleeves, for use in conjunction with mechanical sleeve seals for aboveground pipe penetrations thru exterior-walls into a building or structure:
 - 1. ASTM A 53, Type E, Grade B, Schedule 10 (minimum) pipe, plain ends, hot-dip galvanized according to ASTM A123. Water stop plate not required.
 - 2. Similar sleeve construction without galvanizing using one of the stainless pipe materials directly above is acceptable.
- F. Cast Iron will Not be permitted: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe.
- 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.
- H. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- I. PVC Pipe: ASTM D 1785, Schedule 40.
- J. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.07 MECHANICAL SLEEVE SEALS

- A. Furnish and install mechanical sleeve seals as listed in Article 2.1 above and as described below for underground and aboveground pipe penetrations thru exterior-walls into a building or structure.
- B. Mechanical Sleeve Seal assemblies shall be modular, mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening, and pressure rated to 20 psig.
 - 1. Complete Assembly is defined as a combined:
 - a. Wall Opening (sleeve, cored hole, or formed hole). The wall opening size and/or type shall be selected according to the Mechanical Sleeve Seal manufacturer's Engineering Manual.
 - b. Sufficient quantity and type of Mechanical Sleeve Seals required to effectively provide a hydrostatic and/or fire-rated seal.
 - 2. The elastomeric element shall be sized and selected per manufacturer's written recommendations and have the following properties as designated by ASTM. Refer to Part 3 for additional application requirements.

- a. For Standard Service Applications (-40°F to 250°F) EPDM = ASTM D2000 M3 BA510 (black)
 - b. For Hydrocarbon Service Applications (-40°F to 210°F) NITRILE = ASTM D2000 M1BF510 (green)
 - c. For High Temperature or Fire Seal Applications (-67°F to 400°F) SILICONE = ASTM D2000 M1GE505 (gray)
3. Bolts and Nuts: Type 316 Stainless Steel. Mechanical sleeve seals intended for temporary piping may utilize zinc plated carbon steel bolts and nuts.
4. Pressure plates:
 - a. Reinforced nylon polymer (composite) for standard service applications.
 - b. Type 316 Stainless Steel for high temperature or fire seal applications.
5. Utilize the selected Mechanical Sleeve Seal manufacturer's Engineering Manual sizing procedures and online sizing calculator (if available) for each selection.
6. Piping shall be independently supported, internal to building or manhole, by a specified pipe hanger, such that pipe is concentric with cored penetration or sleeve opening. Mechanical Sleeve Seal assembly shall not be allowed to support weight of piping.
7. Install two Mechanical Sleeve Seal assemblies for each below grade exterior wall penetration greater than 12" thick and where indicated on the drawings.
8. Do not exceed manufacturer's angular misalignment recommendation which varies. Typically this may be approximately 7 degrees. Consult manufacturer for details. Utilize Metraflex product below where a particular application does not meet Mechanical Sleeve Seal manufacturer's requirements.
- C. Seals for misaligned or eccentric underground and aboveground pipe penetrations thru exterior-walls into a building or structure which do not meet Mechanical Sleeve Seal manufacturer's requirements shall be Off Center Seal (Eccentric Seal) by Metraflex, or approved equal.
 1. Product materials, selection, and installation shall meet all the requirements above for Mechanical Sleeve Seals.
 2. This product shall not be used in exchange for preinsulated factory fabricated fittings, as may be indicated on drawings.

2.08 PIPING SPECIALTIES

- A. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type if required to conceal protruding fittings and sleeves.
 1. ID: Closely fit around pipe, tube, and insulation of insulated piping.
 2. OD: Completely cover opening.
 3. Cast Brass: Split casting, with set screw.
 - a. Finish: Rough brass.
 - b. Finish: Polished chrome-plate.

2.09 GROUT

- A. This article shall pertain only to the extent there is not a Division 3 Section "Non-Metallic Non-Shrink Grouting" for grout or notes on the structural drawings addressing same. If so, these shall supersede this article.
- B. Work Included. Furnishing and installing grout for filling joints and setting and anchoring items to masonry and concrete.
- C. Reference Standards
 1. ASTM C109 - Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50 mm Cube Specimens).

2. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
3. ASTM C827 - Early Volume Change of Cementitious Mixtures.
- D. Acceptable Manufacturers
 1. Specifications include references to designated manufacturers to illustrate minimum acceptable requirements for products.
 2. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- E. Non-shrink Cement Grout
 1. Non-shrink, non-metallic cement based grout with a minimum compressive strength of 5,000 psi at 28 days when tested in accordance with ASTM C109, and with no shrinkage when tested in accordance with ASTM C827. Grout shall consist of premixed, prepackaged materials requiring only the addition of potable water. Grout shall meet the requirements of Embeco 153 Grout by Master Builders or Five Star Grout by U.S. Grout Corporation.
- F. Non-shrink Epoxy Grout
 1. Non-shrink, non-metallic epoxy-based grout with a minimum compressive strength of 10,000 psi at 28 days when tested in accordance with ASTM C109, and with no shrinkage when tested in accordance with ASTM C827. Grout shall be pourable, 100% solids epoxy system consisting of three premeasured, prepackaged components. Grout shall meet the requirements of Five Star Grout as manufactured by U.S. Grout Corporation.

PART 3 EXECUTION

3.01 MECHANICAL DEMOLITION

- A. Refer to Division 1 Sections "Cutting and Patching" and "Selective Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.
 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or comparable and compatible piping material. Demolish any existing associated wall sleeves except as noted below.
 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or comparable and compatible piping material.
 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or comparable and compatible ductwork material.
 4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or comparable and compatible ductwork material.
 5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 8. Whenever piping, ductwork, equipment, and appurtenances are indicated to be removed, resulting in a hole, opening, void, or other discontinuity in the adjacent architectural features, these features shall be infilled and restored to a continuous

appearance and function as indicated or to match existing materials of construction. Waterproofing is to be repaired, where it existed before, and where indicated. If the resulting hole is indicated to be reused, any required wall sleeve shall be replaced unless in excellent condition. Fireproofing is to be repaired, where it existed before if damaged, and where indicated.

- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
- D. Disconnect, demolish, and remove Work specified in Division 23 Drawings and Sections.
- E. If pipe, ductwork, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.
- F. Accessible Work: Remove indicated exposed pipe and ductwork in its entirety.
- G. Work Abandoned in Place: Cut and remove underground pipe a minimum of 2 inches beyond face of adjacent construction. Cap and patch surface to match existing finish.
- H. Removal: Remove indicated equipment from Project site.
- I. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

3.02 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following. For new piping use one-piece designs. For existing piping use split-casting designs. Additional escutcheon requirements for both new and existing piping follow:
 - 1. Piping with Fitting or Sleeve Protruding from Wall: Deep-pattern type.
 - 2. Chrome-Plated Piping: Cast-brass type with polished chrome-plated finish.
 - 3. Insulated Piping: One-piece stamped-steel type with spring clips for new piping. Split-plate, stamped-steel type with spring clips for existing piping.
 - 4. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Cast-brass type with polished chrome-plated finish.

5. Bare Piping at Ceiling Penetrations in Finished Spaces: Cast-brass type with polished chrome-plated finish.
6. Bare Piping in Unfinished Service Spaces: Cast-brass type with polished chrome-plated finish.
7. Bare Piping in Equipment Rooms: Cast-brass type.
8. Bare Piping at Floor Penetrations in Equipment Rooms: Floor-plate type.
- M. Sleeve pipe passing through concrete and masonry walls, gypsum-board partitions, elevated floors, and roof penetrations.
 1. When installed as part of a UL-listed fire rated assembly, the sleeve shall meet the requirements of listing.
 2. Position pipe in center of sleeve.
 3. Cut sleeves to length for mounting flush with both surfaces. While not required by this Section, it is preferred that sleeves extend $\frac{1}{2}$ " beyond the wall on each side to the extent not conflicting with escutcheon installations.
 - a. Exception: For elevated floors of mechanical equipment areas, parking garages, commercial kitchens, janitors closets, spaces that can anticipate washdown, and other wet areas, extend sleeves 2 inches above finished floor level to inhibit water on floor from passing to level below.
 4. Install sleeves in new walls and elevated floors as new walls and slabs are constructed. Securely fasten sleeves to the assemblies penetrated. Space outside sleeve perimeter is to be filled as follows.
 - a. Use grout for any portion installed thru existing concrete or CMU walls or concrete floors. Surface to be flush and continuous with existing wall and floor surfaces.
 - b. Use materials in compliance with UL-listed fire rated assembly and as required based upon adjacent materials of construction.
 5. Contractor to determine means and methods to install sleeves in existing walls and partitions. Coring concrete and masonry walls would be one possible method. Where multiple sleeves are required in a tight area, contractor may desire to remove a rectangular section of the wall or slab, and to then reconstruct the section with the sleeves, matching existing materials and finishes. In that case, inquire with the architect and/or structural engineer via the RFI process and furnish a multi-trade coordinated and dimensioned sketch and intended approach to infill wall, to confirm each such location and approach is acceptable. Determination will be based, in part, if existing wall is load-bearing.
 6. Install sleeves for interior wall and floor pipe penetrations that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Any pipe insulation is to be continuous through sleeve, unless not permissible where installed as part of a UL-listed fire rated assembly.
 - a. For interior wall and floor pipe penetrations, use the following sleeve materials:
 - 1) Steel Pipe Sleeves: For pipes smaller than NPS 6 and for all exposed floor pipe penetrations.
 - 2) Steel Sheet Sleeves: For pipes NPS 6 and larger, except exposed floor pipe penetrations. Where installed thru masonry or concrete wall, to be 12 ga (minimum,) with caution taken not to damage sleeve, especially when installing masonry, mortar, and grout. Steel pipe sleeves specified will be permitted.

- 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 above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
 - b. For interior wall and floor pipe penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Use materials in compliance with UL-listed fire rated assembly where required. Refer to Division 7 Section "Joint Sealants" for materials and installation.
- 7. Permanent sleeves are not required in bare concrete walls for suitably sized core-drilled or formed holes with smooth concrete bore, unless a sleeve is required by UL-listed fire rated assembly. These holes may be formed by removable PE sleeves. Concrete walls that are part of a wall assembly (such as combined with insulation, brick, metal studs, gypsum wall board, etc.) require a sleeve extending thru the entire assembly.
- 8. Underground and aboveground pipe penetrations thru exterior-walls into a building or structure: Seal penetrations using specified steel pipe sleeves and mechanical sleeve seals installed per manufacturer's written instructions. Select sleeve size in accordance with the Mechanical Sleeve Seal manufacturer's Engineering Manual. Generally, the annular clear space expected between the pipe OD and sleeve ID for installing mechanical sleeve seals as follows: For most pipes 6" and smaller expect annular space from approximately 9/16" to 1", and for most pipes 8" and larger expect annular space from approximately 1-5/8" to 2". Any pipe penetration thru exterior-walls subject to plumbing code jurisdiction shall comply with International Plumbing Code requirement (305.3) for pipe sleeve to be two pipe sizes greater than the pipe passing through the wall. Install steel pipe sleeve with not greater than seven (7) degrees angular misalignment to pipe, preferably less.
 - a. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material, design temperature, and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
 - b. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
 - c. Underground pipe penetrations thru exterior-walls into a building or structure: Where it is apparent that an opening in the wall was previously saw cut or otherwise created, opening created for installation of this work shall not be smaller than former opening in the same location.
 - d. For exterior wall installations both sleeve-to-wall and sleeve-to-pipe junctures shall be watertight.
- N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Penetration Firestopping" for requirements.
- O. Verify final equipment locations for roughing-in.
- P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.03 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements, applicable codes, manufacturer's instructions, and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe that is to be butt welded.
- C. Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction protect open ends with temporary plugs or caps.
- D. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before and after assembly. Remove all dirt, scale and other foreign matter from inside the pipe by use of a pipe swab or pipe "pig" before connecting pipe sections, valves, equipment or fittings.
- E. Soldered Joints: Apply ASTM B 813, water-flushable lead-free flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 preparation and technique using lead-free solder alloy complying with ASTM B 32. Lead-free shall mean a chemical composition equal to or less than 0.2 percent lead.
- F. Brazed Joints: Construct joints according to Copper Tube Handbook of the Copper Development Association, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- 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 pipe-joint compound to male (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.
- H. Welded Joints: Construct pipe joints according to AWS D1.1 or AWS D10.12 (select one for the project's pipe joints; contractor to determine and utilize the one that has the more stringent Welding Procedure Specifications - WPS's to be followed), using qualified processes and welding operators according to Part 1 "Quality Assurance" Article. Given it is a requirement of ASME B31.9, the pipe joint WPS's shall be prepared and qualified according to ASME Boiler and Pressure Vessel Code (BPVC): Section IX, "Welding, Brazing and Fusing Qualifications."
- I. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use lubricant recommended by gasket manufacturer on bolt and cap screw threads, and underside of nuts and cap screw heads. Torque flange bolts as recommended in writing by gasket manufacturer.
- J. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
- K. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

3.04 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.05 FIELD TESTING

- A. Prepare hydronic piping according to ASME B31.9, "Building Services Piping," and as follows:
 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 3. Flush system with clean water. Clean strainers.
 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install a blank at flanged joints to isolate equipment. Blanks shall be of adequate thickness to prevent deformation under anticipated pressures, typically not less than 3/8" thick plate steel. Utilize equation in ASME B31.9 to calculate minimum required thickness of blank based upon allowable stress of blank material.
 5. Isolate piping outside scope of this work. Do not subject to test pressure.
 6. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following examination and test on hydronic piping:
 1. ASME B31.9 mandates visual examination of all project pressure welds. These shall be performed by any trained and licensed journeyman or master pipefitter who is also a certified welder. The visual examination must be within the scope of his/her experience and he/she must be comfortable doing so.
 2. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used. Pneumatic testing is discouraged due to safety risks and requires justification. Pneumatic testing shall not be used for plastic pipe subject to brittle failure or where manufacturer prohibits (such as PVC), system containing soldered or solvent cement joints over NPS 2, or test pressures exceeding 150 psig. Any pneumatic testing must be done in compliance with requirements of ASME B31.9. In service testing, without a hydrostatic pressure test, will only be permitted for the short sections of hydronic piping connecting to equipment and to existing piping. Owner will not be obliged to fund the replacement any existing valves not shown on the drawings to be replaced and that are found to leak during testing. Contractor is to carry cost for testing means that resolves any such concerns.
 3. Use vents installed at high points to release trapped air while filling system with water.
 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design (working) pressure. Hydrostatic test pressure for ferrous and copper piping systems shall not be less than 150 psig. Review hydrostatic test pressure and methods for plastic piping systems with engineer in advance of testing; comply with manufacturer's test procedures. Test pressures shall not exceed maximum allowable

pressure for any pipe, fitting, vessel, pump, valve, instrument, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength. Contractor is responsible for determining means and methods (to include necessary drains, vents, pipe anchors, etc.) to implement hydrostatic pressure tests, which are to include expansion joints to the extent feasible.

5. After hydrostatic test pressure has been applied for at least 2 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic pressure test until there are no leaks.
 6. Mechanical contractor shall determine location of testing caps and purge valves required for hydrostatic pressure testing.
 7. Where expansion joints are installed at the time of test, the mechanical contractor shall bear all costs of preparing and submitting the design of any required temporary pipe restraints. Such a design shall be prepared by a professional engineer licensed in the state where the project is located.
 8. Use low point drains and high point vents to completely remove liquid when testing is complete.
- C. Prepare written report of hydrostatic pressure tests.

3.06 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Equipment storage prior to installation.
1. All building interior equipment is to be stored indoors prior to installation, protected from weather, precipitation, and construction dust and damage, and in accordance with the manufacturer's installation instructions. Storage of such equipment outdoors during adverse weather (rain, snow, etc.) shall require manufacturer's advance written approval or the owner reserves the right to reject the equipment that in their reasonable opinion has been damaged or suffered a reduction in lifespan by such storage and require the contractor to replace same with new at no additional expense to the owner nor change in construction schedule.
 2. All building exterior equipment may be stored outdoors if stored on dunnage in a high area with good drainage, and in accordance with the manufacturer's installation instructions. Piping connections and any other equipment openings shall be protected from the weather with caps, tarps, etc.
 3. Stored equipment is to be covered with either the original packaging and shipping protection or an equivalent or better protective covering. Repair any damaged packaging. Cap the open ends of pipe connections. In areas where painting, plastering, spraying, and/or other dust generating activities have not been completed, all due precautions must be taken to avoid physical damage to the equipment and contamination by foreign material. Corrosive environments must be avoided. Store equipment in an upright position. Examine equipment before installing, first removing any dirt or debris found in or on the equipment.
- B. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- D. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

- E. Install equipment to allow right of way for piping installed at required slope.
- F. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.
- G. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

3.07 CLEANLINESS CONTROL MEASURES

- A. Clean-Up: Frequently clean-up all waste, remove from site regularly, and legally dispose of offsite. Comply with further requirements of Division 1 Section in regard to construction waste management.
- B. During construction meet or exceed the minimum requirements of the recommended Control Measures of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, Second Edition, November 2007, Chapter 3 to help minimize contamination of a building from construction activities. These shall apply to new building construction as well, to the extent needed to similarly protect the HVAC systems. Below is a list and summary of these Control Measures. These include HVAC System Protection; Source Control; Pathway Interruption; Housekeeping; and Scheduling.
 - 1. HVAC System Protection. Prevent construction dust and debris, moisture, and chemical vapors from entering the ductwork, mechanical equipment, and other components. Isolate the return side of the HVAC system during heavy construction or demolition. If permanently installed air handlers and/or ductwork are permitted to be used during construction, filtration media with a Minimum Efficiency Reporting Value (MERV) of 13, as determined by ASHRAE 52.2-2017, shall be temporarily installed at each return air opening or grille until such time as construction is completed.
 - 2. Source Control. Achieved through the selection of low emission materials and finishes including paints, sealants, adhesives, carpeting, other furnishings, and cleaning products.
 - 3. Pathway Interruption. To prevent the migration of contaminants through a building during construction. Approaches can include ventilation using 100% outside air during installation of Volatile Organic Compound (VOC) emitting materials, preconditioning products which have significant VOC emissions in a offsite dry well ventilated space for sufficient period to dissipate emissions, erecting physical barriers between work areas and non-work areas, and temporary negative pressure zones.
 - 4. Housekeeping. Frequent cleaning to remove construction dust and debris, immediate clean-up of any spills, removal of accumulated water, and other actions to keep work areas dry.
 - 5. Scheduling. The sequence of construction can minimize impact of dust and debris on mechanical systems.
- C. Comply with any additional requirements of a Construction IAQ Management Plan if required elsewhere in these specifications.
- D. Keep equipment in a clean environment or protected from any type of unclean environment.
- E. Operate equipment as recommended in the manufacturers' installation, operation, and maintenance manuals. Do not operate equipment when the adjacent area is unclean or when in a dusty or wet environment.

3.08 PAINTING AND FINISHING

- A. Apply paint to exposed piping according to the following, unless otherwise indicated:

1. Interior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
 2. Interior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
 3. Interior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
 4. Exterior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.
 5. Exterior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
 6. Exterior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.
- B. Coordinate exposed piping painting with the requirements of Division 9.
- C. Do not paint piping specialties with factory-applied finish.
- D. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.09 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit. Provide 3/4" chamfered edges on top of concrete pads. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete." Provide broom finish.

3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Refer to Division 5 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- C. Field Welding: Comply with AWS D1.1, "Structural Welding Code--Steel."

3.11 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor mechanical materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.12 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair cut surfaces to match adjacent surfaces.
- C. Mechanical Contractor shall be responsible for any patching of existing partitions after removal of duct work and HVAC piping.

3.13 GROUTING

- A. Install nonmetallic, nonshrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, anchors, and for sleeve installations where noted. Coordinate with requirements of structural drawings. Mix grout according to manufacturer's written instructions.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.

- D. Avoid air entrapment during placing of grout.
- E. Place grout, completely filling equipment bases and space around sleeves.
- F. Place grout on concrete bases to provide smooth bearing surface for equipment.
- G. Place grout around anchor plates.
- H. Cure placed grout according to manufacturer's written instructions.

3.14 PERMIT REQUIRED CONFINED SPACES

- A. Where appropriate, work is to comply with Confined Spaces in Construction standard 29 CFR 1926 Subpart AA (the 1926.12xx-series) for "Permit Required Confined Spaces."

3.15 FIRESTOPPING

- A. The trade contractor is responsible for providing proper U.L. Listed firestopping and smokestopping for all duct, pipe, controls conduit, and related electrical conduit installed by this trade contractor.
- B. The trade contractor shall utilize the latest fire and smoke protection materials and installation methods. The trade contractor shall guarantee that all materials installed are fire and smoke stopped per U.L. Listing, NFPA, building code requirements.
- C. The trade contractor shall utilize Architectural Life Safety Drawings to identify partition ratings. If the trade contractor is unsure of partition rating then he or she must inquire to Construction Manager.
- D. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078410.
- E. Fire stopping shall be provided to both be compatible with the piping and meet the requirements of ASTM E 814 or ULC CAN-S115, "Fire Tests of Through-Penetration Firestops". Pipe insulations or fire resistive coating shall be removed where the pipe passes through a fire stop and, if required by the firestop manufacturer, for 3 inches beyond the firestop outside of the fire barrier.
- F. Where plastic pipes, such as polypropylene and PVC materials, penetrate fire rated walls, partitions, or elevated floors, furnish firestop collar meeting ASTM E 814 or ULC CAN-S115, installed per UL listing requirements to provide fire rating required.

END OF SECTION

SECTION 23 05 13
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General construction and requirements.
- B. Applications.
- C. Single phase electric motors.
- D. Three phase electric motors.
- E. Electronically Commutated Motors (ECM).

1.02 RELATED REQUIREMENTS

- A. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.
- B. Section 262913 - Variable-Frequency Motor Controllers.

1.03 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015.
- B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; 2004.
- C. NEMA MG 00001 - Motors and Generators; 2024.
- D. IEC Standard 60034-30-1; 2014, or latest edition, prepared by International Electrotechnical Commission (IEC.)
- E. Currently adopted state commercial building energy standards regarding motor type, efficiency, and control.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements. Indicate compliance with Performance Requirements listed below.
- C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
- E. Operation Data: Include instructions for safe operating procedures.
- F. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.05 PERFORMANCE REQUIREMENTS

- A. Electric motors shall meet one or both of the following, except where the actual installation is excluded because it is outside the scope of the standard (due to it's installed configuration):
 - 1. IEC Standard 60034-30-1, "Rotating electrical machines – Part 30-1: Efficiency classes of line operated AC motors." IEC Standard 60034-12:2016 "Rotating Electrical Machines - Part 12: Starting Performance Of Single-Speed Three-Phase Cage Induction Motors", meeting Design N, normal starting torque.
 - 2. NEMA MG-1.
- B. Unless excluded as noted above, each electric motor shall meet one of the following efficiency classes, as further clarified under Article 2.3 of this Section (below.)
 - 1. IEC IE5 classification - Ultra-premium efficiency

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EQUIPMENT

2. IEC IE4 classification - Super-premium efficiency
3. IEC IE3 classification - Premium efficiency
4. NEMA MG-1 - Ultra-premium efficiency
5. NEMA MG-1 - Super-premium efficiency
6. NEMA MG-1 - Premium efficiency
7. Electronically commutated motor (ECM) type

1.06 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 PRODUCTS

2.01 AVAILABLE MANUFACTURERS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 1. Baldor Electric Company/ABB Group: www.baldor.com/#sle.
 2. Leeson Electric Corporation: www.leeson.com/#sle.
 3. Regal-Beloit Corporation (Century): www.centuryelectricmotor.com/#sle.
 4. Grundfos
 5. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Motor horsepower, voltage, phase and Hertz shall be as scheduled on the drawings.
- B. Construction:
 1. Open drip-proof type except where specifically noted otherwise.
 2. Design for continuous operation in 104 degrees F environment.
 3. Design for temperature rise in accordance with NEMA MG 00001 limits for insulation class, service factor, and motor enclosure type.
- C. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
- D. Wiring Terminations:
 1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
 2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.03 APPLICATIONS

- A. Motor type required for each HVAC equipment motor shall be determined by selecting the first motor type standardly or optionally available from the HVAC equipment manufacturer, working sequentially through the list that follows this paragraph. Additionally, the selected (furnished) motor shall not be lower on the list than the motor type scheduled on the

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

mechanical drawings. So, for example, if the drawing schedule indicates ECM, but a proposed HVAC equipment substitution manufacturer offers an option for an IE5 motor, that manufacturer shall furnish an IE5 motor to be considered. As another example, if the drawing schedule indicates IE5 motor, but a potential HVAC equipment substitution manufacturer only offers an IE4 motor, that manufacturer shall not be accepted. As a third example, if the drawing schedule indicates IE4 motor, but that same HVAC equipment manufacturer has now begun (prior to bid date) to offer an option for an IE5 motor, that manufacturer shall furnish an IE5 motor. In summary, each HVAC equipment shall be furnished with the most efficient motor(s) available from the manufacturer, and no less efficient than scheduled on the mechanical drawings and required by adopted energy code.

1. IEC IE5 classification - Ultra-premium efficiency
 - a. Alternatively, NEMA MG-1 - Ultra-premium efficiency
 2. IEC IE4 classification - Super-premium efficiency
 - a. Alternatively, NEMA MG-1 - Super-premium efficiency
 3. Electronically commutated motor (ECM) type
 4. IEC IE3 classification - Premium efficiency
 - a. Alternatively, NEMA MG-1 - Premium efficiency
- B. If a vendor or mechanical contractor desires to furnish a motor type not contained in the list above or scheduled on the drawings, a bidder RFI shall be submitted by the vendor or mechanical contractor expressing such desire. The vendor or mechanical contractor's desire shall not be carried by any bidder unless approved via Addendum. To be considered, the alternative motor type shall be justified in writing by the vendor or mechanical contractor as part of the RFI. Only in that case, may an energy efficient polyphase squirrel-cage induction motor meeting IEC IE2 or IE1 be considered
- C. Exception: Motors less than 250 watts, for intermittent service may be the equipment manufacturer's standard and need not comply with these specifications.

2.04 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

- A. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.05 SINGLE PHASE POWER - ELECTRONICALLY COMMUTATED MOTOR

- A. Motors: Built-in inverter and a magnet rotor.
- B. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.
- C. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.
- D. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed.

2.06 THREE PHASE POWER - SQUIRREL CAGE MOTORS

- A. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
- B. Design, Construction, Testing, and Performance: Comply with NEMA MG 00001 for Design B motors.
- C. Insulation System: NEMA Class B or better.
- D. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

- E. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
- F. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- G. Sound Power Levels: To NEMA MG 00001.
- H. Nominal Efficiency: As indicated at full load and rated voltage when tested in accordance with IEEE 112.
- I. Nominal Power Factor: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

END OF SECTION

SECTION 23 05 19
METERS AND GAUGES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Positive displacement meters.
- B. Pressure gauges and pressure gauge taps.
- C. Thermometers and thermometer wells.
- D. Static pressure gauges.
- E. Filter gauges.

1.02 RELATED REQUIREMENTS

- A. Section 23 21 13 - Hydronic Piping.
- B. Section 25 0000 - HVAC Instrumentation and Controls

1.03 REFERENCE STANDARDS

- A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2013.
- B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014.
- C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014.
- D. AWWA C700 - Cold-Water Meters -- Displacement Type, Metal Alloy Main Case; 2015.
- E. AWWA C701 - Cold-Water Meters -- Turbine Type, for Customer Service; 2012.
- F. AWWA M6 - Water Meters -- Selection, Installation, Testing, and Maintenance; 2012.
- G. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.
- H. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
- C. Project Record Documents: Record actual locations of components and instrumentation.

1.05 FIELD CONDITIONS

- A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 PRODUCTS

2.01 POSITIVE DISPLACEMENT METERS (LIQUID)

- A. AWWA C700, positive displacement disc type suitable for fluid with metal alloy main case and cast iron frost-proof, breakaway bottom cap, hermetically sealed register, remote reading.
- B. Meter: Brass body turbine meter with magnetic drive register.
 - 1. Service: Cold water, 122 degrees F.
 - 2. Accuracy: 1-1/2 percent.

2.02 PRESSURE GAUGES

- A. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
 - 1. Case: Steel with brass bourdon tube.
 - 2. Size: 4-1/2 inch diameter.
 - 3. Mid-Scale Accuracy: One percent.

4. Scale: Psi.

2.03 PRESSURE GAUGE TAPPINGS

- A. Gauge Cock: Tee or lever handle, brass for maximum 150 psi.
- B. Needle Valve: Brass, 1/4 inch NPT for minimum 150 psi.
- C. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.
- D. Syphon: Steel, Schedule 40, 1/4 inch angle or straight pattern.

2.04 STEM TYPE THERMOMETERS

- A. Thermometers - Fixed Mounting: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish.
 1. Size: 9 inch scale.
 2. Window: Clear Lexan.
 3. Accuracy: 2 percent per ASTM E77.
 4. Calibration: Degrees F.
- B. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
 1. Size: 9 inch scale.
 2. Window: Clear Lexan.
 3. Accuracy: 2 percent per ASTM E77.
 4. Calibration: Degrees F.

2.05 THERMOMETER SUPPORTS

- A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

2.06 TEST PLUGS

- A. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with Nordel core for temperatures up to 350 degrees F.

2.07 STATIC PRESSURE GAUGES

- A. 3-1/2 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.
- B. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch diameter tubing.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.
- C. Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Provide syphon on gauges in steam systems. Extend nipples and syphons to allow clearance from insulation.
- D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- E. Install thermometers in air duct systems on flanges.

- F. Install thermometer sockets adjacent to controls system thermostat, transmitter, or sensor sockets. Where thermometers are provided on local panels, duct or pipe mounted thermometers are not required.
- G. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- H. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- I. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- J. Locate test plugs adjacent thermometers and thermometer sockets.

3.02 SCHEDULE

- A. Positive Displacement Meters, Location:
 - 1. Expansion tank make-up.
- B. Pressure Gauges, Location and Scale Range:
 - 1. Pumps, 0 to 100 psi.
 - 2. Expansion tanks, 0 to 100 psi.
- C. Pressure Gauge Tappings, Location:
 - 1. Control valves 3/4 inch & larger - inlets and outlets.
 - 2. Major coils - inlets and outlets.
 - 3. Boiler - inlets and outlets.
- D. Stem Type Thermometers, Location and Scale Range:
 - 1. Headers to central equipment, 0 to 250 degrees F.
 - 2. Coil banks - inlets and outlets, 0 to 250 degrees F.
 - 3. Boilers - inlets and outlets, 0 to 250 degrees F.
 - 4. After major coils, 0 to 250 degrees F.
- E. Thermometer Sockets, Location:
 - 1. Control valves 1 inch & larger - inlets and outlets.
 - 2. Reheat coils - inlets and outlets.
- F. Static Pressure and Filter Gauges, Location and Scale Range:
 - 1. Built up filter banks, 0 to 2 inches W.C..
 - 2. Supply fan discharge, 0 to 4.0" inches W.C..

END OF SECTION

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

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Support and attachment components for equipment, piping, and other HVAC/hydronic work.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 05 50 00 - Metal Fabrications: Materials and requirements for fabricated metal supports.
- C. Section 23 05 48 - Vibration and Seismic Controls for HVAC.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.
- D. MSS SP-58-2018 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation which includes Amendment 1 Issued 10-17-2019.
- E. MSS SP-69-2003 - Pipe Hangers and Supports - Selection and Application.
- F. MSS SP-89-2003 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- G. MSS SP-90-2000 - Guidelines on Terminology for Pipe Hangers and Supports.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

1.05 PERFORMANCE REQUIREMENTS

- A. Design piping and equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- B. Delegated Design: Design Metal Channel (Strut) Framing Systems, metal fabrications, trapeze hangers (for pipe and ductwork), equipment supports, pipe stands, pipe anchors, pipe guides, and determining means of controlling thermal expansion of piping, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

- C. Structural Performance: Hangers and supports for piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE 10.
 - 1. Design supports for multiple pipes, including pipe stands, ductwork, and equipment 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 all components of supports for roof mounted equipment, piping, and ductwork to withstand wind and snow loads.
 - 4. Contractor shall provide a stamped letter from a professional engineer licensed in the state where the project is located stating that all Division 23 piping, ductwork, and equipment supports, including anchors and fasteners, are designed and installed to carry the required loads at all substrates where located.

1.06 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for the following:
 - 1. Pipe hangers and supports.
 - 2. Post-installed concrete and masonry anchors.
 - 3. Nonpenetrating rooftop supports.
 - 4. Metal framing systems.
- C. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; Include Product Data for components:
 - 1. Trapeze hangers.
 - 2. Metal framing systems.
 - 3. Equipment supports.
 - 4. Application of saddles, inserts, and protection shields at pipe hangers for each hydronic service, pipe material, range of pipe sizes, type of insulation, and type of hanger.
- D. Delegated-Design Submittal: For hangers and supports of HVAC equipment, ducts, and piping, submit the following data indicating compliance with performance requirements and design criteria signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Design calculations and detail for fabrication and assembly of trapeze hangers, metal framing systems, equipment supports, pipe stands, pipe anchors, pipe guides, and determining means of controlling thermal expansion of piping. Show methods of attachment to building structure.
 - 2. Contractor shall provide a stamped letter from a professional engineer licensed in the state where the project is located stating that all Division 23 equipment, ducts, and piping supports, including anchors and fasteners, are designed and installed to carry the required loads at all substrates where located.

1.07 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

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- C. Reference "Mechanical General Provisions" in Division 23 for additional Quality Assurance requirements.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements.
- B. Comply with MSS SP-58, Types 1 through 58, factory-fabricated components. If type of hanger or support for a particular situation is not indicated in this Section, select appropriate type using MSS SP-58 and MSS SP-69 recommendations. Refer to MSS SP-58, Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- C. Comply with MSS SP-69, including for pipe hanger selections and applications that are not specified in piping system Sections.
- D. Comply with MSS SP-89.
- E. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of HVAC work.
- F. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
- G. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 1.5. Include consideration for vibration, equipment operation, and shock loads where applicable.

2.02 STEEL PIPE HANGERS AND SUPPORTS

- A. This article was written for the support of steel piping.
- B. This article is to also pertain to the support of copper piping that is scheduled to be uninsulated or to be insulated with other than flexible elastomeric cellular insulation (such as fiberglass insulation.)
- C. This article is to also pertain to the support of plastic piping that is insulated. No steel hangers are to be in direct contact with the plastic piping, which precludes some hanger types below.
- D. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Anvil, An ASC Engineered Solution
 - 2. Advanced Thermal Systems, Inc. (Pipe slide assemblies only)
 - 3. B-Line Systems, Inc.; a division of Cooper Industries (Eaton).
 - 4. ERICO/Michigan Hanger Co.
 - 5. Globe Pipe Hanger Products, Inc.
 - 6. GS Metals Corp.
 - 7. PHD Manufacturing, Inc.
 - 8. PHS Industries, Inc.
 - 9. Piping Technology & Products, Inc.
 - 10. The Pipe Supports Group (including Bergen-Power Pipe Supports and Carpenter & Paterson, Inc)
 - 11. Tolco Inc.
 - 12. Tri-State Industries, Inc. (Pipe slide assemblies only)

13. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- E. Galvanized, Metallic Coatings: Hot-dip galvanized according to ASTM A153 or ASTM A123. Required of all pipe hangers and support steel components (clevis, roller, guides, etc.) and related structural steel framing except Steel Pipe-Covering Protection Saddles (MSS Type 39), pad eyes, and products specified to be painted or furnished in stainless steel.
- F. Where pipe hangers and support steel components (clevis, roller, guides, etc.) and related structural steel framing are exposed to view by the building occupants: (1) in indoor finished spaces normally accessible by occupants, and (2) where specifically noted on the mechanical drawings that aesthetics are a concern, they are to be finished as follows, in lieu of hot-dip galvanized:
1. Prime coat the related structural steel framing.
 2. Pipe support steel components (clevis, roller, guides, etc.) with plain finish or galvanized will be acceptable.
 3. Finish paint the pipe hangers and support steel components (clevis, roller, guides, etc.) and related structural steel framing per Division 9 Section "Painting."
 4. Finish paint color for these items to be selected by project architect and approved by the owner.
- G. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.
- H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Adjustable Clevis Hanger (MSS Type 1): For suspension of stationary pipes, NPS 1/2 to NPS 30. These hangers are permitted only where no movement is expected.
 2. Where noted on drawings, for suspension of plastic pipe such as polypropylene and PEXa, use the clevis hanger specified, except with vee bottom, in conjunction with a continuous vee channel such as Eaton B-Line series B3106 or equal pipe support and pipe/socket clamp.
 3. Single Pipe Roll (MSS Type 41): For support of pipes, NPS 3/4 to NPS 30, from two (2) threaded rods if longitudinal movement caused by expansion and contraction might occur.
 4. Adjustable Steel Yoke Pipe Roll (MSS Type 43): For suspension of insulated pipe sizes NPS 2 1/2 to NPS 24, from one (1) threaded rod if longitudinal movement caused by expansion and contraction might occur.
 5. Adjustable Roller Stand with Base Plate (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if longitudinal movement caused by expansion and contraction might occur. Provide with steel or cast iron base plate. Except where noted otherwise on the mechanical drawings, these roller stands are required wherever support is from a steel frame beneath the pipe. Weld base plate to frame. Shim as required for vertical adjustment, and in compliance with Division 5 Section "Metal Fabrications."
 6. Pipe Slide Assembly (MSS Type 35): For support of pipes, NPS 1 to NPS 24, if longitudinal and transverse movement caused by expansion and contraction might occur. Slide assembly consist of 25% glass filled, 3/32" thick PTFE slide bonded to hot-dip galvanized, minimum 1/4" thick carbon steel slide plate (or 1/2" thick graphite slide epoxy bonded and mechanically attached to hot-dip galvanized, minimum 1/4" thick carbon steel slide plate) which is factory welded to a hot-dip galvanized structural tee or "H". Field weld tee or "H" to pipe. Slide assembly also includes similar PTFE slide

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- bonded to hot-dip galvanized, minimum 1/4" thick carbon steel base plate (or 1/2" thick graphite slide epoxy bonded and mechanically attached to hot-dip galvanized, minimum 1/4" thick carbon steel base plate) which is field secured to support frame by welding.
7. Except where noted otherwise on the mechanical drawings, utilize Anvil Figure 257 Type 4 Pipe Slide Assembly, or equal, with structural tee and base plate for NPS 1 to NPS 4 and Figure 439 Type 4 Pipe Slide Assembly, or equal, with structural "H" and base plate for NPS 6 to NPS 24. Weld base plate to frame. Shim as required for vertical adjustment, and in compliance with Division 5 Section "Metal Fabrications."
 8. Refer to Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for Spider Guides, Pipe Slide Guide Assemblies, and anchor materials.
 9. Pad eyes. For suspension of stationary pipes, NPS 1/2 to NPS 30 where there is inadequate room for another hanger type. Use only where specifically noted on drawings. Otherwise, use requires advance written approval by engineer.
 10. Concrete Rod Attachment Plate. For suspension of pipes, NPS 1/2 to NPS 30 where specifically noted on drawings. Utilize PHD Manufacturing, Inc. Figure 903, or equal, in Type 316 stainless steel material. HDG carbon steel material will not be permitted. Typical applications are as follows:
 - a. Where condition of concrete is not suitable for anticipated point load of threaded rod.
 - b. Where threaded rod size required by this Section is larger diameter than the specified Type 316 stainless steel mechanical expansion anchor available sizes (historically not available above 3/4" diameter.)
 11. Split Ring Hangers, such as MSS Type 12, will not be permitted. Use on an exception basis requires advance written approval by engineer.
- I. 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 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Threaded Rods: For dry interior and temporary installations, use ASTM F1554, Grade 36, manufactured from ASTM A36 low carbon steel, standard threaded rods, hot-dip galvanized according to ASTM A153. Such low carbon steel threaded rods shall never be plain finish. For exterior, damp, and wet locations utilize ASTM A276, Type 316 stainless steel threaded rods. Continuous threaded rods are preferred. Rod couplings shall match threaded rod material and finish.
 3. Nuts: For dry interior and temporary installations, use ASME B18.2.2, ASTM A563, Grade A, Heavy Hex, carbon steel nuts only on threaded rods, sizes 1 1/2" and smaller, and hot-dip galvanized according to ASTM A153. ASTM A563 nuts shall never be plain finish. For exterior, damp, and wet locations utilize ASTM A194, Grade 8M (Type 316 stainless steel) Heavy Hex nuts.
 4. Washers: For dry interior and temporary installations, use ASTM F 844, steel, flat washers, and hot-dip galvanized according to ASTM A153. ASTM F 844 washers shall

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- never be plain finish. For exterior, damp, and wet locations utilize Type 316 stainless steel washers.
- K. Structure Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Welded-Steel Brackets: For support of pipes from above or below. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
- L. Insulated Piping: Comply with the following:
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 according to ASME B31.9.
- 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 SP-58, Type 39A or 39B): Use where insulated carbon steel piping of all sizes (for hydronic systems that's typically 2-1/2" and larger) without vapor barrier is indicated. Use where insulated carbon steel piping NPS 5 and larger with vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation. Seal vapor barrier to ends and sides of saddles.
 2. Protection Shields for pipe (MSS SP-58, Type 40):
 - a. Applications:
 - 1) Use where insulated carbon steel piping NPS 2-1/2 to NPS 4 with vapor barrier is indicated.
 - 2) Use where insulated pipe materials other than carbon steel piping NPS 2-1/2 and larger is indicated.
 - 3) Use where any insulated pipe is supported by a pipe roller, except where Steel Pipe-Covering Protection Saddles are required above.
 - 4) Use where insulated pipe NPS 2 and smaller is supported directly on a Prefabricated Trapeze-Framed Metal Strut System or trapeze hanger.
 - b. Of length recommended in writing by insert (pipe insulation) manufacturer to prevent more than 5% compression of the pipe insulation. Protection Shields shall span an arc of 180 degrees. Protection Shield dimensions (based upon the NPS "hanger sizes" noted below, that is, the pipe insulation outside diameter) shall be not less than the following:
 - 1) NPS 5 and smaller: 12 inches long and 0.048 inch thick (18 gauge)
 - 2) NPS 6 and NPS 8: 12 inches long and 0.06 inch thick (16 gauge)
 - 3) NPS 10: 18 inches long and 0.06 inch thick (16 gauge)
 - 4) NPS 12 to NPS 18: 24 inches long and 0.075 inch thick (14 gauge)
 - 5) MSS SP-58 requires Protection Shield gages listed above to be for use with clevis hangers only. For "point loading", the Protection Shield thickness and

- possibly length shall be increased. "Point loading" shall be interpreted to be the following support conditions. Demonstrate compliance in the submittal.
- (a) Any insulated pipe supported by a pipe roller, except where Steel Pipe-Covering Protection Saddles are required above.
 - (b) Pipe size NPS 2 and smaller where insulated and supported directly on a Prefabricated Trapeze-Framed Metal Strut System or trapeze hanger.
 - c. Pipes NPS 2-1/2 and larger shall include Polyisocyanurate Fabricated Pipe Insulation or Calcium Silicate Fabricated Pipe Insulation inserts meeting requirements found in Section 230719 HVAC Pipe Insulation. Insert material shall span an arc of 180 degrees at the lower half of the pipe, shall be at least as long as Protection Shield where vapor barrier is not indicated, shall extend two inches beyond each end of Protection Shield where vapor barrier is indicated, and be comprised of a singular piece of clamshell rigid molded pipe insulation.
3. As an alternative to Protection Shields where required above, Thermal-Hanger & Support Shield Inserts as specified further below may be used: For supporting insulated pipe; with same insulation thickness as piping insulation.
- N. Spring Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
- 1. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
- O. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- P. Use mechanical expansion anchors or adhesive anchors instead of building attachments where required in concrete construction.
- Q. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

2.03 MATERIALS FOR METAL FABRICATED SUPPORTS: COMPLY WITH SECTION 05 50 00

- A. Prefabricated Trapeze-Framed Metal Strut Systems
- B. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - 2. Ferguson Enterprises Inc: www.fnw.com/#sle.
 - 3. Thomas & Betts Corporation: www.tnb.com/#sle.
 - 4. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
 - 5. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- C. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
- D. Strut Channel or Bracket Material:
 - 1. Indoor Dry Locations: Use galvanized steel.
 - 2. Outdoor and Damp or Wet Indoor Locations: Use stainless steel.
- E. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
- F. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
- G. Accessories: Provide bracket covers, cable basket clips, cable tray clips, clamps, conduit clamps, fire-retarding brackets, j-hooks, protectors, and vibration dampeners.

2.04 COPPER PIPE HANGERS AND SUPPORTS

- A. This article is to pertain only to the following:
 - 1. Copper piping, such as refrigerant piping, that is scheduled to be insulated with flexible elastomeric cellular insulation.
- B. Such piping described above, in horizontal, vertical, and inverted installations shall be supported from insulation clamps / clips providing the following required features to maintain continuous insulation of piping system:
 - 1. Support and secure the piping independent of the insulation.
 - 2. Maintain continuous piping insulation and vapor barrier at insulation clamp.
 - 3. The weight of the piping may not crush or tear the insulation over time.
 - 4. UL Classified 2043 (25/50 flame/smoke) for use in plenums and air handling systems.
 - 5. ANSI/MSS SP-58 Type 61 Certified.
 - 6. All metal components to have a Trivalent (non-hex) plating.
 - 7. Selected for piping insulation wall thickness.
 - 8. Molded with high strength Thermoplastic Olefin (TPO) with UV-Rated Additive.
 - 9. Temperature rating: -60F to +225F.
 - 10. Installed per insulation clamp manufacturer's installation instructions.
 - 11. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Hydra-Zorb Co., Klo-Shure 7-Series, to be used with strut-mounted clamps in horizontal and inverted installations, sizes 1/4" to 4-1/8" O.D. Insulation wall thickness sizes must include 3/8"; 1/2"; 3/4"; 1" and 1-1/2". (Basis of Design)
 - b. Hydra-Zorb Co., Titan Riser Clamps, to be used to support vertical riser installations, sizes 7/8" to 4-1/8" O.D. (Basis of Design)
 - c. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- C. Do not use Protection Shields described in this Section for use with such piping described above, noted to be insulated with flexible elastomeric cellular insulation.
- D. Such piping described above, to be supported from Metal Channel (Strut) Framing Systems.
- E. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- F. Galvanized, Metallic Coatings: Hot-dip galvanized according to ASTM A153 or ASTM A123. Required of copper pipe related structural steel framing except products specified to be painted or furnished in stainless steel.
- G. Where pipe hangers and related structural steel framing are exposed to view by the building occupants: (1) in indoor finished spaces normally accessible by occupants, and (2) where specifically noted on the mechanical drawings that aesthetics are a concern, they are to be finished as follows, in lieu of hot-dip galvanized:
 - 1. Prime coat the related structural steel framing.
 - 2. Finish paint the related structural steel framing per Division 9 Section "Painting."
 - 3. Finish paint color for these items to be selected by project architect and approved by the owner.
- H. For such piping described above, use the following components, similar to those specified above for steel piping hangers and supports: Hanger-Rod Attachments, Structure Attachments, and Materials for Metal Fabricated Supports.

- I. Split Ring Hangers, such as MSS Type 12, will not be permitted. Use on an exception basis requires advance written approval by engineer.
- J. Use mechanical expansion anchors or adhesive anchors instead of building attachments where required in concrete construction.

2.05 TRAPEZE HANGERS

- A. Description: MSS SP-69, Type 59 prefabricated back-to-back channel assembly, or alternatively shop- or field-fabricated pipe-support assembly of a similar format and function fabricated from structural carbon-steel shapes as specified under Miscellaneous Material in this Section.
- B. Except where arrangement justifies otherwise, trapeze hangers are to be installed with hanger-rod attachments (threaded rods, nuts, washers, and steel turnbuckles where appropriate) as specified in this Section.
- C. Metal Trapeze Hanger Installation for piping systems: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-assembled trapeze hangers.
 - 1. Pipes of Various Sizes: Support together and space trapeze hangers for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Select for loads being supported. Brace trapeze hanger if required due to pipe thermal expansion forces.
 - 3. Piping shall be supported from Trapeze Hangers and/or Prefabricated Trapeze-Framed Metal Strut Systems using only Horizontal-Piping Hangers and Supports (Adjustable Clevis Hangers, Single Pipe Roll, Adjustable Steel Yoke Pipe Roll, etc.) indicated in this Section, along with guides and independent anchors as needed.
 - a. Alternatively, at contractor discretion, insulated piping NPS 2 and smaller only may rest on Trapeze Hangers and/or Prefabricated Trapeze-Framed Metal Strut Systems if furnished with Protection Shields and guided with either U-Bolts or spider guides. U-Bolts are to be either MSS Type 24 or U-bolts may be field or shop fabricated from similar diameter threaded rod as specified in this Section.

2.06 THERMAL-HANGER & SUPPORT SHIELD INSERTS

- A. Description: 95-psig minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Carpenter & Paterson, Inc.
 - 2. ERICO/Michigan Hanger Co.
 - 3. PHS Industries, Inc.
 - 4. Pipe Shields, Inc.
 - 5. Rilco Manufacturing Company, Inc.
 - 6. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- C. Insulation-Insert Material:
 - 1. Polyisocyanurate Fabricated Pipe Insulation or Calcium Silicate Fabricated Pipe Insulation inserts meeting requirements found in Section 230719 HVAC Pipe Insulation.
 - 2. ASTM C 552, Type II cellular glass similarly fabricated pipe insulation may be an acceptable alternate.

- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.
- F. Thermal-Hanger & Support Shield Installation: Install in pipe hanger or shield for insulated piping.
- G. Field install mastic or coating over insulation, notably at perimeter of Thermal-Hanger & Support Shield Inserts, to provide a protective barrier where vapor barrier is not required. Field install vapor barrier mastic or coating over insulation, notably at perimeter of Thermal-Hanger & Support Shield Inserts, to provide a vapor barrier and protective barrier where vapor barrier is required.

2.07 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.08 MISCELLANEOUS MATERIALS

- A. This article shall pertain to structural steel framing and supports necessary to support piping and equipment only to the extent there is not a Division 5 Section "Metal Fabrications" or notes on the structural drawings addressing same. If so, these shall supersede this article.
- B. All structural steel shall conform to the latest issue of the American Institute of Steel Construction specifications for the design, fabrication, and erection of structural steel for buildings (AISC-360) and Structural Welding Code – Steel (AWS D1.1.) Structural steel shall be hot-dip galvanized according to ASTM A123 (Coating Grade 100 – 3.94 mils minimum) except areas to receive field welds. Apply ZRC cold galvanizing compound to field weld areas. Refer also to structural drawings and specifications such as for requirements for column base plate anchor bolts.
- C. Material for Structural Steel Shapes, to include plates, bars, channels and angles shall be carbon steel conforming to ASTM A36.
- D. Material for Structural Steel Wide Flange Beam Shapes shall be carbon steel conforming to ASTM A992.
- E. Material for Hollow Structural Sections (HSS) shall be carbon steel, cold formed, rectangular, yield strength 46 ksi minimum, conforming to ASTM A500, Grade B.
- F. Structural Steel bolted connection shall conform to the following:
 - 1. Structural Bolts: ASTM A325, Type 1, heavy hex steel, hot-dip galvanized according to ASTM A153, Class C.
 - 2. Nuts: ASTM A563, heavy hex carbon-steel, hot-dip galvanized according to ASTM A153, Grade C. Retap nuts in accordance with ASTM A385.
 - 3. Washers: ASTM F436 hardened carbon-steel, hot-dip galvanized according to ASTM A153, Class C.
- G. Refer to structural drawings and specifications for fastening systems such as mechanical expansion anchors and adhesive anchors.
- H. See Division 23 "Mechanical General Provisions" for grout.

2.09 NONPENETRATING ROOFTOP SUPPORTS FOR LOW-SLOPE ROOFS:

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Anvil Strut, An ASC Engineered Solution; Fig HBS-H block supports with 1-5/8 steel channel (for use with refrigerant and natural gas piping only; Basis of Design)
 - 2. B-Line, a division of Eaton Corporation

3. nVent Erico, a brand of nVent;[____]: www.erico.com/#sle.
 4. Ferguson Enterprises, LLC
 5. PHP Systems/Design: www.phpsd.com/#sle.
 6. RTS Rooftop Support Systems, division of Eberl Iron Works, Inc.
 7. Unistrut, a brand of Atkore International Inc
 8. Miro Industries, Inc.; 6-DS, 8-DS or 10-DS (for ductwork and small equipment) and 6-H, 8-H, or 10-H (for all other piping services) (Basis of Design)
 9. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. For the purpose of supporting piping, ductwork, and smaller equipment above a roof.
 - C. Provide steel pedestals with UV resistant thermoplastic or rubber base that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified.
 - D. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly. In no case shall maximum loading from the base to the finished roof surface exceed 3.0 psi.
 - E. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
 - F. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.
 - G. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- E. Cutting, notching and boring holes of steel floor / roof decking shall be as prescribed by the registered design professional.
- F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- H. Secure fasteners according to manufacturer's recommended torque settings.
- I. Remove temporary supports.
- J. Metal Channel (Strut) Framing Systems: Install per the MFMA published "Guidelines for the use of Metal Framing, latest edition."

3.02 HANGER AND SUPPORT INSTALLATION

- A. Install hangers and supports complete with necessary inserts, bolts, threaded rods, nuts, washers, shims, and other accessories.
- B. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

- C. 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.
- D. Install lateral bracing with pipe hangers and supports to prevent swaying.
- E. Install structure attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- F. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 are not exceeded. This is required for all projects.
- H. Hanger spacing maximum and threaded rod minimum size in the chart below shall be met.

Hanger Spacing and Rod Size for Straight Horizontal Runs

1. NPS, in. Hanger Spacing, ft Rod Size, in.
 - a. Hydronic, Air,
2. 1/2 7 8 3/8
3. 3/4 7 9 3/8
4. 1 7 9 3/8
5. 1-1/2 9 12 3/8
6. 2 10 13 3/8
7. 2-1/2 11 14 1/2
8. 3 12 15 1/2
9. 4 14 17 5/8
10. 5 14 17 5/8
11. 6 17 21 3/4
12. 8 19 24 3/4
13. 10 20 26 3/4
14. 12 23 30 7/8
15. Spacings above are for carbon steel pipe only and do not apply where concentrated loads are placed between supports such as flanges, valves, specialties, etc. Maximum spans in above table taken from ASME B31.1 table of suggested pipe support spacing. This table shall be a requirement that applies to all projects. Allows for a maximum sag of 0.1 inch between supports.
16. Refer to Division 23 piping Sections for hanger spacing and threaded rod size requirements for other than carbon steel pipe.
- I. Secure slide base plates to steel frames provided for such purpose by welding.
- J. Contractor shall be responsible for coordination of structural steel frames and supports necessary to properly support piping hangers and supports.
- K. Unless otherwise indicated on drawings or otherwise required by delegated design professional engineer, furnish specified Nonpenetrating Rooftop Supports for Low-Slope Roofs for support of roof mounted equipment, piping, and ductwork.

3.03 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 smooth bearing surface.

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.04 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for pipe supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 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 contours of welded surfaces match adjacent contours.

3.05 ADJUSTING

- A. Support Adjustments: Adjust supports to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.06 PAINTING

- A. Touch Up: 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 A 780.
- C. Coatings: All pipe supports and secondary steel that are hot-dip galvanized carbon steel - The galvanizing shall be ground back to a depth of one to four inches prior to welding. A high zinc dust paint shall be used for touch-up after installation in accordance with MIL-P-21035

END OF SECTION

SECTION 23 05 48
VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Vibration isolation requirements.
- B. Seismic control requirements.
 - 1. Includes requirements for seismic qualification of equipment not specified in this section.
- C. Wind design requirements.
- D. Vibration-isolated equipment support bases.
- E. Vibration isolators.
- F. Seismic restraint systems.
- G. Vibration-isolated and/or seismically engineered roof curbs.

1.02 RELATED REQUIREMENTS

- A. Section 01 45 33 - Code-Required Special Inspections and Procedures.
- B. Section 03 30 00 - Cast-in-Place Concrete.
- C. Section 05 50 00 - Metal Fabrications: Materials and requirements for fabricated metal supports.
- D. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

1.03 DEFINITIONS

- A. HVAC Component: Where referenced in this section in regards to seismic controls, applies to any portion of the HVAC system subject to seismic evaluation in accordance with applicable codes, including distributed systems (e.g., ductwork, piping).
- B. Seismic Restraint: Structural members or assemblies of members or manufactured elements specifically designed and applied for transmitting seismic forces between components and the seismic force-resisting system of the structure.

1.04 REFERENCE STANDARDS

- A. ASCE 7 - Minimum Design Loads for Buildings and Other Structures; 2010, with 2013 Supplements and Errata.
- B. ASCE 19 - Structural Applications of Steel Cables for Buildings; 2016.
- C. ICC (IBC) - International Building Code; 2015.
- D. ICC-ES AC156 - Acceptance Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components; 2010, with Editorial Revision (2015).
- E. MFMA-4 - Metal Framing Standards Publication; 2004.
- F. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems; Sheet Metal and Air Conditioning Contractors' National Association; 2008.
- G. ASHRAE - ASHRAE Handbook - HVAC Applications 2023

1.05 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data:
 - 1. Provide schedule of vibration isolator type with location and load on each.
 - 2. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

- a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES, OSHPD, or an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 - C. Delegated-Design Submittal: For vibration isolation, seismic-restraint, and wind design details 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. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, wind forces, seismic forces required to select vibration isolators, seismic restraints, and for designing vibration isolation bases.
 - a. For each seismic restraint calculation, utilize appropriate component importance factor, component response modification factor, and component amplification factor. Where vibration pad isolators are utilized, recommend and provide appropriate pad thickness and quantity. Where vibration isolators are utilized, recommend appropriate minimum deflection, and provide vibration isolators meeting this recommendation.
 - b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
 2. Seismic- Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES, OSHPD, an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
 3. Wind Restraint Details.
 - a. Unit to curb, curb to structure, etc.
 - D. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each. Indicate seismic control measures.
 - E. Coordination Drawings: Show coordination of seismic bracing for mechanical piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

1.06 QUALITY ASSURANCE

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

1.07 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the International Building Code unless requirements in this Section are more stringent

PART 2 PRODUCTS

2.01 VIBRATION ISOLATION REQUIREMENTS

- A. Design and provide vibration isolation systems to reduce vibration transmission to supporting structure from vibration-producing HVAC equipment and/or HVAC connections to vibration-isolated equipment.
- B. Comply with applicable general recommendations of ASHRAE (HVACA), where not in conflict with other specified requirements:
- C. General Requirements:
 - 1. Select vibration isolators to provide required static deflection.
 - 2. Select vibration isolators for uniform deflection based on distributed operating weight of actual installed equipment.
 - 3. Select seismic type vibration isolators to comply with seismic design requirements, including conditions of equipment seismic certification where applicable.
 - 4. Select vibration isolators for outdoor equipment to comply with wind design requirements.
 - 5. Select vibration-isolated equipment support bases and associated vibration isolators to provide minimum 2-inch operating clearance beneath base unless otherwise indicated.
 - 6. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 1.5. Include consideration for vibration, equipment operation, and shock loads where applicable.
- D. Piping Isolation:
 - 1. Provide vibration isolators for piping supports:
 - a. Located within _____ feet of connected vibration-isolated equipment and pressure-regulating valve (PRV) stations.
 - b. For piping over 2 inch located below or within 50 feet of noise-sensitive areas indicated.
 - 2. Minimum Static Deflection:
 - a. First Three Supports Closest to Isolated Equipment: Same as static deflection of equipment; maximum of 2 inch deflection required.
 - b. Remainder of Supports: 0.75 inch deflection unless otherwise indicated.

2.02 SEISMIC CONTROL REQUIREMENTS

- A. Design and provide HVAC component restraints, supports, and attachments suitable for seismic loads determined in accordance with applicable codes, as well as gravity and operating loads and other structural design considerations of the installed location. Consider wind loads for outdoor HVAC components.
- B. Seismic Design Criteria: ICC (IBC).
 - 1. Seismic Design Category (SDC): D.
- C. Component Importance Factor (Ip): HVAC components essential to life safety to be assigned a component importance factor (Ip) of 1.5 as indicated or as required. This includes but is not limited to:
 - 1. HVAC components required to function for life safety purposes after an earthquake.
 - 2. HVAC components that support or otherwise contain hazardous substances.
- D. Seismic Qualification of Equipment:
 - 1. Provide special certification for HVAC equipment furnished under other sections and assigned a component importance factor (Ip) of 1.5, certifying that equipment will remain operable following a design level earthquake.

2. Seismic qualification to be by shake table testing in accordance with recognized testing standard procedure, such as ICC-ES AC156, acceptable to authorities having jurisdiction.
 3. Notify Architect and obtain direction where mounting restrictions required by conditions of seismic certification conflict with specified requirements.
 4. Seismically qualified equipment to be furnished with factory-installed labels referencing certificate of compliance and associated mounting restrictions.
- E. Seismic Restraints:
1. Provide seismic restraints for HVAC components except where exempt according to applicable codes and specified seismic design criteria, as approved by authorities having jurisdiction.
 2. Seismic Restraint Exemptions:
 - a. Exemptions for Seismic Design Category D, E, and F:
 - 1) HVAC components with component importance factor (Ip) of 1.0 where all of the following apply:
 - (a) The component is positively attached to the structure.
 - (b) Flexible connections are provided between the component and associated ductwork, piping, and conduit.
 - (c) Either:
 - (1) The component weighs 400 pounds or less and has a center of mass located 4 feet or less above the adjacent floor level.
 - (2) The component weighs 20 pounds or less or, in the case of a distributed system, 5 pounds per foot or less.
 - 2) HVAC piping with component importance factor (Ip) of 1.0 and nominal pipe size of 3 inch or less, or with component importance factor (Ip) of 1.5 and nominal pipe size of 1 inch or less; exemption does not apply to piping constructed of low-deformability materials (e.g., cast iron, glass, nonductile plastics).
 - b. Ductwork Exemptions, All Seismic Design Categories:
 - 1) Ductwork not designed to carry toxic, highly toxic, or flammable gases and not used for smoke control where any of the following apply:
 - (a) Trapeze supported ductwork weighing less than 10 pounds per foot.
 - (b) Hanger supported ductwork where each hanger in the duct run is 12 inches or less in length from the duct support to the supporting structure; rod hangers, where used, to be equipped with swivels.
 - (c) Ductwork having a cross sectional area of less than 6 square feet or weighing 17 pounds per foot or less, and where there are provisions to avoid impact with other ducts or mechanical components or to protect ducts in the event of such impact.
 - c. HVAC Piping Exemptions, All Seismic Design Categories:
 - 1) Trapeze supported piping weighing less than 10 pounds per foot, where all pipes supported meet requirements for exemption as single pipes described under specific seismic design category exemptions above.
 - 2) Hanger supported piping where each hanger in the piping run is 12 inches or less in length from the pipe support to the supporting structure; rod hangers, where used, to be equipped with swivels.
 3. Comply with applicable general recommendations of the following, where not in conflict with applicable codes, seismic design criteria, or other specified requirements:

- a. ASHRAE (HVACA).
 - b. SMACNA (SRM).
 4. Seismic restraint capacities to be verified by a Nationally Recognized Testing Laboratory (NRTL) or certified by an independent third-party registered professional engineer acceptable to authorities having jurisdiction.
 5. Seismic Type Vibration Isolators:
 - a. Comply with seismic design requirements, including conditions of equipment seismic certification where applicable.
 6. Seismic Restraint Systems:
 - a. Except where otherwise restricted, use of either cable or rigid restraints is permitted.
 - b. Use only cable restraints to restrain vibration-isolated HVAC components, including distributed systems.
 - c. Use only one restraint system type for a given HVAC component or distributed system (e.g., ductwork, piping) run; mixing of cable and rigid restraints on a given component/run is not permitted.
 - d. Size restraint elements, including anchorage, to resist seismic loads as necessary to restrain HVAC component in all lateral directions; consider bracket geometry in anchor load calculations.
 - e. Use rod stiffener clips to attach bracing to hanger rods as required to prevent rod buckling from vertical (upward) compressive load introduced by cable or rigid restraints loaded in tension, in excess of downward tensile load due to supported HVAC component weight.
 - f. Select hanger rods and associated anchorage as required to accommodate vertical (downward) tensile load introduced by rigid restraints loaded in compression, in addition to downward tensile load due to supported HVAC component weight.
 - g. Clevis hangers may only be used for attachment of transverse restraints; do not use for attachment of longitudinal restraints.
 - h. Where seismic restraints are attached to clevis hangers, provide clevis bolt reinforcement accessory to prevent clevis hanger deformation.
 - i. Do not introduce lateral loads on open bar joist chords or the weak axis of beams, or loads in any direction at other than panel points unless approved by project Structural Engineer of Record.
 7. Ductwork Applications:
 - a. Provide independent support and seismic restraint for in-line components (e.g., fans, heat exchangers, humidifiers) having an operating weight greater than 75 pounds.
 - b. Positively attach appurtenances (e.g., dampers, louvers, diffusers) with mechanical fasteners.
- F. Seismic Attachments:
 1. Attachments to be bolted, welded, or otherwise positively fastened without consideration of frictional resistance produced by the effects of gravity.
 2. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) or qualified evaluation service acceptable to authorities having jurisdiction for compliance with applicable building code, and qualified for seismic applications; concrete anchors to be qualified for installation in both cracked and uncracked concrete.

3. Do not use power-actuated fasteners.
4. Do not use friction clips (devices that rely on mechanically applied friction to resist loads). Beam clamps may be used for supporting sustained loads where provided with restraining straps.
5. Comply with anchor minimum embedment, minimum spacing, minimum member thickness, and minimum edge distance requirements.
6. Concrete Housekeeping Pads:
 - a. Increase size of pad as required to comply with anchor requirements.
 - b. Provide pad reinforcement and doweling to ensure integrity of pad and connection and to provide adequate load path from pad to supporting structure.
- G. Seismic Interactions:
 1. Include provisions to prevent seismic impact between HVAC components and other structural or nonstructural components.
 2. Include provisions such that failure of a component, either essential or nonessential, does not cause the failure of an essential component.
- H. Seismic Relative Displacement Provisions:
 1. Use suitable fittings or flexible connections to accommodate:
 - a. Relative displacements at connections between components, including distributed systems (e.g., ductwork, piping); do not exceed load limits for equipment utility connections.
 - b. Relative displacements between component supports attached to dissimilar parts of structure that may move differently during an earthquake.
 - c. Design displacements at seismic separations.
 - d. Anticipated drifts between floors.

2.03 WIND DESIGN REQUIREMENTS

- A. Design and provide HVAC component restraints, supports, and attachments suitable for wind loads determined in accordance with applicable codes, as well as gravity and operating loads and other structural design considerations of the installed location.
- B. Wind Design Criteria: ICC (IBC) and ASCE-7.

2.04 MANUFACTURERS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 1. Mason Industries; www.mason-ind.com/#sle. (Basis of Design)
 2. Vibro-Acoustics by Swegon
 3. Novia Associates, Inc., Novia - A Division of Carpenter & Paterson
 4. Kinetics Noise Control, Inc: www.kineticsnoise.com/#sle.
 5. Vibration Eliminator Company, Inc: www.veco-nyc.com/#sle.
 6. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

2.05 PERFORMANCE REQUIREMENTS

- A. Steel springs to function without undue stress or overloading.
- B. All vibration isolators, base frames and inertia bases to conform to all uniform deflection and stability requirements under all operating loads.
- C. Comply with recommendations of Table 47 "Selection Guide for Vibration Isolation" as well as Article 3.7 "Isolating Vibration and Noise in Piping Systems," both in ASHRAE Handbook -

HVAC Applications 2023, Chapter 49, Noise and Vibration Control. Be aware that Article 3.7 will require this contractor to furnish isolation hangers for piping in mechanical rooms.

2.06 VIBRATION ISOLATORS

- A. General Requirements:
 - 1. Resilient Materials for Vibration Isolators: Oil, ozone, and oxidant resistant.
 - 2. Spring Elements for Spring Isolators:
 - a. Color code or otherwise identify springs to indicate load capacity.
 - b. Lateral Stability: Minimum lateral stiffness to vertical stiffness ratio of 0.8.
 - c. Designed to operate in the linear portion of their load versus deflection curve over deflection range of not less than 50 percent above specified deflection.
 - d. Designed to provide additional travel to solid of not less than 50 percent of rated deflection at rated load.
 - e. Selected to provide designed deflection of not less than 75 percent of specified deflection.
 - f. Selected to function without undue stress or overloading.
 - 3. Seismic Snubbing Elements for Seismic Isolators:
 - a. Air Gap: Between 0.125 inches and 0.25 inches unless otherwise indicated.
 - b. Points of Contact: Cushioned with resilient material, minimum 0.25 inch thick; capable of being visually inspected for damage and replaced.
- B. Vibration Isolators for Nonseismic Applications:
 - 1. Resilient Material Isolator Pads:
 - a. Description: Single or multiple layer pads utilizing elastomeric (e.g., neoprene, rubber) isolator material.
 - b. Pad Thickness: As required for specified minimum static deflection; minimum 0.25 inch thickness.
 - c. Multiple Layer Pads: Provide bonded, galvanized sheet metal separation plate between each layer.
 - 2. Resilient Material Isolator Mounts, Nonseismic:
 - a. Description: Mounting assemblies for bolting equipment to supporting structure utilizing elastomeric (e.g., neoprene, rubber) isolator material; fail-safe type.
 - 3. Housed Spring Isolators:
 - a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) within a metal housing.
 - b. Furnished with integral elastomeric snubbing elements, nonadjustable type, for limiting equipment movement and preventing metal-to-metal contact between housing elements.
 - c. Bottom Load Plate: Steel with nonskid, elastomeric isolator pad with provisions for bolting to supporting structure as required.
 - d. Furnished with integral leveling device for positioning and securing supported equipment.
 - 4. Restrained Spring Isolators, Nonseismic:
 - a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) within a metal housing designed to prevent movement of supported equipment above an adjustable vertical limit stop.
 - b. Bottom Load Plate: Steel with nonskid elastomeric isolator pad with provisions for bolting to supporting structure as required.

- c. Furnished with integral leveling device for positioning and securing supported equipment.
 - d. Provides constant free and operating height.
 - 5. Resilient Material Isolator Hangers, Nonseismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing elastomeric (e.g., neoprene, rubber) isolator material for the lower hanger rod connection.
 - 6. Spring Isolator Hangers, Nonseismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) in series with an elastomeric element for the lower hanger rod connection.
 - b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short-circuiting of isolation.
 - 7. Combination Resilient Material/Spring Isolator Hangers, Nonseismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) for the lower hanger rod connection and elastomeric (e.g., neoprene, rubber) isolator material for the upper hanger rod connection.
 - b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short-circuiting of isolation.
 - 8. Thrust Restraints:
 - a. Description: Assembly utilizing free-standing, laterally stable steel spring designed for resisting horizontal motion due to thrust (e.g., air pressure from a fan), and intended for installation in pairs.
- C. Vibration Isolators for Seismic Applications:
 - 1. Resilient Material Isolator Mounts, Seismic:
 - a. Description: Mounting assemblies for bolting equipment to supporting structure utilizing elastomeric (e.g., neoprene, rubber) isolator material; specifically designed and rated for seismic applications with integral snubbing in all directions.
 - 2. Restrained Spring Isolators, Seismic:
 - a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) in series with elastomeric (e.g., neoprene, rubber) isolator material within a metal housing designed to prevent movement of supported equipment above an adjustable vertical limit stop; specifically designed and rated for seismic applications with integral snubbing in all directions.
 - b. Bottom Load Plate: Steel with provisions for bolting to supporting structure as required.
 - c. Furnished with integral leveling device for positioning and securing supported equipment.
 - d. Provides constant free and operating height.
 - 3. Resilient Material Isolator Hangers, Seismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing elastomeric (e.g., neoprene, rubber) isolator material for the lower hanger rod connection; specifically designed and rated for seismic applications with vertical limit stop to prevent upward travel of hanger rod and cushion impact.
 - 4. Spring Isolator Hangers, Seismic:

- a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) in series with an elastomeric element for the lower hanger rod connection; specifically designed and rated for seismic applications with vertical limit stop to prevent upward travel of hanger rod and cushion impact.
- b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short-circuiting of isolation.
5. Combination Resilient Material/Spring Isolator Hangers, Seismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) for the lower hanger rod connection and elastomeric (e.g., neoprene, rubber) isolator material for the upper hanger rod connection; specifically designed and rated for seismic applications with vertical limit stop to prevent upward travel of hanger rod and cushion impact.
 - b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short-circuiting of isolation.

2.07 SEISMIC RESTRAINT SYSTEMS

- A. Description: System components and accessories specifically designed for field assembly and attachment of seismic restraints.
- B. Cable Restraints:
 1. Comply with ASCE 19.
 2. Cables: Pre-stretched, galvanized steel wire rope with certified break strength.
 3. Cable Connections: Use only swaged end fittings. Cable clips and wedge type end fittings are not permitted in accordance with ASCE 19.
 4. Use protective thimbles for cable loops where potential for cable damage exists.
- C. Rigid Restraints: Use MFMA-4 steel channel (strut), steel angle, or steel pipe for structural element; suitable for both compressive and tensile design loads.

2.08 VIBRATION-ISOLATED AND/OR SEISMICALLY ENGINEERED ROOF CURBS

- A. Vibration Isolation Curbs:
 1. Nonseismic Curb Rail:
 - a. Location: Between existing roof curb and rooftop equipment.
 - b. Construction: Aluminum.
 - c. Integral vibration isolation to comply with requirements of this section.
 - d. Weather exposed components consist of corrosion resistant materials.
 2. Nonseismic Curb:
 - a. Location: Between structure and rooftop equipment.
 - b. Construction: Aluminum.
 - c. Integral vibration isolation to comply with requirements of this section.
 - d. Weather exposed components consist of corrosion resistant materials.
 3. Seismic Curb:
 - a. Location: Between structure and rooftop equipment.
 - b. Construction: Steel.
 - c. Integral vibration isolation to comply with requirements of this section.
 - d. Snubbers consist of minimum 0.25 inch thick resilient pads to avoid metal-to-metal contact without compromising vibration isolating capabilities.
 - e. Weather exposed components consist of corrosion resistant materials.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that mounting surfaces are ready to receive vibration isolation and/or seismic control components and associated attachments.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 CODE-REQUIRED SPECIAL INSPECTIONS

- A. Arrange work to accommodate tests and/or inspections performed by Special Inspection Agency employed by Owner or Architect in accordance with Section 01 45 33 and statement of special inspections as required by applicable building code.
- B. Frequency of Special Inspections: Where special inspections are designated as continuous or periodic, arrange work accordingly.
 - 1. Periodic Special Inspections: Special Inspection Agency to be present in the area where work is being performed and observe the work part-time or intermittently and at the completion of the work.
- C. Seismic special inspections include, but are not limited to:
 - 1. Seismically Qualified Equipment: Verification that label, anchorage, and mounting comply with the certificate of compliance.
 - 2. Installation and anchorage of piping systems designed to carry hazardous materials and their associated mechanical units for Seismic Design Categories C, D, E, and F; periodic inspection.
 - 3. Installation and anchorage of ductwork designed to carry hazardous materials for Seismic Design Categories C, D, E and F; periodic inspection.
- D. Prior to starting work, Contractor to submit written statement of responsibility to authorities having jurisdiction and to Owner acknowledging awareness of special requirements contained in the statement of special inspections.
- E. Special Inspection Agency services do not relieve Contractor from performing inspections and testing specified elsewhere.

3.03 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- C. Secure fasteners according to manufacturer's recommended torque settings.
- D. Install flexible piping connections to provide sufficient slack for vibration isolation and/or seismic relative displacements as indicated or as required.
- E. Vibration Isolation Systems:
 - 1. Spring Isolators:
 - a. Position equipment at operating height; provide temporary blocking as required.
 - b. Lift equipment free of isolators prior to lateral repositioning to avoid damage to isolators.
 - c. Level equipment by adjusting isolators gradually in sequence to raise equipment uniformly such that excessive weight or stress is not placed on any single isolator.
 - 2. Isolator Hangers:
 - a. Use precompressed isolator hangers where required to facilitate installation and prevent damage to equipment utility connection provisions.
 - b. Locate isolator hangers at top of hanger rods in accordance with manufacturer's instructions.

3. Thrust Restraints:
 - a. Adjust restraint movement under normal operating static pressure.
 4. Clean debris from beneath vibration-isolated equipment that could cause short-circuiting of isolation.
 5. Use elastomeric grommets for attachments where required to prevent short-circuiting of isolation.
 6. Adjust isolators to be free of isolation short circuits during normal operation.
 7. Do not overtighten fasteners such that resilient material isolator pads are compressed beyond manufacturer's maximum recommended deflection.
- F. Seismic Controls:
1. Provide specified snubbing element air gap; remove any factory-installed spacers, debris, or other obstructions.
 2. Use only specified components, anchorage, and hardware evaluated by seismic design. Comply with conditions of seismic certification where applicable.
 3. Where mounting hole diameter exceeds bolt diameter by more than 0.125 inch, use epoxy grout, elastomeric grommet, or welded washer to reduce clearance to 0.125 inch or less.
 4. Concrete Housekeeping Pads:
 - a. Size in accordance with seismic design to meet anchor requirements.
 - b. Install pad reinforcement and doweling in accordance with seismic design to ensure integrity of pad and associated connection to slab.
 5. Seismic Restraint Systems:
 - a. Do not attach seismic restraints and gravity supports to dissimilar parts of structure that may move differently during an earthquake.
 - b. Install restraints within permissible angles in accordance with seismic design.
 - c. Install cable restraints straight between component/run and structural attachment; do not bend around other nonstructural components or structural elements.
 - d. Install cable restraints for vibration-isolated components slightly slack to prevent short-circuiting of isolation.
 - e. Install hanger rod stiffeners where indicated using only specified clamps; do not weld stiffeners to hanger rod.
- G. Install Combination Elastomeric-Spring Hanger for all piping systems hangers.
1. Select three hangers closest to vibration source for minimum 1.0 inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 inch static deflection or 1/2 static deflection of isolated equipment.
- H. Provide seismic snubbers for all equipment, piping, and ductwork mounted on isolators. Each inertia base shall have minimum of four seismic snubbers located close to isolators. Snub equipment designated for post-disaster use to 0.05 inch maximum clearance. Other snubbers shall have clearance between 0.15 inch and 0.25 inch.
- I. Piping Restraints: Comply with requirements in MSS SP-127.
- J. Install cables so they do not bend across edges of adjacent equipment or building structure.
- K. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES, OSHPD, or an agency acceptable to authorities having jurisdiction providing required submittals for component.
- L. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

- M. 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
- N. 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.
- O. 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 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.
- B. Comply with requirements in Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for hydronic systems flexible pipe connectors.
- C. Comply with requirements in Division 23 Section "Refrigerant Piping" for refrigerant piping systems flexible pipe connectors.

3.05 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect vibration isolation and/or seismic control components for damage and defects.
- C. Vibration Isolation Systems:
 - 1. Verify isolator static deflections.
 - 2. Verify vibration isolation performance during normal operation; investigate sources of isolation short circuits.
- D. Seismic Controls:
 - 1. Verify snubbing element air gaps.
- E. Correct deficiencies and replace damaged or defective vibration isolation and/or seismic control components.
- F. Test and Inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

3.06 SCHEDULES

- A. Utilize most specific category below, where more than one applies. If equipment manufacturer recommendations vary from the requirements below, contact Engineer prior to proceeding.
- B. Suspended Piping Location: All locations.
 1. Piping Type: All piping. The first two hangers adjacent vibrating equipment shall be the pre-compressed type, pre-compressed to the cold load position by use of travel stops, to prevent load transfer to equipment flanges with the piping system is filled. Utilize pre-compressed type for all isolated pipe hangers for piping NPS 4 and larger.
 2. Isolator Type: Combination Elastomeric-Spring Hangers with Vertical Limit Stops.
- C. Supported Piping Location: All locations.
 1. Piping Type: All piping. The first two hangers adjacent vibrating equipment shall be the pre-compressed type, pre-compressed to the cold load position by use of travel stops, to prevent load transfer to equipment flanges when the piping system is filled. Utilize pre-compressed type for all isolated pipe hangers for piping NPS 4 and larger.
 2. Isolator Type: Freestanding Spring Isolators.
- D. Suspended Ductwork and Boiler Flue Location: All locations.
 1. Type: All ductwork and boiler flues. Utilize pre-compressed type for all isolated hangers, pre-compressed to the cold load position by use of travel stops, to prevent load transfer to equipment flanges/connections.
 2. Isolator Type: Spring Hangers with Vertical Limit Stops.
- E. Supported Ductwork and Boiler Flue Location: All locations.
 1. Type: All ductwork and boiler flues. Utilize pre-compressed type for all isolated hangers, pre-compressed to the cold load position by use of travel stops, to prevent load transfer to equipment flanges/connections.
 2. Isolator Type: Freestanding Spring Isolators
- F. Roof Mounted Equipment: All Locations.
 1. Type: All roof mounted air handling equipment and exhaust fans. Utilize vibration isolated roof curb with seismic restraints.

END OF SECTION

SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Adhesive-backed duct markers.
- D. Pipe markers.
- E. Ceiling tacks.

1.02 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2007.
- B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2013.

1.03 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Product Data: Provide manufacturers catalog literature for each product required.
- E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
- F. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

- A. Air Handling Units: Nameplates.
- B. Air Terminal Units: Tags.
- C. Automatic Controls: Tags. Key to control schematic.
- D. Control Panels: Nameplates.
- E. Dampers: Ceiling tacks, where located above lay-in ceiling.
- F. Ductwork: Nameplates.
- G. Heat Transfer Equipment: Nameplates.
- H. Instrumentation: Tags.
- I. Major Control Components: Nameplates.
- J. Piping: Pipe markers.
- K. Pumps: Nameplates.
- L. Relays: Tags.
- M. Small-sized Equipment: Tags.
- N. Tanks: Nameplates.
- O. Thermostats: Nameplates.
- P. Valves: Tags and ceiling tacks where located above lay-in ceiling.
- Q. Water Treatment Devices: Nameplates.

2.02 NAMEPLATES

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.

1. Advanced Graphic Engraving, LLC: www.advancedgraphicengraving.com/#sle.
 2. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 3. Seton Identification Products, a Tricor Direct Company: www.seton.com/#sle.
 4. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Description: Laminated piece with up to three lines of text.
1. Letter Color: White.
 2. Letter Height: 1/4 inch.
 3. Background Color: Black.
 4. Nameplate Material:
 - a. Flexible: Vinyl with adhesive backing per ASTM D709.

2.03 TAGS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
1. Advanced Graphic Engraving: www.advancedgraphicengraving.com/#sle.
 2. Brady Corporation: www.bradycorp.com/#sle.
 3. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 4. Seton Identification Products, a Tricor Company: www.seton.com/#sle.
 5. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Metal: Brass, 19 gauge 1-1/2 inch in diameter with smooth edges, stamped and black filled, and corrosion-resistant ball chain. Up to three lines of text.
- C. Valve Tag Chart: Typewritten 12-point letter size list in anodized aluminum frame.

2.04 ADHESIVE-BACKED DUCT MARKERS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
1. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 2. Seton Identification Products, a Tricor Company: www.seton.com/#sle.
 3. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.
- C. Style: Individual Label.
- D. Color: Yellow/Black.

2.05 PIPE MARKERS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
1. Brady Corporation: www.bradycorp.com/#sle.
 2. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 3. Seton Identification Products, a Tricor Company: www.seton.com/#sle.
 4. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Color: Comply with ASME A13.1.

- C. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- D. Flexible Tape Pipe Markers: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.
- E. Underground Plastic Pipe Markers: Bright-colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil, 0.004 inch thick, manufactured for direct burial service.
- F. Color code as follows:
 - 1. Heating, Cooling, and Boiler Feedwater: Green with white letters.
 - 2. Toxic and Corrosive Fluids: Orange with black letters.
 - 3. Compressed Air: Blue with white letters.

2.06 CEILING TACKS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 - 2. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Description: Steel with 3/4 inch diameter color coded head.
- C. Color code as follows:
 - 1. HVAC Equipment: Yellow.
 - 2. Fire Dampers and Smoke Dampers: Red.
 - 3. Heating/Cooling Valves: Blue.

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION

- A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Install plastic pipe markers in accordance with manufacturer's instructions.
- D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- E. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- F. Use tags on piping 3/4 inch diameter and smaller.
 - 1. Identify service, flow direction, and pressure.
 - 2. Install in clear view and align with axis of piping.
 - 3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
- G. Install ductwork with self adhesive duct markers. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

- H. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

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

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Testing, adjustment, and balancing of air systems.
- B. Testing, adjustment, and balancing of hydronic and refrigerating systems.
- C. Measurement of final operating condition of HVAC systems.
- D. Commissioning activities.

1.02 RELATED REQUIREMENTS

- A. Section 01 40 00 - Quality Requirements: Employment of testing agency and payment for services.
- B. Section 01 91 13 - General Commissioning Requirements: Commissioning requirements that apply to all types of work.
- C. Section 23 3100 - HVAC Ducts and Casings.
- D. Section 23 08 00 - Commissioning of HVAC.
- E. Section 25 0000 - HVAC Instrumentation and Controls

1.03 REFERENCE STANDARDS

- A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition; 2016.
- B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2008.
- C. NEBB (TAB) - Procedural Standards for Testing Adjusting and Balancing of Environmental Systems; 2015, Eighth Edition.
- D. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing; 2002.

1.04 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
- C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - 1. Submit to Architect.
 - 2. Submit three weeks prior to starting the testing, adjusting, and balancing work.
 - 3. Include certification that the plan developer has reviewed Contract Documents, the equipment and systems, and the control system with the Architect and other installers to sufficiently understand the design intent for each system.
 - 4. Include at least the following in the plan:
 - a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - c. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - d. Final test report forms to be used.
 - e. Detailed step-by-step procedures for TAB work for each system and issue, including:

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- 1) Terminal flow calibration (for each terminal type).
- 2) Diffuser proportioning.
- 3) Branch/submain proportioning.
- 4) Total flow calculations.
- 5) Rechecking.
- 6) Diversity issues.
- f. Expected problems and solutions, etc.
- g. Criteria for using air flow straighteners or relocating flow stations and sensors; analogous explanations for the water side.
- h. Details of how TOTAL flow will be determined; for example:
 - 1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
 - 2) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
- i. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
- j. Confirmation of understanding of the outside air ventilation criteria under all conditions.
- k. Method of checking building static and exhaust fan and/or relief damper capacity.
- l. Time schedule for TAB work to be done in phases (by floor, etc.).
- m. Time schedule for deferred or seasonal TAB work, if specified.
- n. False loading of systems to complete TAB work, if specified.
- o. Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
- p. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
- q. Procedures for formal progress reports, including scope and frequency.
- r. Procedures for formal deficiency reports, including scope, frequency and distribution.
- D. Field Logs: Submit at least twice a week to the Construction Manager.
- E. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
- F. Progress Reports.
- G. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 1. Submit under provisions of Section 01 40 00.
 2. Revise TAB plan to reflect actual procedures and submit as part of final report.
 3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
 4. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 5. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 6. Units of Measure: Report data in I-P (inch-pound) units only.

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PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
 - 1. AABC (NSTSB), AABC National Standards for Total System Balance.
 - 2. SMACNA (TAB).
- B. Begin work after completion of each phase of each system. Systems to be tested, adjusted, or balanced and work completed prior to Substantial Completion of each phase and the project.
- C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- D. TAB Agency Qualifications:
 - 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 - 2. Having minimum of three years documented experience.
 - 3. Certified by one of the following:
 - a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.
 - b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.
 - c. TABBB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/#sle.
- E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.02 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.
 - 9. Access doors are closed and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage is minimized.
 - 12. Hydronic systems are flushed, filled, and vented.
 - 13. Pumps are rotating correctly.
 - 14. Proper strainer baskets are clean and in place.
 - 15. Service and balance valves are open.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

- A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
 - 1. Require attendance by all installers whose work will be tested, adjusted, or balanced.
- B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Engineer to facilitate spot checks during testing.
- C. Provide additional balancing devices as required.

3.04 ADJUSTMENT TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets: Adjust total to within plus 5 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 5 percent of design.
- C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.05 RECORDING AND ADJUSTING

- A. Field Logs: Maintain written logs including:
 - 1. Running log of events and issues.
 - 2. Discrepancies, deficient or uncompleted work by others.
 - 3. Contract interpretation requests.
 - 4. Lists of completed tests.
- B. Ensure recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
- E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.
- H. Check and adjust systems approximately six months after final acceptance and submit report.

3.06 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Air system leakage testing shall be performed by either TAB contractor or mechanical contractor. Coordinate leakage requirements and testing requirements with 23 31 00 - HVAC Ducts and Casings.
- D. Measure air quantities at air inlets and outlets.
- E. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- F. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- G. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

- H. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- I. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- J. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- K. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- L. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
- M. Where different operating modes are indicated, test systems in each mode, such as minimum outside air and full economizer mode.
- N. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.

3.07 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.08 COMMISSIONING

- A. See Sections 01 91 13 - General Commissioning Requirements and 23 08 00 for additional requirements.
- B. Perform prerequisites prior to starting commissioning activities.
- C. Fill out Prefunctional Checklists for:
 - 1. Air side systems.
 - 2. Water side systems.
- D. Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.
- E. In the presence of the Commissioning Authority, verify that:
 - 1. Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.
 - 2. 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, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all

terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.

3. 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, established control setpoints, and 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 percent or more open.

3.09 SCOPE

- A. Test, adjust, and balance the following:
 1. Plumbing Pumps.
 2. HVAC Pumps.
 3. Air Cooled Refrigerant Condensers.
 4. Air Coils.
 5. Terminal Heat Transfer Units.
 6. Air Handling Units.
 7. Fans.
 8. Air Filters.
 9. Air Inlets and Outlets.
 10. Energy Recovery Ventilators
 11. Variable Air Volume boxes

3.10 MINIMUM DATA TO BE REPORTED

- A. Electric Motors:
 1. Manufacturer.
 2. Model/Frame.
 3. HP/BHP.
 4. Phase, voltage, amperage; nameplate, actual, no load.
 5. RPM.
 6. Service factor.
 7. Starter size, rating, heater elements.
 8. Sheave Make/Size/Bore.
- B. V-Belt Drives:
 1. Identification/location.
 2. Required driven RPM.
 3. Driven sheave, diameter and RPM.
 4. Belt, size and quantity.
 5. Motor sheave diameter and RPM.
 6. Center to center distance, maximum, minimum, and actual.
- C. Pumps:
 1. Identification/number.
 2. Manufacturer.
 3. Size/model.
 4. Impeller.
 5. Service.
 6. Design flow rate, pressure drop, BHP.
 7. Actual flow rate, pressure drop, BHP.
 8. Discharge pressure.
 9. Suction pressure.

10. Total operating head pressure.
11. Shut off, discharge and suction pressures.
12. Shut off, total head pressure.
- D. Air Cooled Condensers:
 1. Identification/number.
 2. Location.
 3. Manufacturer.
 4. Model number.
 5. Serial number.
 6. Entering DB air temperature, design and actual.
 7. Leaving DB air temperature, design and actual.
 8. Number of compressors.
- E. Cooling Coils:
 1. Identification/number.
 2. Location.
 3. Service.
 4. Manufacturer.
 5. Air flow, design and actual.
 6. Entering air DB temperature, design and actual.
 7. Entering air WB temperature, design and actual.
 8. Leaving air DB temperature, design and actual.
 9. Leaving air WB temperature, design and actual.
 10. Saturated suction temperature, design and actual.
 11. Air pressure drop, design and actual.
- F. Heating Coils:
 1. Identification/number.
 2. Location.
 3. Service.
 4. Manufacturer.
 5. Air flow, design and actual.
 6. Water flow, design and actual.
 7. Water pressure drop, design and actual.
 8. Entering water temperature, design and actual.
 9. Leaving water temperature, design and actual.
 10. Entering air temperature, design and actual.
 11. Leaving air temperature, design and actual.
 12. Air pressure drop, design and actual.
- G. Air Moving Equipment:
 1. Location.
 2. Manufacturer.
 3. Model number.
 4. Serial number.
 5. Arrangement/Class/Discharge.
 6. Air flow, specified and actual.
 7. Return air flow, specified and actual.
 8. Outside air flow, specified and actual.
 9. Total static pressure (total external), specified and actual.

TESTING, ADJUSTING, AND BALANCING FOR
HVAC

10. Inlet pressure.
11. Discharge pressure.
12. Sheave Make/Size/Bore.
13. Number of Belts/Make/Size.
14. Fan RPM.
- H. Return Air/Outside Air:
 1. Identification/location.
 2. Design air flow.
 3. Actual air flow.
 4. Design return air flow.
 5. Actual return air flow.
 6. Design outside air flow.
 7. Actual outside air flow.
 8. Return air temperature.
 9. Outside air temperature.
 10. Required mixed air temperature.
 11. Actual mixed air temperature.
 12. Design outside/return air ratio.
 13. Actual outside/return air ratio.
- I. Exhaust Fans:
 1. Location.
 2. Manufacturer.
 3. Model number.
 4. Serial number.
 5. Air flow, specified and actual.
 6. Total static pressure (total external), specified and actual.
 7. Inlet pressure.
 8. Discharge pressure.
 9. Sheave Make/Size/Bore.
 10. Number of Belts/Make/Size.
 11. Fan RPM.
- J. Duct Traverses:
 1. System zone/branch.
 2. Duct size.
 3. Area.
 4. Design velocity.
 5. Design air flow.
 6. Test velocity.
 7. Test air flow.
 8. Duct static pressure.
 9. Air temperature.
 10. Air correction factor.
- K. Duct Leak Tests:
 1. Description of ductwork under test.
 2. Duct design operating pressure.
 3. Duct design test static pressure.
 4. Duct capacity, air flow.

5. Maximum allowable leakage duct capacity times leak factor.
6. Test apparatus:
 - a. Blower.
 - b. Orifice, tube size.
 - c. Orifice size.
 - d. Calibrated.
7. Test static pressure.
8. Test orifice differential pressure.
9. Leakage.
- L. Flow Measuring Stations:
 1. Identification/number.
 2. Location.
 3. Size.
 4. Manufacturer.
 5. Model number.
 6. Serial number.
 7. Design Flow rate.
 8. Design pressure drop.
 9. Actual/final pressure drop.
 10. Actual/final flow rate.
 11. Station calibrated setting.
- M. Terminal Unit Data:
 1. Manufacturer.
 2. Type, constant, variable, single, dual duct.
 3. Identification/number.
 4. Location.
 5. Model number.
 6. Size.
 7. Minimum static pressure.
 8. Minimum design air flow.
 9. Maximum design air flow.
 10. Maximum actual air flow.
 11. Inlet static pressure.
- N. Air Distribution Tests:
 1. Air terminal number.
 2. Room number/location.
 3. Terminal type.
 4. Terminal size.
 5. Area factor.
 6. Design air flow.
 7. Inlet static pressure.

END OF SECTION

SECTION 23 07 13 DUCT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Duct insulation.
- B. Duct liner.
- C. Jacketing and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 078413 - Penetration Firestopping: Through-penetration firestop systems.
- B. Section 23 05 53 - Identification for HVAC Piping and Equipment.
- C. Section 23 31 00 - HVAC Ducts and Casings: Glass fiber ducts.

1.03 REFERENCE STANDARDS

- A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2010.
- B. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013.
- C. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014.
- D. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation; 2014.
- E. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2021.
- F. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts; 2011.
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- H. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2014.
- I. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.
- J. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- C. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of experience and approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.07 FIELD CONDITIONS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, FLEXIBLE

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Johns Manville: www.jm.com/#sle.
 - 2. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
 - 3. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Insulation: ASTM C553; flexible, noncombustible blanket.
 - 1. K value: 0.25 at 75 degrees F, when tested in accordance with ASTM C518.
 - 2. Density: 1.5 lb/cu. ft.
 - 3. Maximum Service Temperature: 1,200 degrees F.
 - 4. Maximum Water Vapor Absorption: 5.0 percent by weight.
- C. Vapor Barrier Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 3. Secure with pressure-sensitive tape.
- D. Vapor Barrier Tape:
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.
- E. Outdoor Vapor Barrier Mastic:
 - 1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

2.03 GLASS FIBER, RIGID: INTERIOR APPLICATIONS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Knauf Insulation: www.knaufusa.com.
 - 2. Johns Manville Corporation: www.jm.com.
 - 3. Owens Corning Corp: www.owenscorning.com.
 - 4. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Insulation: ASTM C612; rigid, noncombustible blanket.
 - 1. 'K' value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
 - 2. Maximum service temperature: 450 degrees F.
 - 3. Maximum Water Vapor Sorption: 5.0 percent by weight.
 - 4. Minimum Density: 3.0 lb/cu ft.
- C. Vapor Barrier Jacket:

1. Kraft paper with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
3. Secure with pressure sensitive tape.
- D. Vapor Barrier Tape:
 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
- E. Indoor Vapor Barrier Finish:
 1. Cloth: Untreated; 9 oz/sq yd weight, glass fabric.
 2. Vinyl emulsion type acrylic, compatible with insulation, black color.

2.04 POLYISOCYANURATE, RIGID: EXTERIOR APPLICATIONS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 1. Carlisle SynTec Systems is a division of Carlisle Construction Materials, a wholly owned subsidiary of Carlisle Companies, InsulBase Polyiso Insulation (Basis of Design.)
 2. Hunter Panels, H-Shield
 3. Holcim Elevate, ISO 95+ GL and ISO GARD GL
 4. Johns Manville, Flat & Tapered ENRGY 3
 5. Johns Manville, Flat & Tapered XSPECT ISOFOAM APF
 6. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Insulation Material: Rigid-roof insulation panel composed of a closed-cell polyisocyanurate foam core bonded on each side to glass-reinforced felt (GRF).
 1. ASTM C1289, Type II (Glass Mat Facers,) Class 1 (Non-Reinforced Foam Core,) Grade 2 (20 psi per ASTM D1621) or Grade 3 (25 psi per ASTM D1621.)
 2. Alternatively, ASTM C1289, Type I (Foil Facers,) Class 1 (Non-Reinforced Foam Core,) Grade 1 (16 psi per ASTM D1621.)
 3. Furnish panel thickness suitable for required R-value (third party certified Long Term Thermal Resistance (LTTR) value.) Basis of design product requires 3-1/2" thick panel to provide not less than LTTR R-20. Utilizing tapered boards as the top piece of rooftop duct insulation system is preferred on ducts wider than 36" to help to prevent ponding water. A 4ft wide board sloping from 4in to 3in thick (1/4" per ft) with LTTR R-20 would meet this requirement. Refer to Part 3 below where duct liner is required to be installed for LTTR R-4 credit for the thickness of the liner.
 4. Produced with an EPA-compliant hydrocarbon-based blowing agent that has zero Ozone Depletion Potential (ODP), CFC- and HCFC-free, and virtually no Global Warming Potential (GWP.)
 5. Approved for direct application to steel decks (or in this case, to sheetmetal ducts.) Mechanically Fasten (MF) to ductwork and/or Fully Adhere (FA) using adhesive as may be directed by manufacturer. Suitable for use with EPDM roofing jacket. Storage, handling, and installation to be per manufacturer's recommendations.
 6. Thermal Conductivity (k-Value): 0.16 BTU*in/°F • ft² • hr at 75 deg F mean temperature per ASTM C518.
 7. Moisture Vapor Permeance: ASTM E96, <1 perm
 8. Water Absorption: ASTM C1763 or ASTM C209, <1% by volume
 9. FM Standards 4450/4470 Approvals.

10. UL Standard 790, 263 and 125

2.05 JACKETING AND ACCESSORIES

A. EPDM Jacket:

1. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Carlisle SynTec Systems, Sure-White EPDM Membrane, 90-mil (Basis of Design)
 - b. Holcim Elevate, RubberGard EcoWhite EPDM Membrane, Platinum 90-mil..
 - c. Johns Manville, JM EPDM NR 90-mil, only if available in white.
 - d. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
2. EPDM Membrane (Exterior insulated duct) Jacket: ASTM D 4637, Type I, Class A, non-reinforced uniform, flexible EPDM sheet.
 - a. Thickness: 90 mils. Resistance to UV radiation, ozone per ASTM D1149, and weathering. Long-term waterproofing performance when used in a fully adhered roof system application.
 - b. Exposed Face Color: White on black. Cool Roof Council (CRRC): Initial / 3 yr, Solar Reflectance 0.77 / 0.71.
 - c. FM Approved.
 - d. 10 year material and labor warranty required. Contractor is responsible for guarantee application, charges, inspection, and registration.
 - e. Storage, handling, and installation to be per manufacturer's recommendations. Installation by factory authorized installers.

2.06 DUCT LINER

- ### **A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.**
1. Armacell, AP CoilFlex duct liner (Basis of Design.)
 2. KFlex USA
 3. Armacell, AP ArmaFlex and FS duct liner will not be accepted; its acoustical properties (Sound Absorption Coefficients at Frequency and NRC) are not equal to the basis of design product. Glass fiber products will also not be accepted; not specified material.
 4. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- ### **B. Flexible Elastomeric Duct Liner: Comply with NFPA 90A and NFPA 90B.**
1. Black, conformable, elastomeric, thermal and acoustical duct liner in roll form. NBR based is basis of design.
 2. ASTM C1534-20a, Standard Specification for Flexible Polymeric Foam Sheet Insulation Used as a Thermal and Sound Absorbing Liner for Duct Systems. Type I is a closed flexible foam. Type II is an open cell flexible foam.
 3. Thickness: 1 inch.
 4. Thermal Conductivity (k-Value): 0.25 at 75 deg F mean temperature.
 5. Noise Reduction Coefficient (NRC): 0.6 or greater, according to ASTM C423-22, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
 6. Water Absorption, % by Volume: 0.2%, ASTM C 209

7. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84-21a.
 8. Liner Adhesive: Materials and methods as recommended by duct liner manufacturer and complying with NFPA 90A or NFPA 90B.
 9. Mold Growth, Fungi Resistance: ASTM G21, passed.
 10. Erosion Resistance: Does not break away, flake off or show evidence of delamination at velocities of 10,000 ft/min. Tested per ASTM C1071-19.
 11. Manufactured without CFCs, HFCs, HCFCs, PBDEs, or formaldehyde.
- C. Adhesive: Waterproof, fire-retardant type, ASTM C916.
1. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Design Polymerics; DP 2502 Water Based, Low VOC, Duct Liner Adhesive: www.designpoly.com/#sle.
 - b. Elgen Manufacturing Company, Inc; Water Based Liner Adhesive: www.elgenmfg.com/#sle.
 - c. Vimasco Corporation; ____: www.vimasco.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements

2.07 SPIRAL DUCT LINER

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
1. Armacell, AP SpiralFlex Spiral Duct Liner Insulation (Basis of Design.) Glass fiber products will not be accepted; not specified material.
 2. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Flexible Elastomeric Duct Liner: Comply with NFPA 90A and NFPA 90B.
1. Black, conformable, elastomeric, composite material for use as a thermal and acoustical duct liner in spiral ducts.
 2. ASTM C1534-20a, Standard Specification for Flexible Polymeric Foam Sheet Insulation Used as a Thermal and Sound Absorbing Liner for Duct Systems. Type I is a closed flexible foam. Type II is an open cell flexible foam.
 3. Thickness: 1 inch.
 4. Thermal Conductivity (k-Value): 0.28 at 75 deg F mean temperature.
 5. Noise Reduction Coefficient (NRC): 0.4 or greater, according to ASTM C423-22, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
 6. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84-21a.
 7. Liner Adhesive: Materials and methods as recommended by duct liner manufacturer and complying with NFPA 90A or NFPA 90B.
 8. Mold Growth, Fungi Resistance: ASTM G21, passed.
 9. Erosion Resistance: Does not break away, flake off or show evidence of delamination at velocities of 10,000 ft/min. Tested per ASTM C1071-19.
 10. Manufactured without CFCs, HFCs, HCFCs, PBDEs, or formaldehyde.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Test ductwork for design pressure prior to applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install in accordance with manufacturer's instructions.
- E. Install in accordance with NAIMA National Insulation Standards.
- F. Insulated Ducts Conveying Air Below Ambient Temperature:
 - 1. Provide insulation with vapor barrier jackets.
 - 2. Finish with tape and vapor barrier jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system, including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- G. Insulated Ducts Conveying Air Above Ambient Temperature:
 - 1. Provide with or without standard vapor barrier jacket.
 - 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- H. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- I. Install multiple layers of insulation with longitudinal and end seams staggered.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Insulated Ducts Exposed in Mechanical Equipment Rooms (below 10 feet above finished floor): Finish with canvas jacket sized for finish painting.
- L. Insulated Rectangular Ducts Exposed in Finished Spaces: Finish with canvas jacket sized for finish painting.
- M. Insulated Round Ducts Exposed in Finished Spaces: Utilize Spiral Duct Liner insulation installed per manufacturer's instructions, instead of flexible glass fiber. Duct liner must be installed for 100 percent coverage.
- N. Exterior Applications: Cover polyisocyanurate or other insulation specified with EPDM jacket. Install products in accordance with manufacturer's current written instructions, details, workmanship, and warranty/guarantee requirements.
- O. Duct and Plenum Liner Application:
 - 1. Adhere insulation with adhesive for not less than 90 percent coverage.
 - 2. Seal and smooth joints. Seal and coat transverse joints.
 - 3. Seal liner surface penetrations with adhesive.
 - 4. Duct dimensions indicated are net inside dimensions required for air-flow. Increase duct size to allow for insulation thickness.

5. For air handling units, rooftop units, heat recovery units, and energy recovery units that handle 1,000 cfm or more of supply air, apply duct liner to first 20 feet of ductwork downstream of unit, or up to first elbow, whichever is a greater length.
 6. Apply duct liner to return plenum (or if there is no return plenum, to first five feet of return ductwork) adjacent each water source heat pump, fan coil unit, and ducted VRF unit.
 7. Apply duct liner to first 10 feet of supply ductwork adjacent each water source heat pump, fan coil unit, and ducted VRF unit that is nominally rated for 1,000 to 1,600 cfm.
 8. Apply duct liner to first 20 feet of supply ductwork adjacent each water source heat pump, fan coil unit, and ducted VRF unit that is nominally rated for greater than 1,600 cfm.
 9. Apply duct liner from duct connections to roof top units down to first branch take-off.
 10. In locations where the duct liner is required to be installed and building interior duct insulation is also required by the schedules below, the required duct insulation thickness may be reduced by 1" as a credit for the thickness of the liner. Also, where building interior supply air ductwork 1-1/2" thick glass fiber insulation is indicated in the schedule below, this duct insulation may be omitted where the 1" thick duct liner is installed for 100 percent coverage.
 11. In locations where the duct liner is required to be installed and building exterior duct polyisocyanurate insulation is also required by the schedules below, the required duct polyisocyanurate insulation thickness may be reduced by LTTR R-4 as a credit for the thickness of the liner.
- P. Flexible Glass Fiber Duct Wrap Insulation Installation: Follow the manufacturer's duct wrap stretch-outs table to achieve not less than the installed compressed thickness in the table. The contractor shall be responsible for removing Flexible Glass Fiber and replacing with new due to installed compressed thickness being less than indicated on the datasheet table, resulting in reduction of duct wrap installed R-value below that shown.

3.03 SCHEDULES

Service	Location	Size	Insulation Type	Minimum R-Value, thickness	Insulation Jacket

- A. Insulation thickness to be not less than required by commercial building energy code.
- B. Supply air systems indicated below to include outside air (OA) tagged ductwork where located downstream of an ERV.

Round Supply Air Ductwork	Interior, Concealed	All Sizes	Flexible Glass Fiber	1-1/2"	Vapor Barrier Jacket
Rectangular Supply Air Ductwork	Interior, Concealed	Smaller than 24"	Flexible Glass Fiber	1-1/2"	Vapor Barrier Jacket
Rectangular Supply Air Ductwork	Interior, Concealed	24" and Larger	Rigid Glass Fiber	1-1/2"	Vapor Barrier Jacket

Round Exhaust Air Ductwork	Interior, From Equipment Connection to Louver	All Sizes	Flexible Glass Fiber	2 layers of 2"	Vapor Barrier Jacket
Rectangular Exhaust Air Ductwork	Interior, From Equipment Connection to Louver	All Sizes	Rigid Glass Fiber	3"	Vapor Barrier Jacket
Round Outdoor Air Ductwork	Interior, From Equipment Connection to Louver	All Sizes	Flexible Glass Fiber	2 layers of 2"	Vapor Barrier Jacket
Rectangular Outdoor Air Ductwork	Interior, From Equipment Connection to Louver	All Sizes	Rigid Glass Fiber	3"	Vapor Barrier Jacket
Rectangular Ductwork (Supply, Return, Exhaust, Outdoor Air)	Interior, Unconditioned Space	All Sizes	Flexible Glass Fiber	3"	Vapor Barrier Jacket
Round Ductwork (Supply, Return, Exhaust, Outdoor Air)	Interior, Unconditioned Space	All Sizes	Flexible Glass Fiber	2 layers of 1-1/2"	Vapor Barrier Jacket
Rectangular Supply Air Ductwork	Exterior	All Sizes	Polyiso-cyanurate board	3-1/2"	EPDM Membrane
Rectangular Return Air Ductwork	Exterior	All Sizes	Polyiso-cyanurate board	3-1/2"	EPDM Membrane
Rectangular Exhaust Air	Exterior	All Sizes	Polyiso-cyanurate	3-1/2"	EPDM Membrane

DUCT INSULATION

Ductwork			board		

END OF SECTION

SECTION 23 07 19
HVAC PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping insulation.
- B. Jacketing and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 078413 - Penetration Firestopping: Through-penetration firestop systems.
- B. Section 23 21 13 - Hydronic Piping: Placement of hangers and hanger inserts.
- C. Section 23 23 00 - Refrigerant Piping: Placement of inserts.

1.03 REFERENCE STANDARDS

- A. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.
- B. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- C. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2013.
- D. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2013).
- E. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2013).
- F. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2010.
- G. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2013.
- H. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2014.
- I. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2015.
- J. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing; 2010.
- K. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation; 2015.
- L. ASTM D1056 - Standard Specification for Flexible Cellular Materials--Sponge or Expanded Rubber; 2014.
- M. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- N. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2014.
- O. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

- D. Armacell Qualified Installer Program (AQIP) training certifications or equal by actual flexible elastomeric cellular product manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum three years of experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.07 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, UL 723, ASTM E84, or UL 723.

2.02 GLASS FIBER, RIGID

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Johns Manville Corporation: www.jm.com/#sle.
 - 2. Knauf Insulation: www.knaufinsulation.com/#sle.
 - 3. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
 - 4. Manson Insulation: www.imanson.com.
 - 5. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Insulation: ASTM C547; rigid molded, noncombustible.
 - 1. Heavy-density, one-piece insulation made from inorganic glass fibers bonded with a thermosetting resin.
 - 2. Materials to comply with ASTM C 547, Type I, Grade A, 850°F or ASTM C 547, Type IV, 1,000°F.
 - 3. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
 - 4. Furnish with factory-applied ASJ jacket.
 - 5. Complete, integrated system to meet maximum 25/50 flame-spread/smoke-developed indexes per ASTM E84.
 - 6. Thermal Conductivity (k Values): 0.23 BTU-in/hr-sq.ft.-°F at 75°F mean temperature per ASTM C335.
 - 7. Service Temperature Range not less than 0 to 850°F.
 - 8. Moisture Sorption after 96 hours @120°F, 95%RH, ASTM C1104.
 - a. Fiberglass products: <5% by weight.
 - 9. Water Vapor Transmission: Jacket water vapor permeance of 0.02 perms or less per ASTM E96
- C. Provide Hamfab Type 1000°, as manufactured by ICA Insulation, or approved equal, preformed (molded under heat and pressure with thermo-setting resin) fiberglass or mineral wool pipe fitting insulation in two matching half sections. Routed, mitered, or segmented

fitting insulation made from blocks, boards, or pipe insulation shall not be accepted except as noted. Mitered or segmented fitting insulation made from pipe insulation will be accepted in lieu of specified Hamfab product for all pipe sizes 2" and under only, and where greater insulation thickness is required than Hamfab has available product (which may be the case for steam pipe fitting sizes 2-1/2" and 5".) Where "Hamfab" is mentioned below, it shall include these mitered or segmented fittings 2" and under. Fitting insulation shall be 4-10 lb per cu.ft. density and shall also comply with the glass fiber insulation properties directly above, except furnish fitting insulation unfaced from the factory.

1. For Hamfab pipe fittings, install PVC fitting covers (except where aluminum fitting covers are specifically indicated, that is, for exterior pipe fittings and for heat traced pipe fittings.)
 2. Where PVC covers are not molded or otherwise commercially available, such as for valves and some joints, install glass cloth or 100% cotton canvas jacket, 6-8 oz./sq.yd., plain weave with mastic or coating over fitting insulation to provide a protective barrier. Canvas shall be as manufactured by GLT Products, Chas. Harmon & Company, Inc., or approved equal. Glass cloth shall be rewettable fiberglass cloth Ami-Glas Cloth style no. RGL1450 as manufactured by Auburn Manufacturing, Inc. (14.5 oz/sq.yd. minimum, 0.027" thickness minimum) or approved equal.
 3. Install all per manufacturers' written instructions.
 4. PVC fitting covers with fiberglass inserts will not be permitted.
 5. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- D. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
- E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- F. Vapor Barrier Lap Adhesive: Compatible with insulation.
- G. Indoor Vapor Barrier Finish:
1. Vinyl emulsion type acrylic, compatible with insulation, black color.
- H. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

2.03 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following. Use only one insulation product for the entire system.
1. Aeroflex USA, Inc; Aerocel SSPT: www.aeroflexusa.com/#sle (sub-paragraph B.2 below)
 2. Armacell LLC; AP Armaflex, 1-1/2" through 2" wall: www.armacell.us/#sle (sub-paragraph B.2 below)
 3. Armacell LLC; AP Armaflex, 3/8" through 1" wall: www.armacell.us/#sle (sub-paragraph B.1 below)
 4. K-Flex USA LLC; K-Flex Titan: www.kflexusa.com/#sle (sub-paragraph B.1 below)
 5. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Comply with one of the following, in accordance with sub-paragraph D below:
1. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Type 1, Grade 1; use molded tubular material (Type 1) wherever possible. Sheet form (Type II) will be accepted when the insulation is factory installed as

- part of line sets, where lines sets are permitted under Section 232300 Refrigerant Piping.
- a. Material: Closed-cell expanded rubber or NBR/PVC (Nitrile Butadiene Rubber) polymeric blend.
 - b. Minimum Service Temperature: -70 degrees F.
 - c. Maximum Continuous Service Temperature: 220 degrees F.
 - d. Thermal Conductivity (k Values): 0.245 (or 0.23) BTU-in/hr-sq.ft.-°F at 75°F per ASTM C 177 or C 518.
 - e. Connection: Waterproof vapor barrier adhesive.
2. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Type 1, Grade 1; use molded tubular material (Type 1) wherever possible.
- a. Material: Closed-cell EPDM-based rubber.
 - b. Minimum Service Temperature: -320 degrees F.
 - c. Maximum Continuous Service Temperature: 257 degrees F.
 - d. Thermal Conductivity (k Values): 0.28 BTU-in/hr-sq.ft.-°F at 75°F per ASTM C 177 or C 518.
 - e. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.
- D. The insulation product shall comply with the maximum service temperature of any installed VRF system. Coordinate maximum service temperature with manufacturer's product data of the selected system (based upon any approved VRF system submittal.) If any part of the insulated system may exceed 220 deg F service temperature, Aerocel SSPT by Aeroflex or comparable insulation (if accepted as a substitution) shall be furnished. The insulation shall be installed to comply with the maximum service temperature of the VRF system. In any case, the insulation thicknesses scheduled below shall apply.
- E. Copper piping, such as refrigerant piping, that is scheduled to be insulated with flexible elastomeric cellular insulation, in horizontal, vertical, and inverted installations to be supported from insulation clamps / clips as specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment" to maintain continuous insulation of piping system. Comply with manufacturer's installation instructions.
- F. Flexible elastomeric cellular components shall be installed per manufacturer's written instructions and by trained and currently certified installers under Armacell Qualified Installer Program (AQIP), or equal by actual product manufacturer. Submittal of such training and manufacturer certification shall be required before the start of work.
1. Fittings shall be insulated with mitered sections of pipe insulation. All joints and seams to be fully adhered and sealed

2.04 JACKETING AND ACCESSORIES

- A. PVC Plastic.
1. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Johns Manville Corporation; Zeston 2000 Series White PVC: www.jm.com/#sle.
 - b. Proto Corp.; LoSmoke PVC Fitting Covers: www.protocorporation.com.
 - c. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
 2. Jacket: One piece molded type fitting covers and sheet material, off-white color.

- a. Minimum Service Temperature: 0 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 20 mil.
 - e. Connections: Brush on welding adhesive.
 - f. Containing UV inhibitor.
3. Covering Adhesive Mastic: Compatible with insulation.
- B. Aluminum Jacket:
 1. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Johns Manville, Aluminum Jacketing, formerly Pabco/Childers Metal
 - b. Ideal Products; Aluminum Roll Jacketing
 - c. RPR Products, Inc.; Insul-Mate.
 - d. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
 2. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
 3. Comply with ASTM B209/B209M, Alloy 3003, 3005, 3105 or 5005, Temper H14, minimum thickness of 0.024 inch with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
 4. Thickness: 0.020 inch sheet.
 5. Type: Factory-applied, self-adhesive jacketing.
 6. Finish: Smooth. (less susceptible to poulitice/crevice corrosion than stucco embossed finish).
 7. Joining: Longitudinal slip joints and 2 inch laps.
 8. Factory-Fabricated Fitting Covers: 0.024 inch thick die-shaped fitting covers with factory-attached protective liner.
 - a. Same material, finish, and thickness as jacket. ASTM B209, Alloy 1100 for fitting covers also acceptable.
 - b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - c. Tee covers.
 - d. Flange and union covers.
 - e. End caps.
 - f. Beveled collars.
 - g. Valve covers.
 - h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
 9. Metal Jacket Bands: 1/2 inch wide; 0.020 inch thick aluminum composed of alloys 3105 or 3003. Use aluminum bands when insulation OD is less than or equal to 8".
 10. Metal Jacket Bands: 1/2 inch wide; 0.020 inch thick stainless steel composed of alloys T304 or T316 with annealed temper. Use SS bands when insulation OD is greater than 8".

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.

- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with North American Insulation Manufacturers Association (NAIMA) National Insulation Standards.
- C. Exposed Piping: Locate insulation and cover seams in least visible locations.
- D. Insulated pipes conveying fluids below ambient temperature. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- E. Glass Fiber Insulated Pipes Conveying Fluids Below Ambient Temperature:
 - 1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic. Insulation shall have a complete and continuous vapor barrier with no openings at valve stems, pipe hangers, etc.
 - 2. Insulate fittings with insulation noted above. Insulate joints and valves with molded insulation of like material and thickness as adjoining pipe. Finish each fitting, joint, and valve with one of the following depending on the application:
 - a. On exterior systems and for heat traced systems install aluminum covers over complete insulated piping system.
 - b. For other piping systems, install PVC covers over fittings, joints, and valves.
 - c. Where PVC covers are indicated, but are not molded or otherwise commercially available, such as for valves and some joints, install glass cloth or 100% cotton canvas, as specified above, with vapor barrier mastic or coating over insulation to provide a protective barrier.
- F. For hot piping conveying fluids 110 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- G. For hot piping conveying fluids over 110 degrees F, insulate flanges and unions at equipment.
- H. Glass Fiber Insulated Pipes Conveying Fluids Above Ambient Temperature:
 - 1. Provide standard jackets, with or without vapor barrier, factory-applied, or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples.
 - 2. Insulate fittings with insulation noted above. Insulate joints and valves with molded insulation of like material and thickness as adjoining pipe. Finish each fitting, joint, and valve with one of the following depending on the application:
 - a. On exterior systems and for heat traced systems install aluminum covers over complete insulated piping system.
 - b. For other piping systems, install PVC covers over fittings, joints, and valves.
 - c. Where PVC covers are indicated, but are not molded or otherwise commercially available, such as for valves and some joints, install glass cloth or 100% cotton canvas, as specified above, with mastic or coating over insulation to provide a protective barrier.
- I. Inserts and Shields:
 - 1. Application: Piping 1 inches diameter and larger.
 - 2. Furnish insulation shields with or without inserts for NPS 1 thru NPS 2 insulated pipe supports, because these smaller pipe sizes are unlikely to significantly compress the pipe insulation. Furnish Polyisocyanurate Fabricated Pipe Insulation or Calcium Silicate Fabricated Pipe Insulation as an insert in addition to insulation shields for NPS 2-1/2 thru

NPS 4 insulated steel pipe supports and for NPS 2-1/2 and larger insulated non-steel pipe supports. Furnish same thickness insert as adjacent insulation. Using wood, high density molded fiberglass, or other insert materials not meeting this Section will not be accepted.

3. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 4. Insert Location: Between support shield and piping and under the finish jacket.
 5. Insert Configuration: Insert material shall be at least as long as protective shield, of same thickness and contour as adjoining insulation, and factory fabricated.
 6. Insert Material: Polyisocyanurate insulation or Calcium silicate insulation.
 7. Refer to also inserts and shields requirements in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- J. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 078413.
- K. Insulated pipe exposed in kitchens, bathrooms, walkin coolers, and other sanitary finished spaces where regular cleaning of piping is required, as well as where exposed indoors in a location that is potentially subject to damage. Cover such pipe, fittings, joints, and valves with PVC jacket, locate seams on bottom side of horizontal piping. Overlap radial joints to shed water for vertical piping. Alternatively for refrigerant piping only, PVC line set covers and fittings furnished by the equipment manufacturer may be installed per manufacturer's instructions.
- L. Exterior applications and parking garages (to include refrigerant piping): Provide vapor barrier jacket. Insulate pipe and fittings with insulation noted above. Insulate joints and valves with molded insulation of like material and thickness as adjoining pipe. Cover such pipe, fittings, joints, and valves with aluminum jacket, locate seams on bottom side of horizontal piping. Overlap radial joints to shed water for vertical piping.
- M. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover such pipe, fittings, joints, and valves with aluminum jacket with seams located on bottom side of horizontal piping.

3.03 SCHEDULE

- A. Heating and cooling systems.

Service	Size	Minimum Thickness	Insulation Type
Low Pressure Steam (to 15 PSIG, 250 degrees F)	4" and Larger	3"	Glass Fiber
Low Pressure Steam (to 15 PSIG, 250 degrees F)	3" and Smaller	1-1/2"	Glass Fiber
Refrigerant Piping (High Pressure)	All Sizes	1-1/2"	Flexible Elastomeric Cellular Insulation
Refrigerant Piping (Liquid)	All Sizes	1-1/2"	Flexible Elastomeric Cellular Insulation
Heating Water Piping, above grade (operating max 141 to 200°F)	1-1/2" and Larger	2"	Glass Fiber

Heating Water Piping, above grade (operating max 141 to 200°F)	1-1/4" and Smaller	1-1/2"	Glass Fiber

END OF SECTION

SECTION 23 21 13 HYDRONIC PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Hydronic system requirements.
 - 2. Heating water piping, above grade.
 - 3. Pipe and pipe fittings for:
 - a. Heating water piping system.
 - b. Equipment drains and overflows.
 - c. Pipe hangers and supports.
 - d. Unions, flanges, and dielectric connections.
 - 4. Valves:
 - a. Check valves.
 - b. Pressure independent temperature control valves and balancing valves.
 - 5. Flow controls.
- B. This Division 23 Section shall apply in every respect to temporary piping shown on drawings. Temporary piping shall be removed and areas restored to pre-existing conditions after Commissioning of permanent piping systems, unless otherwise indicated on the drawings.

1.02 RELATED REQUIREMENTS

- A. Section 078410 - Penetration Firestopping: Through-penetration firestop systems.
- B. Section 083113 - Access Doors and Frames
- C. Section 230500 - Mechanical General Provisions: Additional quality assurance requirements, joining materials, field testing requirements, and more.
- D. Section 230516 - Expansion Fittings and Loops for HVAC Piping.
- E. Section 230529 - Hangers and Supports for HVAC Piping and Equipment
- F. Section 23 05 48 - Vibration and Seismic Controls for HVAC.
- G. Section 23 05 53 - Identification for HVAC Piping and Equipment.
- H. Section 23 07 19 - HVAC Piping Insulation.
- I. Section 23 21 14 - Hydronic Specialties: Relief valves, strainers, and more.
- J. Section 232410 – HVAC Valves: Ball Valves and Butterfly Valves.
- K. Section 23 25 00 - HVAC Water Treatment: Pipe cleaning and closed loop system chemical treatment.

1.03 REFERENCE STANDARDS

- A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications; 2015.
- B. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard; 2013.
- C. ASME B16.9 - Factory-Made Wrought Buttwelding Fittings; 2018.
- D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
- E. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.
- F. ASME B16.24 - Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves: Classes 150, 300, 600, 900, 1500, and 2500; 2016.
- G. ASME B16.25 - Buttwelding Ends; 2017.
- H. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.

- I. ASME B31.9 - Building Services Piping; 2020.
- J. ASTM A105/A105M - Standard Specification for Carbon Steel Forgings for Piping Applications; 2018.
- K. ASTM A312 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes; 2017.
- L. ASTM A403 - Standard Specification for Wrought Austenitic Stainless Steel Pipe Fittings; 2022.
- M. ASTM A778 - Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products; 2022.
- N. ASTM A106/A106M - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service; 2014.
- O. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
- P. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2015.
- Q. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).
- R. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2014.
- S. ASTM D1693 - Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics; 2021.
- T. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fitting Materials; 2021.
- U. ASTM F714 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter; 2022.
- V. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011-AMD 1.
- W. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020.
- X. MSS SP-58-2018 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation which includes Amendment 1 Issued 10-17-2019.
- Y. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.
- Z. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.

1.04 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures:
 - 1. Hot water heating piping (unless noted otherwise):
 - a. Design (Working) Pressure/Temperature 150 psig/200°F
 - b. Normal Operating Pressure/Temperature 30 psig/180°F
 - 2. Relief-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.
 - 3. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.

1.05 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Firestopping materials.
- C. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.
- D. Product Data:
 - 1. Include data on pipe materials, pipe fittings, manifolds, flanges, joining materials, valves, and accessories.

2. Provide manufacturers catalog information.
3. Indicate valve data and ratings.
- E. All submittals of Division 23 Section "Hangers and Supports for HVAC Piping and Equipment," to include Delegated-Design requirements.
- F. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- G. Shop Drawings: Detail, 1/2 inch equals 1 foot scale, fabrication of pipe anchors, pipe support frames, hangers, pipe, multiple pipes, alignment guides, expansion joints, expansion loops, offsets, swing joints and their attachment to the building structure. Detail locations of anchors, alignment guides, expansion joints, expansion loops, offsets, and swing joints.
- H. Project Record Documents: Field survey and document actual locations and sizes of hydronic equipment, piping, transitions, pipe fittings, valves, hydronic specialties, etc. Record changes in pipe location and additional fittings used. Record drawings are to be contractor-prepared by modifying the source digital files (typically AutoCAD and/or Revit to be furnished by the Design Engineer.) Submit both the modified digital files as well as Adobe PDF format record drawings. Refer to Division 23 Section "Mechanical General Provisions" and the Division 1 specifications for additional record drawing requirements.
- I. Operation and Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
- J. Installer Certificates shall be submitted before welding commences:
 1. Welders' certificates for welding processes and operators.

1.06 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping" for materials, products, and installation.
- B. Reference Division 23 Section "Mechanical General Provisions" for additional Quality Assurance requirements.
- C. Relief valves and pressure vessels shall bear the appropriate ASME label.
- D. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.
- E. Installer Qualifications: Company specializing in performing work of the type specified in this section with minimum 3 years of experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
- E. Care and handle plastic piping in accordance with manufacturers written instructions.

PART 2 PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
- B. Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:

1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
3. Grooved mechanical joints, associated mechanical couplings, and mechanical press seal joints are not permitted in any location.
 - a. Furnish a deductive alternate price for owners' consideration to furnish mechanical press seal joints and pressed ends, to the extent the contractor prefers to utilize such products in lieu of those specified. Mechanical press seal joints furnished shall be only ProPress as manufactured by Viega. No other manufacturer's products will be permitted. ProPress components shall be installed per manufacturer's written instructions and by trained and currently certified installers. Submittal of such training and manufacturer certification shall be required before the start of work.
4. Provide pipe hangers and supports in accordance with ASME B31.9, MSS SP-58, MSS SP-69, and MSS SP-89 unless indicated otherwise.
- C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges or unions to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
- D. Valves: Provide valves where indicated:
 1. Provide drain valves where indicated, and if not indicated provide at least at main shut-off, low points of piping, bases of vertical risers, at equipment, and elsewhere as required for complete system drainage when any valves are closed. Use minimum 3/4 inch ball valves with cap, larger if appropriate to drain a large volume system in a reasonable time; pipe to nearest floor drain.
 2. On discharge of condenser water and circulating pumps, use spring loaded check valves.
 3. Provide valves where indicated for venting, and provide at each high point, with air vent.
 4. Isolate equipment using ball or butterfly valves.
 5. For throttling, bypass, or manual flow control services, use ball or butterfly valves.
 6. For shut-off and to isolate parts of systems or vertical risers, use ball or butterfly valves.
 7. For throttling service, use plug cocks. Use non-lubricated plug cocks only when shut-off or isolating valves are also provided.
- E. Welding Materials and Procedures: Comply with ASME BPVC-IX.
 1. Welding Filler Metals: Reference Division 23 Section "Mechanical General Provisions".

2.02 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M or ASTM A106, carbon steel, Type E (ERW) or Type S (seamless), Grade B, and ASME B36.10M standard weight. Include ends matching joining method.
 1. Seamless Forged (Wrought) Steel, Butt Weld Fittings (2-1/2" to 26"): ANSI B16.9, ASTM A234, Grade B (WPB), and standard weight. Elbows shall be long radius.
 2. Seamless Forged (Wrought) Steel, Butt Weld Branch Connections (2-1/2" to 26"): ANSI B16.9, ASTM A105, and standard weight.
 3. Forged Steel, Socket Weld Fittings and Branch Connections (NPS 2" and smaller): ASME B16.11, ASTM A105; Class 3000, 2000 psig, WOG (minimum) class.
 4. Forged Steel, Welding Neck or Slip On Flanges (2-1/2" to 24"): ANSI B16.5, ASTM A105, face to match connected valve or equipment. Weld inside and outside. ANSI Class 150.
 5. Forged Steel, Blind Flanges (3/4" to 24"): ANSI B16.5, ASTM A105, face to match connected valve or equipment, ANSI Class 150.

6. Refer to Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for packed slip expansion joints and hydronic systems flexible pipe connectors.

2.03 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.
 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings unless indicated otherwise. No other copper joint methods or fittings (such as with grooved mechanical joints, associated mechanical couplings, or mechanical press seal joints) shall be permitted.
 - a. Furnish a deductive alternate price for owners' consideration to furnish mechanical press seal joints and pressed ends, to the extent the contractor prefers to utilize such products in lieu of those specified. Mechanical press seal joints furnished shall be only ProPress as manufactured by Viega. No other manufacturer's products will be permitted. ProPress components shall be installed per manufacturer's written instructions and by trained and currently certified installers. Submittal of such training and manufacturer certification shall be required before the start of work.
 2. Bronze Flanges: ASME B16.24, ANSI Class 150, with solder-joint or threaded ends. Furnish ANSI Class 300 flanges if required to match piping.
 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
 4. Refer to Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for packed slip expansion joints and hydronic systems flexible pipe connectors.

2.04 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Supports used on hydronic piping are to typically be hot-dip galvanized construction according to either ASTM A153 or ASTM A123. See Division 23 Section "Hangers and Supports for HVAC Piping and Equipment" for additional requirements and clarification.
- C. Provide hangers and supports that comply with MSS SP-58.
 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 and MSS SP-69 recommendations.

2.05 UNIONS, FLANGES, AND DIELECTRIC CONNECTIONS

- A. Unions for Pipe of 2 Inches and Less:
 1. Ferrous Piping: Not normally used since piping 2 inch and under is not steel.
 2. Copper Pipe: See earlier in this Section.
- B. Flanges for Pipe 2-1/2 Inches and Greater:
 1. Ferrous Piping: See earlier in this Section.
 2. Copper Piping: Not normally used since piping 2-1/2 inch and larger is not copper.
 3. Gaskets: Requirements in 230500 Mechanical General Provisions.
- C. Dielectric Connections: Union or waterway fitting with water impervious isolation barrier and one galvanized or plated steel end and one copper tube end, end types to match pipe joint types used. Refer to Division 23 Section "Mechanical General Provisions" for additional requirements.

2.06 SWING CHECK VALVES

- A. Up To and Including 2 Inches:
 1. Bronze body, bronze trim, bronze rotating swing disc, solder or threaded ends.
- B. Over 2 Inches:

1. ASTM A126 Iron body, bronze trim, bronze swing disc, renewable disc and seat, flanged ends, class 125, 200 psig CWP rating, clear or full waterway.

2.07 SPRING LOADED CHECK VALVES

- A. ASTM A126 Iron body, bronze trim, split plate, hinged with stainless steel spring, metal seat, flanged ends, class 125, 200 psig CWP rating.

2.08 FLOW CONTROLS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 1. Victaulic Company; _____: www.victaulic.com/#sle.
 2. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
- C. Calibration: Control flow within 10 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, minimum pressure 2 psi.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment using jointing system specified.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- E. After completion, fill, clean, and treat systems. See Section 23 25 00 for additional requirements.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install piping to ASME B31.9 requirements.
- C. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- D. Install fittings for changes in direction and branch connections.
- E. Fish-mouth / stub-in branch connections shall not be permitted. Where permitted by paragraph 3.7, branch connections must be made using materials listed in Part 2.
- F. Install shutoff duty / isolation valve close to supply and return mains on each branch connection. Install shutoff duty / isolation valve at supply and return connection to each piece of equipment, arranged to allow service, maintenance, and equipment removal without system shutdown. Where only one piece of equipment is connected to a branch line, only the shutoff duty valves at the supply and return branch connections are required. Each piece of equipment must have an individual shutoff valve on the supply and return.
- G. Install piping to conserve building space and to avoid interference with use of space.
- H. Group piping whenever practical at common elevations.
- I. Sleeve pipe passing through partitions, walls and floors. When installed as part of a UL-listed fire rated assembly, the sleeve shall meet the requirements of listing. Refer to Division 23 Section "Mechanical General Provisions" for additional sleeve and mechanical sleeve seal requirements.

- J. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078413 and Division 23 Section "Mechanical General Provisions."
- K. Slope piping and arrange to drain at low points.
- L. Install piping to allow for thermal expansion and contraction without stressing pipe, joints, or connected equipment. Install pipe expansion loops, offsets, swing joints, expansion joints, anchors, supports, and pipe alignment guides as indicated on drawings and as determined necessary by delegated design. Refer to Section 23 05 16 for additional requirements, including hydronic systems packed slip expansion joints.
- M. Pipe miters may be implemented by the Installing Contractor in accordance with ASME B31.1 (and not ASME B31.9) limitations. Generally, larger miter angles are permitted as the pipe diameter decreases, and also as the pipe wall thickness increases. As a quick reference, based upon the herein specified standard weight carbon steel piping, the following are the range of maximum permitted miter angles:
 - 1. NPS 2 to NPS 10 hydronic service carbon steel piping: 4.77 to 7.02 degrees.
 - 2. NPS 12 to NPS 24 hydronic service carbon steel piping: 3.21 to 4.43 degrees
 - 3. Refer to ASME B31.1 Section 104.3.3 and Appendix D, Table D-1, for specific limitations based upon pipe size and weights. Wherever a greater angle is required than a miter permits, contractor shall use cut elbows in lieu of multiple/segmented miters.
- N. Inserts:
 - 1. Refer to Division 23 Section "Hangers and Supports for HVAC Piping and Equipment" for Steel or Malleable Concrete Inserts (MSS Type 18) requirements.
 - 2. Provide inserts for placement in concrete formwork.
 - 3. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- O. Support vertical piping at each floor and/or as specified in the applicable code. Piping 2" (63mm) and smaller shall be installed with mid-story guides.
- P. Firestopping: Install per requirements found in Division 23 Section "Mechanical General Provisions."
- Q. Pipe Hangers and Supports:
 - 1. Install in accordance with Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." For steel piping, comply with requirements according to that Section for maximum spacing. For copper piping, comply with requirements that follow below for maximum spacing. For plastic piping (where permitted), comply with requirements published by the plastic piping manufacturer, ASME B31.9, and the applicable mechanical code for hanger and support requirements, including maximum spacing. Plastic piping support spacing requirements may vary (as they do for PP-RCT) based upon design temperature, SDR, and pipe size.
 - 2. Install in accordance with ASME B31.9, MSS SP-58, MSS SP-69, and MSS SP-89.
 - 3. Support horizontal piping as scheduled.
 - 4. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
 - 5. Place hangers within 12 inches of each horizontal elbow.
 - 6. Use hangers with 1-1/2 inches minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 7. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.

8. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
9. Provide copper plated hangers and supports for copper piping.
10. For heating hot water and any other hot hydronic systems, arrange piping and supports suitable to accommodate thermal expansion and comply with Division 23 Section "Expansion Fittings and Loops for HVAC Piping."
- R. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Division 23 Section "HVAC Piping Insulation."
- S. Select system components with pressure rating equal to or greater than system design (working) pressure.
- T. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 083113.
- U. Install valves with stems upright or horizontal, not inverted.
- V. Refer to Division 23 Section "HVAC Valves" for selection and proper application of ball valves and butterfly valves in hydronic application.
- W. Pump-Discharge Check Valves:
 1. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
 2. NPS 2-1/2 and Larger: Iron, center-guided, metal-seat check valves.
- X. Bronze Swing Check Valves NPS 2 and smaller for use in chilled water, heating water and condenser water: Class 125 or Class 150, bronze disc. Use nonmetallic disc for open-loop condenser-water valves.
- Y. Iron Swing Check Valves NPS 2-1/2 and Larger for use in chilled water, heating water and condenser water: Class 125, metal seats. UL Listed in heating-water service.
- Z. Iron, Center-Guided Check Valves NPS 2-1/2 and Larger for use in chilled water, heating water and condenser water: Class 125, globe, metal seat. At discharge of all pumps where check valve is located within 6 pipe diameters of pump discharge. Size per manufacturer's recommendations.
- AA. Relief Valve Installation: Refer to requirements of Division 23 Section "Hydronic Specialties."
- BB. Refer to Division 23 Sections "Water Source Heat Pumps," "Water-to-Water Heat Pumps," "Air Coils," and "Convection Heating and Cooling Units" for hose kit requirements.

3.03 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 23 Section "Mechanical General Provisions."
- B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.
- C. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article. Welding Filler Metals: Comply with AWS D10.12. Comply with the ASME Boiler and Pressure Vessel Code: Section II, Part C, for materials appropriate for pipe being welded.

3.04 PIPE JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and basic piping joint construction requirements specified in Division 23 Section "Mechanical General Provisions." Welded pipe joints and soldered joints are to meet the requirements therein.

3.05 FIELD TESTING

- A. Reference Division 23 Section "Mechanical General Provisions" for Field Testing requirements, including hydrostatic pressure tests.

3.06 SCHEDULES

- A. Permissible Piping Systems materials.
 - 1. Furnish a deductive alternate price for owners' consideration to furnish mechanical press seal joints and pressed ends, to the extent the contractor prefers to utilize such products in lieu of those specified. Mechanical press seal joints furnished shall be only ProPress as manufactured by Viega. No other manufacturer's products will be permitted. ProPress components shall be installed per manufacturer's written instructions and by trained and currently certified installers. Submittal of such training and manufacturer certification shall be required before the start of work.
 - 2. Heating Water Piping, Above Ground, 2" and smaller.
 - a. Hard copper, soldered. Threaded or soldered valves and hydronic specialties. Grooved mechanical joints, associated mechanical couplings, and mechanical press seal joints will not be accepted.
 - 3. Heating Water Piping, Above Ground, 2-1/2" and larger.
 - a. Steel, welded. Grooved mechanical joints, associated mechanical couplings, and mechanical press seal joints will not be accepted.
 - 4. Relief Valve Piping: Same materials and joining methods as for piping specified for the service in which relief valve is installed.
- B. Hanger Spacing for Copper Tubing.
 - 1. 1/2 inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. 1 inch and 1-1/4 inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. 1-1/2 inch and 2 inch: Maximum span, 8 feet; minimum rod size, 3/8 inch.
- C. Hanger Spacing for Steel Piping. Refer to Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

END OF SECTION

SECTION 23 23 00
REFRIGERANT PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping.
- B. Refrigerant.
- C. Moisture and liquid indicators.
- D. Valves.
- E. Strainers.
- F. Check valves.
- G. Filter-driers.
- H. Solenoid valves.
- I. Expansion valves.
- J. Receivers.
- K. Flexible connections.

1.02 RELATED REQUIREMENTS

- A. Section 078413 - Penetration Firestopping: Through-penetration firestop systems.
- B. Section 083113 - Access Doors and Frames.
- C. Section 23 07 16 - HVAC Equipment Insulation.
- D. Section 23 07 19 - HVAC Piping Insulation.
- E. Section 26 05 83 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. AHRI 495 - Performance Rating of Refrigerant Liquid Receivers; 2005.
- B. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; 2015.
- C. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications; 2015.
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.
- E. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; 2013.
- F. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2013.
- G. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 1992 (Reapproved 2008).
- H. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011-AMD 1.
- I. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2009.
- J. ANSI/ASHRAE Standard 15, Safety Standard for Refrigeration Systems; 2024, with all Addenda and Errata.
- K. ANSI/ASHRAE Standard 15.2, Safety Standard for Refrigeration Systems in Residential Applications; 2024, with all Addenda and Errata.
- L. ANSI/ASHRAE Standard 34, Designation and Safety Classification of Refrigerants; 2024 with all Addenda and Errata.
- M. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.
- N. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.

- O. UL 429 - Electrically Operated Valves; Current Edition, Including All Revisions.

1.04 SYSTEM DESCRIPTION

- A. Provide pipe hangers and supports in accordance with ASME B31.5 unless indicated otherwise.

1.05 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.
- C. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.
- D. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of Metal Channel (Strut) Framing Systems, trapeze, multiple pipe, and riser support hangers.
- E. Test Reports: Indicate results of leak test, acid test.
- F. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.
- G. Submit welders and brazers certification of compliance with ASME BPVC-IX.
- H. Project Record Documents: Field survey and document actual locations and sizes of refrigerant equipment, piping, transitions, pipe fittings, valves, refrigeration accessories, etc. Record changes in pipe location and additional fittings used. Record drawings are to be contractor-prepared by modifying the source digital files (typically AutoCAD and/or Revit to be furnished by the Design Engineer.) Submit both the modified digital files as well as PDF format record drawings. Refer to Division 23 Section "Mechanical General Provisions" and the Division 1 specifications for additional record drawing requirements.
- I. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

1.06 QUALITY ASSURANCE

- A. Designer Qualifications: Design piping system under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

1.07 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.5 for installation of piping system.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store piping and specialties in shipping containers with labeling in place.
- B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.
- C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. Filter-Driers:
 - 1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.
- B. Solenoid Valves:
 - 1. Use in liquid line of systems operating with single pump-out or pump-down compressor control.
 - 2. Use in liquid line of single or multiple evaporator systems.

- C. Receivers:
 - 1. Use on systems 10 tons and larger, sized to accommodate pump down charge.
 - 2. Use on systems with long piping runs.
- D. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

2.02 PIPING

- A. Copper Tube: ASTM B 280, ACR drawn temper (hard).
 - 1. Fittings: ASME B16.22 wrought copper.
 - 2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy.
 - 3. Mechanical press seal joints and pressed ends will not be permitted.
- B. Pipe Supports and Anchors:
 - 1. Conform to ASME B31.5.
 - 2. Copper refrigerant piping in horizontal, vertical, and inverted installations to be supported from insulation clamps / clips as specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment" to maintain continuous insulation of piping system. Comply with manufacturer's installation instructions.
 - 3. Refrigerant piping to be supported from Metal Channel (Strut) Framing Systems as indicated in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
 - 4. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
 - 5. Refer to Division 23 Section "Hangers and Supports for HVAC Piping and Equipment" for "NONPENETRATING ROOFTOP SUPPORTS FOR LOW-SLOPE ROOFS."

2.03 REFRIGERANT

- A. Refrigerant to be as noted on plans for the scheduled equipment.
- B. Refrigerant type to be compliant with all current requirements.

2.04 MOISTURE AND LIQUID INDICATORS

- A. Indicators: Single port type, UL listed, with copper or brass body, flared or soldered ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

2.05 VALVES

- A. Diaphragm Packless Valves:
 - 1. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, soldered or flared ends, with positive backseating; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.
- B. Packed Angle Valves:
 - 1. Forged brass or nickel plated forged steel, forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, soldered or flared ends; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.
- C. Ball Valves:
 - 1. Two piece bolted forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psi and maximum temperature of 300 degrees F.
- D. Service Valves:

1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or soldered ends, for maximum pressure of 500 psi.

2.06 STRAINERS

- A. Straight Line or Angle Line Type:
 1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi.

2.07 CHECK VALVES

- A. Globe Type:
 1. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum temperature of 300 degrees F and maximum working pressure of 425 psi.
- B. Straight Through Type:
 1. Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psi and maximum temperature of 200 degrees F.

2.08 FILTER-DRIERS

- A. Performance:
 1. Pressure Drop: 2 psi, maximum, when operating at full connected evaporator capacity.
 2. Design Working Pressure: 350 psi, minimum.
- B. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns, with secondary filtration to 20 microns; of construction that will not pass into refrigerant lines.
- C. Construction: UL listed.
 1. Connections: As specified for applicable pipe type.

2.09 SOLENOID VALVES

- A. Valve: AHRI 760 I-P, pilot operated, copper, brass or steel body and internal parts, synthetic seat, stainless steel stem and plunger assembly (permitting manual operation in case of coil failure), integral strainer, with flared, soldered, or threaded ends; for maximum working pressure of 500 psi.
- B. Coil Assembly: UL 429 UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box with pilot light.

2.10 ELECTRONIC EXPANSION VALVES

- A. Valve:
 1. Brass body with flared or soldered connection, needle valve with floating needle and machined seat, stepper motor drive.
- B. Evaporation Control System:
 1. Electronic microprocessor based unit in enclosed case, proportional integral control with adaptive superheat, maximum operating pressure function, preselection allowance for electrical defrost and hot gas bypass.
- C. Refrigeration System Control: Electronic microprocessor based unit in enclosed case, with proportional integral control of valve, on/off thermostat, air temperature alarm (high and low), solenoid valve control, liquid injection adaptive superheat control, maximum operating pressure function, night setback thermostat, timer for defrost control.

2.11 RECEIVERS

- A. Internal Diameter 6 inch and Smaller:

1. AHRI 495, UL listed, steel, brazed; 400 psi maximum pressure rating, with tappings for inlet, outlet, and pressure relief valve.
- B. Internal Diameter Over 6 inch:
 1. AHRI 495, welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; 400 psi with tappings for liquid inlet and outlet valves, pressure relief valve, and magnetic liquid level indicator.

2.12 FLEXIBLE CONNECTORS

- A. Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure of 500 psi.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

- A. Install refrigeration specialties in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and avoid interference with use of space.
- D. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Pipe Hangers and Supports:
 1. Install in accordance with ASME B31.5.
 2. Support horizontal piping as indicated.
 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 4. Place hangers within 12 inches of each horizontal elbow.
 5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 6. Provide copper plated hangers and supports for copper piping.
- G. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
- H. Provide clearance for installation of insulation and access to valves and fittings.
- I. Provide access to concealed valves and fittings. Coordinate size and location of access doors with Section 083113.
- J. Flood piping system with nitrogen when brazing.
- K. Insulate piping and equipment.
- L. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.
- M. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.
- N. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.
- O. Fully charge completed system with refrigerant after testing.
- P. Provide electrical connection to solenoid valves. See Section 26 05 83.

3.03 REFRIGERANT EQUIPMENT PRESSURE RELIEF VALVE VENTING

- A. Where refrigerant-containing equipment installed indoors is factory furnished with a refrigerant pressure relief valve, contractor shall install discharge (vent) piping connected to the relief valve in accordance with the adopted versions of ASHRAE Standard 15 and ASME Boiler and Pressure Vessel Code: Section VIII or XIII, Division 1, paragraphs UG-154 and UG-155. This shall apply unless the manufacturer's installation instructions do not mention the potential need, such as may be the case for smaller single zone systems. Install relief valve discharge (vent) piping without valves except as noted below.
- B. Pipe vent to atmosphere outside building and away from windows, outdoor intake louvers, and other such concerns.
- C. Relief valves are to be independently vented to atmosphere, even though relief valves headered to a common vent are not prohibited by any code. However, paragraph 9.4.7 of ASHRAE Standard 15-2022 provides common discharge header language below which will be acceptable so long as a stop valve is installed as noted for each relief valve.
 - 1. When relief valves are connected to discharge to a common discharge header, as described in Section 9.7.9.3, a full area stop valve is not prohibited from being installed in the discharge pipe between the relief valve and the common header. When such a stop valve is installed, a locking device shall be installed to ensure that the stop valve is locked in the open position. This discharge stop valve shall not be shut unless one of the following conditions exists:
 - a. A parallel relief valve is installed that protects the system or vessels.
 - b. The system or vessels being protected have been depressurized and are vented open to the atmosphere.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Test refrigeration system in accordance with ASHRAE Standard 15. Test shall include Piping System Strength Test and Leakage Test per ASHRAE Standard 15. Pressure Test and Vacuum Test minimum durations to be as specified in ASHRAE Standard 15, Table 9-7 plus adequate time to then look for leaks.
- C. Pressure test system with oxygen-free dry nitrogen. Test pressure shall not exceed maximum allowable pressure for any pipe, fitting, vessel, valve, instrument, or other component in system under test. Look for leaks with electronic leak detector with hydrogen or helium tracer gas premixed in the nitrogen and/or using soap test looking for bubbles. Test all joints to no leakage. Repair leaks and retest until no leaks exist.

3.05 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
 - 1. 1/2 inch, 5/8 inch, and 7/8 inch OD: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. 1-1/8 inch OD: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. 1-3/8 inch OD: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 - 4. 1-5/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 5. 2-1/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 6. 2-5/8 inch OD: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - 7. 3-1/8 inch OD: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 - 8. 3-5/8 inch OD: Maximum span, 11 feet; minimum rod size, 1/2 inch.
 - 9. 4-1/8 inch OD: Maximum span, 12 feet; minimum rod size, 1/2 inch.

END OF SECTION

SECTION 23 24 10
HVAC VALVES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Bronze Ball Valves
 - 2. Cast Iron Butterfly Valves
- B. This Division 23 Section shall apply in every respect to temporary piping shown on drawings. Temporary piping shall be removed, and areas restored to pre-existing conditions upon satisfactory commissioning of the permanent piping, unless otherwise indicated on the drawings.

1.02 RELATED REQUIREMENTS

- A. Section 232113 - Hydronic Piping for hydronic system check valves.

1.03 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: For each type of valve indicated.

1.04 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions (except where another dimensional standard is identified below) and design criteria.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

- A. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
 - 1. Hydronic system minimum working pressures and temperatures are identified in Division 23 Section "Hydronic Piping" and shall apply to valves in that system.
- B. Valve Sizes: Same as upstream piping unless otherwise indicated.
- C. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
 - 2. Handwheel: For valves other than quarter-turn types.
- D. Furnish 2-inch stem extensions for ball valves installed in insulated piping systems. Along with the extended operating handle, furnish protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
- E. Valve-End Connections:
 - 1. Flanged: With flanges according to ASME B16.5-2020.
 - 2. Threaded: With threads according to ASME B1.20.1.
 - 3. Solder Joint: With sockets according to ASME B16.18.

2.02 BRONZE BALL VALVES

- A. Two-Piece, Bronze Ball Valves ("Non-critical" ball valve as noted in Articles 3.4 and 3.5):
 - 1. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Nibco T-585-70 (threaded), Nibco T-585-70-HC (threaded x hose) in compliance with specification, up to and including 2 inches (Basis of design.)

- b. Apollo Valves, Aalberts Integrated Piping Systems.
 - c. Milwaukee
 - d. Hammond Valve
 - e. Watts Industries, Inc.
 - f. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- 2. Bronze two piece body with full size port, chrome plated brass ball, teflon seats and stuffing box ring, bronze trim, blowout-proof stem, lever handle, threaded ends, 600 psi non-shock cold working pressure, conforming to MSS SP-110, and extended handle. Furnish with hose connection and cap for low point drain service.
- 3. End connections: Threaded or soldered. Pressed and grooved valve ends will not be accepted.
 - a. Furnish a deductive alternate price for owners' consideration to furnish mechanical press seal joints and pressed ends, to the extent the contractor prefers to utilize such products in lieu of those specified. Mechanical press seal joints furnished shall be only ProPress as manufactured by Viega. No other manufacturer's products will be permitted. ProPress components shall be installed per manufacturer's written instructions and by trained and currently certified installers. Submittal of such training and manufacturer certification shall be required before the start of work.
- 4. For good corrosion resistance, bronze ball valve bodies shall meet one of these ASTM specs, which demonstrate less than 10% zinc: ASTM B61, ASTM B62, and ASTM B584 alloys ASTM C84400, ASTM C89833, and ASTM C89836.
- B. Three-Piece, Bronze Ball Valves ("Critical" ball valve as noted in Articles 3.4 and 3.5):
 - 1. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Milwaukee Valve 30BS0F02-XH in compliance with specification, up to and including 2 inches (Basis of Design)
 - b. Apollo Valves,
 - c. Hammond Valve
 - d. Watts Industries, Inc.
 - e. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
 - 2. Bronze three piece body with full size port, stainless steel ball, reinforced PTFE seats, lever handle, NPT female ends, 1000 WOG, conforming to MSS SP-110, extended handle, and blowout-proof stem.
 - 3. For good corrosion resistance, bronze ball valve bodies shall meet one of these ASTM specs, which demonstrate less than 10% zinc: ASTM B61, ASTM B62, and ASTM B584 alloys ASTM C84400, ASTM C89833, and ASTM C89836.
 - 4. End connections: Threaded or soldered. Pressed and grooved valve ends will not be accepted.
 - a. Furnish a deductive alternate price for owners' consideration to furnish mechanical press seal joints and pressed ends, to the extent the contractor prefers to utilize such products in lieu of those specified. Mechanical press seal joints furnished shall be only ProPress as manufactured by Viega. No other manufacturer's products will be permitted. ProPress components shall be installed per manufacturer's written

instructions and by trained and currently certified installers. Submittal of such training and manufacturer certification shall be required before the start of work.

2.03 CAST IRON BUTTERFLY VALVES

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Milwaukee Valve (Basis of Design)
 - a. ML223E series Rev. D for NPS 2-1/2 thru NPS 4 (lever operated)
 - b. ML323E series Rev D for NPS 6 thru NPS 12 (gear operated)
 - 2. Watts Industries, Inc.; Water Products Div.
 - 3. Hammond Valve
 - 4. Bray International, Inc., Series 31H
 - 5. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Body Style: Lug pattern. Suitable for installation between Class 125 or Class 150 flanges, although Class 150 is preferred where possible.
- C. Specifications: API-609 MSS SP-67 Type 1
- D. 200 psi Non-Shock WOG. Bi-Directional Dead End Service to 200 psi maximum. Bubble tight shut off.
- E. Body Material: ASTM A126 Cl. B cast iron.
- F. Disc Material: Aluminum/Bronze ASTM B148
- G. Packing: High Density, High Purity Graphite
- H. Stem: Type 416 Stainless Steel
- I. Liner Material, Seals: EPDM
- J. Operator:
 - 1. For NPS 2-1/2 thru NPS 4 provide lever operated. 10-position, pad lockable, ductile iron lever handle.
 - 2. For NPS 6 thru NPS 12 provide factory mounted cast iron body, weather resistant, gear operator.

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.
- F. Protect valves against corrosion during shipping and storage. Store in a dry and heated environment. Comply with all requirements to maintain manufacturer's warranty.

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 swing check valves for proper direction of flow and in horizontal position with hinge pin level.
- F. Refer to Division 23 Section "Hydronic Piping" for check valve requirements for hydronic systems.

3.03 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- B. Select valves, except wafer types, with the following end connections for use in hydronic systems:
 - 1. For Steel Piping, NPS 2-1/2 and larger: Use cast iron butterfly valves.
 - 2. For Copper Tubing, NPS 2 and Smaller: Use bronze ball valves, threaded or soldered-joint valve-ends.
- C. "Critical" valves for all hydronic services (to include Heating Water, Heat Pump Loop, Interior Ground Loop Geothermal, Chilled Water, etc.) shall be as follows:
 - 1. Those ball valves used to isolate more than one end-user (equipment, etc.)
 - 2. The first ball valve NPS 2 and smaller located in a branch connected to a header NPS 2½ or larger.
 - 3. Drain valve NPS 2 and smaller draining a header NPS 2½ or larger.
 - 4. Unless noted otherwise, sub-paragraphs 1 through 3 above shall not apply where the largest pipe main in the entire hydronic system is NPS 2 and smaller; that is, these valves need not be "Critical" valves. All valves which are not "Critical" shall be "Non-Critical".

3.05 HYDRONIC VALVE SCHEDULE

- A. Shut-Off Valves

Service	Pipe Size	Valve Type
Heating Water Piping	2" and Smaller	"Critical": Three-Piece, Bronze Ball Valves "Non-Critical": Two-Piece, Bronze Ball Valves
Heating Water Piping	2-1/2" and Larger	Cast Iron Butterfly Valves

3.06 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 21 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above center of pipe.
- E. Install valves in position to allow full stem movement.
- F. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.

2. Lift Check Valves: With stem upright and plumb.

3.07 JOINT CONSTRUCTION

- A. Refer to Division 23 Section "Mechanical General Provisions" for basic piping joint construction.
- B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.08 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.

END OF SECTION

SECTION 23 31 00
HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal ducts.
- B. Flexible ducts.
- C. Air plenums and casings.
- D. Cleaning of new duct installations.

1.02 RELATED REQUIREMENTS

- A. Section 07 8413 - Penetration Firestopping: Through-penetration firestop systems.
- B. Section 09 91 23 - Interior Painting: Weld priming, paint or coating.
- C. Section 23 07 13 - Duct Insulation: External insulation and duct liner.
- D. Section 23 33 00 - Air Duct Accessories.
- E. Section 23 33 19 - Duct Silencers.
- F. Section 23 36 00 - Air Terminal Units.
- G. Section 23 37 00 - Air Outlets and Inlets: Fabric air distribution devices.

1.03 REFERENCE STANDARDS

- A. ASHRAE (FUND) - ASHRAE Handbook - Fundamentals; 2013.
- B. ASHRAE Std 126 - Method of Testing HVAC Air Ducts; 2016.
- C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.
- D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- E. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.
- F. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable; 2015.
- G. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2014.
- H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- I. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2012.
- J. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements; 2012.
- K. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2013.
- L. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2013.
- M. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.
- N. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2015.
- O. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2014.
- P. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.
- Q. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; 2012, 2nd Edition.

- R. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; current edition, including all revisions.

1.04 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide data for duct materials.
- C. Shop Drawings: Indicate duct fittings, particulars such as gauges, sizes, welds, and configuration prior to start of work for all pressure class systems.
- D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate per appropriate seal class, following SMACNA (LEAK).
- E. Project Record Documents: Field survey and document actual locations and sizes of air moving equipment, ducts, duct fittings, air duct accessories, air outlets and inlets, etc. Record changes in fitting location and type. Show additional fittings used. Record drawings are to be contractor-prepared by modifying the source digital files (typically AutoCAD and/or Revit to be furnished by the Design Engineer.) Submit both the modified digital files as well as PDF format record drawings. Refer to Division 23 Section "Mechanical General Provisions" and the Division 1 specifications for additional record drawing requirements.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience, and approved by manufacturer.
- B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum 3 years of documented experience.

1.06 REGULATORY REQUIREMENTS

- A. Construct ductwork to NFPA 90A standards.

1.07 FIELD CONDITIONS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Provide UL Class 1 ductwork, fittings, hangers, supports, and appurtenances in accordance with NFPA 90A and SMACNA (DCS) guidelines unless stated otherwise.
- B. Provide metal duct unless otherwise indicated.
- C. Acoustical Treatment: Provide sound-absorbing liners and sectional silencers for metal-based ducts in compliance with Section 23 33 19.
- D. Duct Fabrication Requirements:
 - 1. Duct and Fitting Fabrication and Support: SMACNA (DCS) including specifics for continuously welded round and oval duct fittings.
 - 2. Use reinforced and sealed sheet-metal materials at recommended gauges for indicated operating pressures or pressure class.
 - 3. Construct tee's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.
 - 4. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.

5. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
6. Provide turning vanes of perforated metal with glass fiber insulation when an acoustical lining is required.
7. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.
- E. All Ducts: Galvanized steel, unless otherwise indicated.
- F. Duct pressure class requirements:
 1. AHU & Ventilation Supply: 4 inch w.g. pressure class, galvanized steel.
 2. Ventilation Air Return: 4 inch w.g. pressure class, galvanized steel.
 3. Ventilation Air Exhaust: 4 inch w.g. pressure class, galvanized steel.
 4. Ventilation Air Outdoor Air: 4 inch w.g. pressure class, galvanized steel.
 5. Terminal Unit Supply: 3 inch w.g. pressure class, galvanized steel.
 6. Terminal Unit Return: 3 inch w.g. pressure class, galvanized steel.
 7. General Exhaust: 4 inch w.g. pressure class, galvanized steel.
 8. Fan Coil Ductwork: 3 inch w.g. pressure class, galvanized steel.
 9. Outside Air Intake: 4 inch w.g. pressure class, galvanized steel.

2.02 MATERIALS

- A. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
- B. Hanger Fasteners: Attach hangers to structure using appropriate fasteners.

2.03 METAL DUCTS

- A. Material Requirements:
 1. Galvanized Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating.
- B. Round Spiral Duct:
 1. Round spiral lock seam duct with galvanized steel outer wall.
- C. Connectors, Fittings, Sealants, and Miscellaneous:
 1. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
 - a. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
 - b. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
 2. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
 3. Hanger Fasteners: Attach hangers to structure using appropriate fasteners as follows:
 - a. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
 - b. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
 - c. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
 - d. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
 - e. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
 4. Cutting, notching and boring holes of steel floor / roof decking shall be as prescribed by the registered design professional.

2.04 FLEXIBLE DUCTS

- A. Flexible Air Ducts with Rip-Resistant Scrim:

1. UL 181, Class 1, aluminum laminate and polyester vapor barrier with rip-resistant scrim reinforcement supported by helically wound spring steel wire.
2. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
3. Pressure Rating: From 10 in-wc to 0.5 in-wc negative.
4. Maximum Velocity: 4,000 fpm.
5. Temperature Range: Minus 20 to 175 degrees F.

2.05 AIR PLENUMS AND CASINGS

- A. Fabricate in accordance with SMACNA (DCS) for indicated operating pressures indicated.
- B. Minimum Fabrication Requirements:
 1. Fabricate acoustic plenum or casing with reinforcing turned inward.
 2. Provide 16 gauge, 0.059-inch sheet steel back facing and 22 gauge, 0.029-inch perforated sheet steel front facing with 3/32 inch diameter holes on 5/32 inch centers.
 3. Construct panels 3 inches thick packed with 4.5 pcf minimum glass fiber insulation media, on inverted channel of 16 gauge, 0.059-inch sheet steel.
 4. Mount floor mounted plenum or casings on 4 inch high concrete curbs. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, provide liner of galvanized 18 gauge, 0.052-inch expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.
- C. Access Doors:
 1. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.
 2. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles.
 3. Provide clear wire glass observation ports, minimum 6 by 6 inch size.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. Install products following the manufacturer's instructions.
- C. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering the ductwork system.
- D. Flexible Ducts: Connect to metal ducts with stainless steel hose clamp-type draw bands.
- E. Duct sizes indicated are inside precise dimensions. For lined ducts, maintain sizes inside lining.
- F. Provide openings in ductwork as indicated to accommodate thermometers and controllers. Provide pilot tube openings as indicated for testing of systems, complete with metal can with spring device or screw to insure against air leakage. For openings, insulate ductwork and install insulation material inside a metal ring.
- G. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- H. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with a crimp in the direction of airflow.
- I. Use double nuts and lock washers on threaded rod supports.
- J. Connect terminal units to supply ducts directly or with one foot maximum length of flexible duct. Do not use a flexible duct to change direction.
- K. Connect diffusers or light troffer boots to low-pressure ducts directly or with 5 feet maximum length of flexible duct held in place with strap or clamp.

- L. Set plenum doors at 6 to 12 inches above the floor. Arrange door swings so that fan static-pressure holds the door in a closed position.
- M. At exterior wall louvers, seal duct to louver frame and install blank-out panels.
- N. Painting: Provide surface finish as indicated on drawings and Sections 09 91 13 and 09 91 23.

3.02 DUCT INSTALLATION

- A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards-- Metal and Flexible," unless otherwise indicated.
- B. Install round ducts in lengths not less than 12 feet unless interrupted by fittings.
- C. Install ducts with fewest possible joints.
- D. Install fabricated fittings for changes in directions, size, and shape and for connections.
- E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.
- F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness, except where access panels are required.
- I. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
- J. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.
- K. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
- L. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.
- N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Air Duct Accessories." Firestopping materials and installation methods are specified in Division 7 Section "Penetration Firestopping."
- O. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by applicable building codes. Refer to SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
- P. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction Guidelines." See further below for more information.

3.03 DUCT SEALING

- A. Seal ducts in both conditioned and unconditioned spaces to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Supply-Air Ducts: Seal Class A.
 - 2. Exhaust Ducts: Seal Class A.

3. Return-Air Ducts: Seal Class A.
- B. SMACNA Seal Class A requires sealing of joints, seams, and all wall penetrations, and provides a formula to determine the installed duct Leakage Class (C_L , rate of air leakage) based upon the measured leakage rate, F (cfm per 100 sq.ft.), and the static pressure of the test. The maximum duct Leakage Class (C_L) shall not exceed the following:
 1. Rectangular metal duct Leakage Class (C_L): 6 cfm leakage per 100 sq.ft. @ 1 in wg.
Because this specification Section requires minimum 3 inch w.g. pressure class duct construction, the Commercial Building Energy Standards actually require maximum C_L of 4 cfm leakage per 100 sq.ft. @ 1 in wg.
 2. Round metal duct Leakage Class (C_L): 3 cfm leakage per 100 sq.ft. @ 1 in wg.
- C. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.04 HANGING AND SUPPORTING

- A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
- B. Support vertical ducts at maximum intervals of 16 feet and at each floor.
- C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
- D. Install concrete inserts before placing concrete.
- E. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

3.05 CONNECTIONS

- A. Make connections to equipment with flexible connectors according to Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.06 FIELD QUALITY CONTROL

- A. 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: Test 100 percent of the duct mains. Randomly test representative branch duct sections totaling no less than 50 percent of total installed branch ducts.
 - b. Return Ducts: Test 100 percent of the duct mains. Randomly test representative branch duct sections totaling no less than 50 percent of total installed branch ducts.
 - c. Exhaust Ducts: Test 100 percent of the duct mains. Randomly test representative branch duct sections totaling no less than 50 percent of total installed branch ducts.
 - d. Outdoor Air Ducts: Test 100 percent of the duct mains. Randomly test representative branch duct sections totaling no less than 50 percent of total installed branch ducts.
- B. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:
 1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing to the Construction Manager and Clerk of the Works or other approved owner's representative.
3. Determine leakage from entire system or section of system by relating leakage to surface area of test section.
4. Determine duct leakage test pass / fail based upon the following. Must pass both.
 - a. Must be less than allowable leakage for SMACNA Seal Class noted above.
 - b. Must have no audible or perceptable leakage in normal operation.
5. Remake leaking joints and retest until leakage does not exceed maximum duct Leakage Class (CL). If initial duct leakage tests comprising more than 5% of the total project branch ducts surface area fail allowable leakage, leakage test is then required for 100 percent of total installed supply, return, exhaust, and outside air branch ducts.
6. Remake leaking joints so there is no audible or perceptable leakage in normal operation.

3.07 CLEANING OF NEW DUCT INSTALLATIONS

- A. Follow SMACNA's "Duct Cleanliness for New Construction Guidelines", 2000 or latest edition.
 1. At minimum new duct installation shall meet the Intermediate Level of Duct Cleanliness. While the Guidelines shall govern and are more detailed, in general Intermediate Level requires clean and dry storage and working areas, internal surfaces of duct wiped down to remove excess dust immediately prior to installation, and open ends of installed ductwork to be sealed nightly.
 2. Advanced Level of Duct Cleanliness shall be the minimum requirements for any LEED project and any area of a project where a cleanroom requirement is identified. Advanced Level, in addition to the provisions for Intermediate Level, requires ductwork to be sealed during shipment and storage, and no internal labels. Again, the Guidelines shall govern and are more detailed.
 3. No excess dust or any debris shall be allowed to enter duct after wipe down. Construction Manager shall be responsible for verifying and enforcing these Guidelines.
 4. If the Guidelines are not followed initially, Contractor shall be responsible for all remedial actions required to produce the equivalent Level of Duct Cleanliness. This may include adding access doors. Work is to comply with Confined Spaces in Construction standard 29 CFR 1926 Subpart AA (the 1926.12xx-series) for "Permit Required Confined Spaces."

END OF SECTION

SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air turning devices/extractors.
- B. Backdraft dampers - metal.
- C. Duct access doors.
- D. Duct test holes.
- E. Flexible duct connections.
- F. Ultra-low leakage manual volume dampers
- G. Splitter Dampers
- H. Control dampers.
- I. Birdscreen.
- J. Air measuring control dampers.

1.02 RELATED REQUIREMENTS

- A. Section 078413 - Penetration Firestopping.
- B. Section 23 05 48 - Vibration and Seismic Controls for HVAC.
- C. Section 23 31 00 - HVAC Ducts and Casings.
- D. Section 23 36 00 - Air Terminal Units: Pressure regulating damper assemblies.
- E. Section 25 35 13 - Integrated Automation Actuators and Operators: Damper operators.

1.03 REFERENCE STANDARDS

- A. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2012.
- B. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2012.
- C. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.
- D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.
- E. UL 33 - Safety Heat Responsive Links for Fire-Protection Service; Current Edition, Including All Revisions.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers.
- D. Project Record Drawings: Record actual locations of access doors and test holes.

1.05 QUALITY ASSURANCE

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

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.01 AIR TURNING DEVICES/EXTRACTORS

- A. Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.

2.02 BACKDRAFT DAMPERS - METAL

- A. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Extruded aluminum, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.03 DUCT ACCESS DOORS

- A. Fabricate in accordance with SMACNA (DCS) and as indicated.
- B. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 1 inch thick insulation with sheet metal cover.
 - 1. Less Than 12 inches Square: Secure with sash locks.
 - 2. Up to 18 inches Square: Provide two hinges and two sash locks.
 - 3. Up to 24 by 48 inches: Three hinges and two compression latches with outside and inside handles.
- C. Access doors with sheet metal screw fasteners are not acceptable.
- D. Service panels sealed with gaskets, duct sealants, mastic or tape will not be an acceptable substitution for Duct Access Doors.

2.04 DUCT TEST HOLES

- A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

2.05 FIRE DAMPERS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Greenheck
 - 2. Nailor Industries, Inc: www.nailor.com/#sle.
 - 3. Ruskin Company: www.ruskin.com/#sle.
 - a. Model FD-60, air foil style, rectangular ducts, 1-1/2 hour fire rating, Basis of design.
 - 4. United Enertech: www.unitedenertech.com/#sle.
 - 5. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.
- C. Multiple Blade Dampers: 16 gauge, 0.0598 inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.
- D. Provide factory sleeve and collar for each damper.
- E. Fusible Links: UL 33, separate at 165 degrees F with adjustable link straps for combination fire/balancing dampers.

2.06 FLEXIBLE DUCT CONNECTIONS

- A. Fabricate in accordance with SMACNA (DCS) and as indicated.
- B. Flexible Duct Connections: Fabric crimped into 24 gauge galvanized steel edging strip.
 - 1. Indoor applications. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric. Minimum density 30 oz per sq yd. Meets NFPA 90A, 90B, and 701. UL 723

compliant. Suitable for kitchen exhaust. Airtight and waterproof at 10 in. w.g. to 10 in. negative w.g. Meet or exceed SMACNA steel requirements.

2. Outdoor applications. Fabric: UL listed fire-retardant hypalon coated woven glass fiber fabric. Minimum density 24 oz per sq yd. Meets NFPA 90A, 90B, and 701. UL 723 compliant. Suitable for kitchen exhaust. Airtight and waterproof at 10 in. w.g. to 10 in. negative w.g. Meet or exceed SMACNA steel requirements. UV resistant.

2.07 ULTRA-LOW LEAKAGE MANUAL VOLUME DAMPERS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 1. Nailor Industries, Inc. (Basis of Design)
 2. Ruskin Company
 3. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Multiple- or single-blade, parallel- or opposed-blade design as indicated, ultra-low leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications. Provide SMACNA approved volume dampers.
- C. Round Dampers
 1. Basis-of-Design Products: Subject to compliance with the requirements, provide Nailor Industries model 1090 round 4" to 24" manual volume dampers with accessory option model HLQ2 hand locking quadrant with 2" standoff bracket. See Rectangular Dampers below for applications involving round ducts larger than 24".
 2. Alternate products which may be acceptable, subject to compliance with the requirements: Ruskin CDRS25 (round balancing damper).
 3. Products which do not meet this Ultra-Low Leakage Manual Volume Damper specification will be rejected. Based upon prior experience, these include:
 - a. Buckley 3300 takeoff damper. These are lighter duty, are not supplied with locking quadrant and standoff mounting bracket for insulated duct, and do not have blade and bearing seals.
 4. Steel Frames: 20 ga with stiffening beads.
 5. Blades: 2x20 ga steel, laminated toge
 6. Blade Seals: Cross-linked polyethylene.
 7. Shaft: 1/2" dia., extending 6" beyond frame.
 8. High quality hand locking quadrants. Include 2 inch standoff bracket for insulated ducts.
 - a. 1/2" dia Celcon bearings.
 9. Round dampers shall have less than 10 cfm per square foot leakage at 4" w.g., per AMCA Standard 500-D, Fig 5.5.
- D. Rectangular Dampers
 1. Basis-of-Design Products: Subject to compliance with the requirements, provide Nailor Industries models 1110 (a single parallel blade, for ducts less than or equal to 9" high) and 1120 (opposed blade, for ducts greater than or equal to 10" high) rectangular manual volume dampers with accessory option model CDQUAD hand locking quadrant with HQ2 2" standoff bracket. For round ducts larger than 24", furnish Nailor Industries model 1120CR (with round transition) or similar shop-fabricated transition.
 2. Alternate products which may be acceptable, subject to compliance with the requirements: Ruskin CD60 (rectangular balancing damper). Ruskin CD40 Thinline

would be required for rectangular balancing dampers less than 18" high since those have 4" wide blades.

3. Products which do not meet this Ultra-Low Leakage Manual Volume Damper specification will be rejected. Based upon prior experience, these include:
 - a. Nailor 1810/1820 rectangular manual volume dampers. These are not airfoil or low leakage design.
4. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts. Provide double flange type frame for rectangular dampers 8" high and under. Do not use channel frame (which are set inside duct) for rectangular dampers 8" high and under.
5. Blades: Airfoil shape, 0.064-inch-thick, galvanized sheet steel.
6. Blade Seals: Vinyl.
7. Blade Axles: Round with seals at penetrations, galvanized steel.
8. Shaft: Round with seals at penetrations
9. Tie Bars and Brackets: Galvanized steel.
10. High quality hand locking quadrants. Include 2 inch standoff bracket for insulated ducts.
 - a. Self-lubricating bronze bearings.
11. Rectangular dampers shall be Ultra-low Leakage, Class 1A (less than 8 cfm per square foot leakage at 4" w.g), per AMCA Standard 500-D-98.

2.08 SPLITTER DAMPERS

- A. Material: Same gage as duct to 24 inches size in either direction, and two gages heavier for sizes over 24 inches.
- B. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
- C. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw .

2.09 CONTROL DAMPERS

- A. Control dampers shall be as specified on the drawings and shall meet the following minimum construction standards. Coordinate also with Division 25 Section "HVAC Instrumentation and Controls" and mechanical drawings for additional requirements as well as responsibilities for furnishing and installing control dampers and damper actuators.
 1. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Ruskin Company, model TED50XT (Basis of design for thermally-isolated control damper).
 - b. Ruskin Company, model CD-40, 16" duct and below, CD-60 for 18" duct and above (basis of design for interior control dampers).
 - c. TSI, Inc.
 - d. Tamco, Series 9000
 - e. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
 2. Low temperature, foam-injected, thermally-isolated control dampers: Dampers frame shall be 5" x 1" x .125" minimum thickness 6063T6 extruded aluminum hat channel with hat mounting flanges on both sides of the frame. Each corner shall include two die formed internal braces that are machine staked for maximum rigidity. Blades shall be

airfoil type extruded aluminum (maximum 6" depth) with thermal break located underneath tooled blade edge seal pocket. Damper blades to be provided with thermal protecting high density CFC foam. Blade edge seals shall be Santoprene type or equivalent mechanically locked into the blade edge. Adhesive or clip-on type seals are unacceptable. Jamb seals shall be polycarbonate compression type to prevent leakage between blade end and damper frame. Blade end overlapping frame is unacceptable. Multiple section dampers must have factory installed jackshafts unless clearly eliminated by engineer. Bearings shall be corrosion resistant, stainless steel. Axles shall be hexagonal shaped, positively locked into the damper blade. Linkage shall be concealed out of airstream, within the damper frame to reduce pressure drop and noise generation. Temperature limits shall be -40°F to +165°F maximum. Submittal must include leakage, maximum air flow and maximum pressure ratings based on testing performance in accordance with AMCA std. 500D for Air Performance, Air Leakage and Thermal Efficiency. Maximum damper leakage shall not exceed 8 cfm/sq. ft. @ 4" w.g. Thermal efficiency shall be no less than 300%. Damper shall be Ruskin model TED50XT or equal approved in writing by engineer.

- B. Quadrants:
 - 1. Provide locking, indicating quadrant regulators on single and multi-blade manual volume dampers.
 - 2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
 - 3. Where rod lengths exceed 30 inches provide regulator at both ends.

2.10 BIRDSCREEN

- A. Birdscreen: To be 304 Stainless Steel, 0.5" x 0.5" wire mesh, woven-intercrimp weave, 16 ga. wire, and 79% free area.
- B. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. McNichols, Item 3805064810 (Basis of Design)
 - 2. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

2.11 AIR MEASURING CONTROL DAMPERS

- A. Manufacturers
 - 1. Ebtron, Inc; _____: www.ebtron.com/#sle.
- B. Factory-Mounted Assembly Requirements:
 - 1. Damper Unit or Multi-Unit:
 - a. Construction: In-duct frame made of extruded aluminum with V or 3V blades for low to medium pressure applications, zinc-plated steel hardware, frame-mounted shaft bearings, frame-assembly sleeve, and silicone seals at frame and blade ends.
 - b. Control: Opposed blade modulation by damper actuator(s) from air measuring sensor transmitter-controller unit.
 - 2. Air Measuring Sensor Transmitter-Controller:
 - a. Transmitter: Five percent accuracy, adjustable zero and span, 10 to 1 turndown, 0.1 percent of calibrated span linearity, 30 to 50 millisecond response time, minimum overpressure of 150 percent over highest range value, alphanumeric indicating display, wired or wireless connectivity for configuration, and terminal strip within enclosed electronic components.

- b. Hardwired External Damper Actuator Output: Two-wire, 4 to 20 mA.
 - c. BTU Metering: Provide temperature sensor for field mounting upstream or downstream of heating or cooling source.
 - d. BAS, SCADA, or other Integrated Automation System Link: ASHRAE Std 135 BACnet MS/TP.
- C. Service Temperature Range: Minus 20 to 160 degrees F.
- D. Enclosure Rating for Transmitter-Controller and Damper Actuator(s):
- 1. General: UL 50 or UL 50E listed for use in non-hazardous locations.

2.12 MISCELLANEOUS PRODUCTS

- A. Duct Opening Closure Film: Mold-resistant, self-adhesive film to keep debris out of ducts during construction.
- 1. Thickness: 2 mils.
 - 2. High tack water based adhesive.
 - 3. UV stable light blue color.
 - 4. Elongation Before Break: 325 percent, minimum.
 - 5. Manufacturers:
- B. Airflow Measuring, Thermal Dispersion Type:
- 1. Manufacturers:
 - a. Ebtron; _____: www.ebtron.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Configuration: Duct or plenum inserted assembly using up to eight water-resistant thermal dispersion sensors per metal probe wired into external access box holding self-diagnosing sensor interface electronics with respective field wire and cable landing terminals.
 - 3. Monitoring Range:
 - a. Air Velocity: 0 to 5,000 fpm converted to airflow using section area.
 - b. Temperature: Minus 20 to 120 degrees F.
 - 4. Accuracy: Plus or minus 2 percent with a plus or minus 0.25 percent repeatability over listed range. Includes means to zero, adjust, and calibrate outputs.
 - 5. Interface: Fitted with 16 character, 2-line, backlit, alphanumeric display and labeled pad-type surface membrane buttons.
 - 6. Outputs: Two-wire, 4 to 20 mA, for airflow and temperature signals, configurable.
 - 7. BAS, SCADA, or other Integrated Automation Link: ASHRAE Std 135 BACnet MS/TP.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). See Section 23 31 00 for duct construction and pressure class.
- B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, and elsewhere as indicated. Provide minimum 8 by 8 inch size for hand access, size for shoulder access, and as indicated. Provide 4 by 4 inch for balancing dampers only. Review locations prior to fabrication.
- D. Provide duct test holes where indicated and required for testing and balancing purposes.
- E. Demonstrate re-setting of fire dampers to Owner's representative.

- F. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.
- G. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment. This would include inline fans, heat pumps, fan coil units, VRV units, air handling units, and any other equipment containing fans or compressors and with a duct connection.
- H. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
- I. Use splitter dampers only where indicated.
- J. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.
- K. Provide birdscreen where indicated. Size to suite each opening. Furnish 304 stainless steel intermediate supports. Furnish with edging.

END OF SECTION

SECTION 23 34 16
CENTRIFUGAL HVAC FANS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Square inline direct drive backward inclined fans
- B. Mixed flow fans.
- C. Bearings and drives.
- D. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
- B. Section 23 05 48 - Vibration and Seismic Controls for HVAC.
- C. Section 23 07 13 - Duct Insulation.
- D. Section 23 33 00 - Air Duct Accessories: Backdraft dampers.
- E. Section 26 05 83 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015.
- B. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings; 1990 (Reapproved 2008).
- C. AMCA 99 - Standards Handbook; 2010.
- D. ANSI/AMCA Standard 208 - Calculation of the Fan Energy Index (FEI); 2018.
- E. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2007.
- F. AMCA Publication 211 - Certified Ratings Program Product Rating Manual for Fan Air Performance; 2013.
- G. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2014.
- H. AMCA Publication 311 - Certified Ratings Program Product Rating Manual for Fan Sound Performance; 2016.
- I. NEMA MG 00001 - Motors and Generators; 2024.
- J. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.
- K. ANSI/AMCA Standard 204 - Balance Quality and Vibration Levels for Fans; 2020.

1.04 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base air ratings on actual site elevations.
- B. Operating Limits: Classify according to AMCA 99.

1.05 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with 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 Sound Rating Seal.
- B. Fan Performance Ratings:
 - 1. Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating." Label fans with the AMCA-Certified Rating Seal.
 - 2. Conform to AMCA Publication 211-2013, "Certified Ratings Program Product Rating Manual for Fan Air Performance."
 - 3. Conform to AMCA Publication 311-2016, "Certified Ratings Program Product Rating Manual for Fan Sound Performance."

- C. Fan Efficiency: In accordance with ANSI/ASHRAE/IES 90.1-2019 (section 6.5.3.1.3), each fan and fan array shall have a Fan Energy Index (FEI) of 1.00 or higher at the design point of operation, as determined in accordance with AMCA Standard 208-2018 by an approved independent testing laboratory and labeled by the manufacturer. Each fan and fan array used for a variable-air-volume system that meets the requirements of ANSI/ASHRAE/IES 90.1-2019, section 6.5.3.2.1 shall have an FEI of 0.95 or higher at the design point of operation. The FEI for each fan and fan array shall be AMCA Standard 208-2018 certified. The FEI for fan arrays shall be calculated in accordance with AMCA 208-2018 Annex C. Exceptions to section 6.5.3.1.3 as listed therein are permissible. For reference only, the 2021 editions of the International Energy Conservation Code (IECC) and International Green Construction Code (IgCC) have similar requirements.
- D. UL 762 listed for use with grease-laden vapors.
- E. UL 705 listed as Power Ventilator.

1.06 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide data on centrifugal fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements. Include required submittal for furnished motor per Division 23 Section "Common Motor Requirements for HVAC Equipment."
- C. Shop Drawings: Indicate assembly of centrifugal fans and accessories including fan curves with specified operating point plotted, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.
- D. Manufacturer's Instructions: Include complete installation instructions.
- E. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements for additional provisions.
 - 2. Extra Fan Belts: One set for each individual fan.

1.07 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- C. Mechanical contractor shall verify the mechanical equipment, including motor controllers and variable frequency drives furnished under the mechanical contract, short circuit current rating (SCCR) is selected and coordinated to accommodate the minimum available fault current at the location it is installed. This shall be based on the Power System Study results performed under the electrical contract. Where the Power System Study is not available prior to the equipment submission process, it shall be assumed that any equipment rated 10 horsepower and above shall have an SCCR rating of no less than 10,000 amperes. Equipment shall be provided with an SCCR label as required by the National Electrical Code.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors, shafts, and bearings from weather and construction dust.

1.09 FIELD CONDITIONS

- A. Permanent fans may not be used for ventilation during construction.

1.10 WARRANTY

- A. Provide a minimum of 1 year warranty for fan and motor.

PART 2 PRODUCTS

2.01 AVAILABLE MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated into the Work include only those listed below. The following shall occur for any manufacturer's series, other than the Basis of Design manufacturer's series noted below and on the drawings, to be proposed as a substitution: (1) A bidder RFI shall be submitted by the vendor or mechanical contractor expressing such desire. For Engineer of Record review, furnish a preliminary submittal including any additional requested supporting documentation not later than one week in advance of the RFI deadline (to allow additional time for the review.) The vendor or mechanical contractor's desire shall not be carried by any bidder unless approved via Addendum. (2) Be submitted as a substitution to not only demonstrate manufacturer's series compliance with the requirements, but also demonstrate equivalency to the Basis of Design series. The mechanical and electrical designs are based upon the Basis of Design manufacturer's series equipment. If other than the Basis of Design manufacturer's series is furnished and: (a) if the power requirements differ, the mechanical contractor shall coordinate all requirements with the electrical contractor including circuit breaker, conductor, and conduit sizes. In such a case, the power shall still come from the same panel as currently designed. (b) if the duct connections or sizes differ, the mechanical contractor shall coordinate with affected trades and shall provide all required modifications to accommodate. The mechanical contractor is responsible for any additional cost to any trade as noted above and as required to coordinate installation and provide proper service clearances for other than the Basis of Design manufacturer's series. The mechanical contractor is responsible for paying any design fees associated with redesigning architectural, structural, mechanical, and electrical systems to accommodate other than the Basis of Design manufacturer's series.
 - 1. Greenheck; www.greenheck.com; Basis of design.
 - 2. Twin City Fan and Blower; www.tcf.com
 - 3. Loren Cook Company; www.lorencook.com/#sle.
 - 4. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

2.02 PERFORMANCE REQUIREMENTS

- A. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
- C. Fabrication: Comply with AMCA 99.
- D. Static and Dynamic Balance: Eliminate vibration or noise transmission to occupied areas.
- E. Refer to drawing schedule for additional performance requirements.

2.03 SQUARE INLINE DIRECT DRIVE BACKWARD INCLINED FANS

- A. Housings - Housing assembly features heavy-gauge galvanized steel construction.
- B. Removable Side Panels - Removable side panels provide easy access for service and maintenance without the need to remove duct connections. Complete removal of the power assembly is also possible through side access panels. Side panels can provide a 90-degree side discharge. Requires optional side discharge accessory.

- C. Duct Collars - Duct collars provide ready attachment to ductwork and eliminate the need for square to round duct transitions.
- D. Drive Frame - Motor and drive frame are constructed of heavy gauge galvanized steel. The pivoting motor base makes for simple belt tensioning (where belt drive is indicated or required.)
- E. Impeller - Backward inclined non-overloading, all aluminum impeller and hub statically and dynamically balanced to assure long life and quiet operation.
- F. Mounting Brackets - Galvanized steel mounting brackets for easy mounting in horizontal or vertical position.
- G. Shaft - Precision ground and polished with a first critical speed of at least 125% of the fan's maximum operating speed.
- H. Bearings - All models are furnished with prelubricated cast iron pillow block bearings with zerk fittings, designed for an average life (L-50) of 500,000 hours or more at maximum cataloged operating speeds.
- I. Disconnect Switch - Mounted and prewired NEMA 1 disconnect switch provided as standard for servicing the unit without the danger of an accidental start.

2.04 WHEEL AND INLET

- A. Mixed Flow: Fan wheels shall have die-formed blades designed for maximum efficiency, and quiet and stable operation. Blades shall be continuously welded to the back plate and wheel cone. Wheels shall be statically and dynamically balanced and the complete fan assembly including motor and drive shall be test balanced at or near the operating speed at the factory prior to shipment.
- B. Fan impeller shall be manufactured with continuously welded steel airfoils and coated with a Polyester Urethane finish, electrostatically applied and baked on.
- C. The wheel and fan inlet shall be carefully matched and shall have precise running tolerances for maximum performance and efficiency.

2.05 HOUSING

- A. Mixed Flow Housing
 - 1. Heavy gage steel, spot welded for AMCA 99 Class I and II fans, and continuously welded for Class III, adequately braced, designed to minimize turbulence with spun inlet bell and shaped cut.
 - 2. Housings shall be rectangular and welded steel throughout. Inlets shall be fully streamlined. Housings shall be suitably braced to prevent vibration or pulsation. Punched inlet flange shall be equipped for curb cap or mixing plenum box mounting. Extended lube lines shall be provided for ease of lubrication.
 - 3. Fan housing shall be coated with a Polyester Urethane, electrostatically applied and baked. No uncoated metal fan parts will be allowed.
 - 4. Units shall incorporate a universal mounting system that allows the fan to be mounted horizontal orientation and field rotation of the motor position in 90 degree increments which should not affect fan life.
 - 5. An access door shall be supplied for impeller inspection and service.
 - 6. OSHA compliant belt guard or motor cover to be included to completely cover the motor pulley and belts.

2.06 BEARINGS AND DRIVES

- A. Bearings shall be heavy duty, grease lubricated, anti-friction ball or roller, self-aligning, pillow block type and selected for a minimum L-10 life of 200,000 hours at the maximum fan RPM.

Bearings shall be equipped with extended lubrication lines with grease fittings outside of the fan housing.

- B. Shafts shall be AISI 1040 or 1045 hot rolled steel, accurately turned, ground, polished, and ring gauged for accuracy. Shafts shall be sized for the first critical speed of at least 1.43 times the maximum speed.
- C. Fans to be direct drive.

2.07 MOTORS

- A. Motors to meet requirements of Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.08 ACCESSORIES

- A. Mixed Flow Fans:
 - 1. Access Doors: Shaped to conform to scroll, hinged, gasketed, and bolted.
 - 2. Interior fans are to be provided with inlet airflow station that can output the return air volume to the BACnet BMS system.
 - 3. Ductwork is to be connected to the fan with flexible connectors. This may be provided by mechanical contractor.
 - 4. Fan to be mounted on vibration isolators.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install flexible connections between fan inlet and discharge ductwork; see Section 23 33 00. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.
- C. Provide sheaves required for final air balance.
- D. Fans are to be installed with vibration isolation on structural supports.

END OF SECTION

SECTION 23 36 00
AIR TERMINAL UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Single duct variable volume units.

1.02 RELATED REQUIREMENTS

- A. Section 23 31 00 - HVAC Ducts and Casings.
- B. Section 23 33 00 - Air Duct Accessories.
- C. Section 23 37 00 - Air Outlets and Inlets.
- D. Section 23 82 00 - Convection Heating and Cooling Units: Air coils.
- E. Section 26 05 83 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. ASHRAE Std 130 - Methods of Testing Air Terminal Units; 2008 (R2014).
- B. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.
- C. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems; Sheet Metal and Air Conditioning Contractors' National Association; 2008.
- D. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; current edition, including all revisions.

1.04 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate airflow, static pressure, and NC designation. Include electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.
 - 1. Include schedules listing discharge and radiated sound power level for each of the second through sixth-octave bands at inlet static pressures of 1 to 4 in-wc.
- D. Manufacturer's Installation Instructions: Indicate support and hanging details, installation instructions, recommendations, and service clearances required.
- E. Project Record Documents: Record actual locations of units and locations of access doors required for access of valving.
- F. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant-volume regulators.
- G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Mechanical contractor shall verify the mechanical equipment, including motor controllers and variable frequency drives furnished under the mechanical contract, short circuit current rating (SCCR) is selected and coordinated to accommodate the minimum available fault current at the location it is installed. This shall be based on the Power System Study results performed under the electrical contract. Where the Power System Study is not available prior to the equipment submission process, it shall be assumed that any equipment rated 10

horsepower and above shall have an SCCR rating of no less than 10,000 amperes. Equipment shall be provided with an SCCR label as required by the National Electrical Code.

1.06 WARRANTY

- A. Provide five year manufacturer warranty for air terminal units.

PART 2 PRODUCTS

2.01 VARIABLE AIR VOLUME BOXES

- A. Available Variable Air Volume box manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Envirotec Product SDR for supply, return, and general exhaust systems
 - 2. Johnson Controls, Inc. model TSS.
 - 3. Nailor Industries 3001 for supply, 3001X for return and exhaust (Basis of Design.)
 - 4. Price Industries
 - 5. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

2.02 MANUFACTURED UNITS

- A. Ceiling mounted variable air volume supply air control terminals for connection to single duct, central air systems, with electronic variable volume controls, .
- B. Identify each terminal unit with clearly marked identification label and air flow indicator. Include unit nominal air flow, maximum factory set airflow, minimum factory set air flow, and coil type.

2.03 SINGLE DUCT VARIABLE VOLUME UNITS

- A. Basic Assembly:
 - 1. Casings: Minimum 22 gage, 0.0299 inch galvanized steel. Casing leakage to meet ASHRAE Standard 130.
 - 2. Factory-assembled, AHRI 880 (I-P) rated and bearing the AHRI seal, air volume control terminal with damper assembly, flow sensor, externally mounted volume controller, duct collars, and all required features.
 - 3. For units in return air and exhaust systems furnish optional rectangular inlet connection, extending beyond the round air flow sensor, for duct field connection.
 - 4. Provide standard 3/4" thick elastomeric insulation meeting 25/50 rating for flame spread/smoke. Insulation shall meet ASTM C1136 for mold, mildew, and humidity resistance. The terminal casing shall be double wall construction, where scheduled, using a 22 gauge stainless steel solid metal liner covering all insulation.
 - 5. Primary Air Valve. The primary air valve shall consist of a minimum 22 gauge cylindrical body that includes embossment rings for rigidity. The damper blade shall be connected to a solid shaft by means of an integral molded sleeve which does not require screw or bolt fasteners. The shaft shall be manufactured of a low thermal conducting composite material, and include a molded damper position indicator visible from the exterior of the unit. The damper shall pivot in self lubricating bearings. The damper actuator shall be mounted on the exterior of the terminal for ease of service. The valve assembly shall include internal mechanical stops for both full open and closed positions. The damper blade seal shall be secured without use of adhesives. The air valve leakage shall not exceed 1% of maximum inlet rated airflow at 3" W.G. inlet pressure.

- B. Attenuator Section: Line attenuator sections with insulation matching that in the Basic Assembly above. The attenuator and terminal unit shall be single piece construction at least 36" long. Attenuator casing shall be constructed as specified for the base terminal.
- C. Primary Airflow Sensor
 - 1. For inlet diameters 6" or greater, the differential pressure airflow sensor shall traverse the duct along two perpendicular diameters. Cylindrically shaped inlets shall utilize the equal cross sectional area or log-linear traverse method. Single axis sensor shall not be acceptable for duct diameters 6" or larger. A minimum of 12 total pressure sensing points shall be utilized. The total pressure inputs shall be averaged using a pressure chamber located at the center of the sensor. A sensor that delivers the differential pressure signal from one end of the sensor is not acceptable. The sensor shall output an amplified differential pressure signal that is at least 2.5 times the equivalent velocity pressure signal obtained from a conventional pitot tube. The sensor shall develop a differential pressure of 0.03" w.g. at an air velocity of < 450 FPM. Documentation shall be submitted which substantiates this requirement. Balancing taps and airflow calibration charts shall be provided for field airflow measurements.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install the inlets of air terminal units and air flow sensors a minimum of four duct diameters from elbows, transitions, and duct takeoffs.
- C. Provide ceiling access doors or locate units above easily removable ceiling components.
- D. Support units individually from structure _____ in accordance with SMACNA (SRM).
- E. Do not support from ductwork.
- F. Connect to ductwork in accordance with Section 23 31 00.
- G. Install heating coils in accordance with Section 23 82 00.

3.02 ADJUSTING

- A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to zero percent full flow. Set units with heating coils for minimum 50 percent full flow.

END OF SECTION

SECTION 23 37 00
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Diffusers:
- B. Rectangular ceiling diffusers.
- C. Round ceiling diffusers.
- D. Registers/grilles:
 - 1. Ceiling-mounted, exhaust and return register/grilles.
 - 2. Ceiling-mounted, supply register/grilles.
 - 3. Wall-mounted, supply register/grilles.
 - 4. Wall-mounted, exhaust and return register/grilles.
- E. Fabric air distribution devices.
- F. Louvers:
- G. Roof hoods.
- H. Goosenecks.

1.02 REFERENCE STANDARDS

- A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; 2012.
- B. AMCA 550 - Test Method for High Velocity Wind Driven Rain Resistant Louvers; 2022.
- C. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Inlets; 2006 (R2011).
- D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.

1.03 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
- C. Project Record Documents: Record actual locations of air outlets and inlets.

1.04 QUALITY ASSURANCE

- A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.
- B. Test and rate louver performance in accordance with AMCA 500-L.

PART 2 PRODUCTS

2.01 AVAILABLE MANUFACTURERS

- A. Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to those that are scheduled on the drawings.
- B. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

2.02 ROUND CEILING DIFFUSERS

- A. Type: Round, adjustable pattern, stamped or spun, multi-core diffuser to discharge air in 360 degree pattern, with sectorizing baffles where indicated. Diffuser collar shall project not more than 1 inch above ceiling. In plaster ceilings, provide plaster ring and ceiling plaque.
- B. Fabrication: Steel with baked enamel finish.
- C. Color: As selected by Architect from manufacturer's standard range.
- D. Accessories: Radial opposed blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.03 RECTANGULAR CEILING DIFFUSERS

- A. Type: Square and rectangular, adjustable pattern, multi-louvered diffuser to discharge air in 360 degree pattern with sectorizing baffles where indicated.
- B. Frame: Inverted T-bar type. In plaster ceilings, provide plaster frame and ceiling frame.
- C. Fabrication: Aluminum with baked enamel finish.
- D. Color: As selected by Architect from manufacturer's standard range.

2.04 DUCT-MOUNTED SUPPLY AND RETURN REGISTERS/LOUVERS

- A. Type: Duct-mounted, rectangular register for round-spiral duct with adjustable pivot-ended blades, end caps, built-in volume damper, and dual cover flanges to lay flush on duct surface regardless of diameter. Performance to match manufacturer's catalog data.
- B. Material: 22 gauge, 0.0299 inch.
 - 1. Provide crossing spiral fitting-body of matching duct diameter.
- C. Color: As selected by Architect from manufacturer's standard range.

2.05 CEILING SUPPLY REGISTERS/GRILLES

- A. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, two-way deflection.
- B. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.
- C. Fabrication: Aluminum extrusions with factory enamel finish.
- D. Color: As selected by Architect from manufacturer's standard range.

2.06 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

- A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with blades set at 45 degrees, vertical face.
- B. Frame: 1-1/4 inch margin with countersunk screw mounting.
- C. Fabrication: Aluminum with 20 gage minimum frames and 22 gage minimum blades, or aluminum extrusions, with factory baked enamel finish.
- D. Color: To be selected by Architect from manufacturer's standard range.

2.07 WALL SUPPLY REGISTERS/GRILLES

- A. Type: Streamlined and individually adjustable blades, 3/4 inch minimum depth, 3/4 inch maximum spacing with spring or other device to set blades, vertical face, single deflection.
- B. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.
- C. Fabrication: Aluminum with 20 gauge, 0.0359 inch minimum frames and 22 gauge, 0.0299 inch minimum blades, or aluminum extrusions, with factory baked enamel finish.
- D. Color: To be selected by Architect from manufacturer's standard range.

2.08 WALL EXHAUST AND RETURN REGISTERS/GRILLES

- A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with spring or other device to set blades, vertical face.
- B. Frame: 1-1/4 inch margin with countersunk screw mounting.
- C. Fabrication: Aluminum extrusions, with factory baked enamel finish.
- D. Color: To be selected by Architect from manufacturer's standard range.

2.09 LOUVERS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, those that are scheduled on the drawings.
 - 1. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Type: 4 inch deep with blades on 35 degree slope with center baffle and return bend, heavy channel frame, 1/2 inch square mesh screen over exhaust and 1/2 inch square mesh screen

over intake. Bird screen to comply with requirements in Division 23 Section "Air Duct Accessories".

- C. Color: To be selected by Architect from manufacturer's standard range.
- D. Fabrication: 0.125 inch thick extruded aluminum frame and 0.081" thick extruded aluminum blades, welded assembly, with Kynar finish.

2.10 GOOSENECKS

- A. Fabricate in accordance with of minimum 18 gauge, 0.0598 inch galvanized steel.
- B. Mount on minimum 12 inch high curb base where size exceeds 9 by 9 inch.

2.11 DUCT MOUNTED EXHAUST GRILLES

- A. Type: Streamlined and individually adjustable blades, 3/4 inch minimum depth, 3/4 inch maximum spacing with spring or other device to set blades, vertical face, single deflection.
- B. Filter: Filter clips capable of accommodating 2" deep filter.
- C. Grille Attachment: Grill is attached to frame with full length piano hinge.
- D. Material: Formed Aluminum.
- E. Finish: Electrocoat acrylic baked enamel.
- F. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.12 DUCT MOUNTED SUPPLY DIFFUSER

- A. Type: Duct Diffuser, perforated holes with mitered, offset, aluminum frame for easy installation on a round, flat oval, or rectangular duct assembly or fitting body using sheet metal screws.
 - 1. Provide units with Integral Balance Damper.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Coordinate with ceiling types and fit to ceiling grid.
- C. Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.
- D. Install diffusers to ductwork with air tight connection.
- E. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.

END OF SECTION

SECTION 23 41 00
AIR FILTERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes factory-fabricated air-filter devices and media used to remove particulate matter from air for HVAC applications.

1.03 DEFINITIONS

- A. HEPA: High-efficiency particulate air.

1.04 SUBMITTALS

- A. Product Data: Include dimensions; shipping, installed, and operating weights; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.
- B. Shop Drawings: Include plans, elevations, sections, and details to illustrate component assemblies and attachments.
 - 1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
 - 2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
- C. Maintenance Data: For each type of filter and rack to include in maintenance manuals specified in Division 1.

1.05 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air filters and are based on the specific system indicated. Other manufacturers systems with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."
- B. Comply with NFPA 90A and NFPA 90B.
- C. ASHRAE Compliance: Comply with provisions of ASHRAE 52.1 and 52.2 for method of testing and rating air-filter units.
- D. Comply with NFPA 70 for installing electrical components.

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 3 Section "Cast-in-Place Concrete."

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. Provide one complete set of filters for each filter bank. If system includes prefilters, provide one set of prefilters.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, those scheduled on the drawings.

- 1. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

2.02 FILTER GAUGE REQUIREMENTS

- A. Furnish and install an air filter gauge to indicate the pressure drop across each filter section. Each gauge shall be installed in an easily accessible and readable location. Locate the static pressure taps at least 1'-0" upstream and 1'-0" down stream from the filters. The static heads shall be placed in a zone of minimum turbulence. Properly level inclined manometers and calibrate all filter gauges.
- B. Provide Magnehelic differential pressure gauges complete with static pressure tips, aluminum tubing and vent valves for filters mounted above the ceiling. Remote mount gauge for filters installed above ceiling system. Coordinate gauge location with owner prior to installation.

2.03 DISPOSABLE PLEATED AIR FILTERS

- A. Disposable pleated filter, cotton polyester media with wire backing. Filter bonded to heavy paperboard or internal metal frame on front, back and sides. Average filter efficiency of 25-30% as measured by ASHRAE 52-76. Provide permanent holding frame of sizes scheduled on drawings. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - 1. Arrestance (ASHRAE 52.1): 90.
 - 2. MERV (ASHRAE 52.2): 8.

2.04 95% EFFICIENT DRY FILTERS

- A. 95%-efficiency filters shall be factory constructed disposable pleated filters. Filter media shall be made of microglass paper with a water repellent binder. Rigid media pack shall consist of media pleats structurally bonded one to the other. Frame to be foil laminated fiber board to provide strength and moisture resistance. Pack shall be bonded inside the double wall frame on all four edges. The filter shall have an average atmospheric dust spot efficiency of 90-95% as determined by the ASHRAE 52-76 test method. Provide prefilters and permanent holding frame of sizes scheduled on drawings. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - 1. Arrestance (ASHRAE 52.1): 95.
 - 2. MERV (ASHRAE 52.2): 13.

2.05 FILTER GAGES

- A. Description: Diaphragm type with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.
 - 1. Diameter: 4-1/2 inches
 - 2. Range: 0- to 3.0-inch wg.
- B. Manometer-Type Filter Gage: Molded plastic with epoxy-coated aluminum scale, logarithmic-curve tube gage with integral leveling gage, graduated to read from 0- to 3.0-inch wg, and accurate within 3 percent of full scale range.
- C. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install filter frames according to manufacturer's written instructions.

- B. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
- C. Install filters in position to prevent passage of unfiltered air.
- D. Coordinate filter installations with duct and air-handling unit installations.

3.02 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components, filter and filter-frame installation, and electrical wiring. Report results in writing.
- B. HEPA Filters: Pressurize housing to a minimum of 3.0-inch wg or to designed operating pressure, whichever is higher; and test housing joints, door seals, and sealing edges of filter for air leaks according to ASME N510 pressure-decay method.

END OF SECTION 23 41 00

SECTION 23 63 20
PACKAGED AIR COOLED HEAT PUMP UNITS

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.
- B. General Description
 - 1. This section includes the design, controls and installation requirements for air-cooled condensers / condensing units.
- C. Quality Assurance
 - 1. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.
 - 2. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.
 - 3. System Seasonal Energy Efficiency Ratio/Energy Efficiency Ratio (SEER/EER) shall be equal to or greater than prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
 - 4. Unit shall be safety certified by ETL and be ETL US and ETL Canada listed. Unit nameplate shall include the ETL/ETL Canada label.
- D. Submittals
 - 1. Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, factory supplied accessories, electrical characteristics, and connection requirements. Installation, Operation and Maintenance manual with startup requirements shall be provided.
 - 2. Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, construction details, clearances, and connection details. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.
- E. Delivery, Storage, and Handling
 - 1. Unit shall be shipped with doors bolted shut to prevent damage during transport and thereafter while in storage awaiting installation.
 - 2. Follow Installation, Operation and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.
 - 3. Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the Installation, Operation and Maintenance manual.
- F. Warranty
 - 1. Manufacturer shall provide a "parts only" warranty for a period of 12 months from the date of equipment startup or 18 months from the date of shipment, whichever is less. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer's written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance and refrigerant.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. Products shall be provided by the following manufacturers:

PACKAGED AIR COOLED HEAT PUMP UNITS

1. Daikin
 2. Or Equal
 3. Substitute equipment may be considered for approval that includes at a minimum:
 - a. R-32 refrigerant
 - b. Hinged access doors with lockable handles
 - c. Variable capacity compressor with 10-100% capacity
 - d. All other provisions of the specifications must be satisfactorily addressed
- B. Condensing Units
1. General Description
 - a. Condensing unit shall include compressors, air-cooled condenser coils, condenser fans, suction and liquid connection valves, and unit controls.
 - b. Condenser shall include air-cooled condenser coils, condenser fans, discharge and liquid connection valves, and unit controls.
 - c. Unit shall be factory assembled and tested including leak testing of the coil and run testing of the completed unit. Run test report shall be supplied with the unit in the controls compartment's literature pocket.
 - d. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
 - e. Unit components shall be labeled, including pipe stub outs, refrigeration system components and electrical and controls components.
 - f. Installation, Operation and Maintenance manual shall be supplied within the unit.
 - g. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's access door.
 - h. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's access door.
 2. Construction
 - a. Unit shall be completely factory assembled, piped, wired and shipped in one section.
 - b. Unit shall be specifically designed for outdoor application.
 - c. Condenser coils shall be mechanically protected from physical damage by painted galvanized steel louvers (wire grille) covering the full area of the coil.
 - d. Access to condenser coils, condenser fans, compressors, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles.
 - e. Exterior paint finish shall be capable of withstanding at least 1,000 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
 - f. Unit shall include a forkliftable base.
 3. Electrical
 - a. Unit shall be provided with standard power block for connecting power to the unit.
 - b. Mechanical contractor shall verify the mechanical equipment, including motor controllers and variable frequency drives furnished under the mechanical contract, short circuit current rating (SCCR) is selected and coordinated to accommodate the minimum available fault current at the location it is installed. This shall be based on the Power System Study results performed under the electrical contract. Where the Power System Study is not available prior to the equipment submission

process, it shall be assumed that any equipment rated 10 horsepower and above shall have an SCCR rating of no less than 10,000 amperes. Equipment shall be provided with an SCCR label as required by the National Electrical Code.

- c. Control circuit transformer and wiring shall provide 24 VAC control voltage from the line voltage provided to the unit.
 - 1) Air-source heat pump shall include an optimized start defrost cycle to prevent frost accumulation on the outdoor coil during heat pump heating operation and to minimized defrost cycle energy usage. If the temperature of the outdoor heat exchanger and/or the suction line is less than a predetermined value, a deferred defrost cycle is initiated wherein the defrost cycle starts after a variable, continuously optimizing, time interval has elapsed. The defrost cycle is terminated when the relative temperatures of the outdoor heat exchanger and/or the suction line indicate that sufficient frost is melted from the heat exchanger to insure adequate time between successive defrost cycles for optimizing the efficiency and reliability of the system, or after a predetermined time interval has elapsed, whichever condition occurs first. During defrost cycle all compressors shall energize, reversing valves shall de-energize, and auxiliary heat shall energize.
 - 2) Unit shall be provided with factory installed and factory wired 115V, 15 amp GFI outlet with outlet disconnect switch in the unit control panel.
 - 3) Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more that 10% out of balance on voltage, the voltage is more that 10% under design voltage, or on phase reversal.
- 4. Refrigeration System
 - a. Compressors shall be scroll type with thermal overload protection, (independently) circuited, and carry a 5 year non-prorated warranty.
 - b. Variable capacity compressor shall be capable of modeling capacity from 10-100%.
 - c. Each compressor shall include a crankcase heater.
 - d. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged access doors shall provide access to the compressors.
 - e. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
 - f. Compressor to furnished with sound attenuating blankets.
 - g. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides, and service valves for liquid and suction connections. Liquid line filter driers shall be factory provided. Finished field installed refrigerant circuits shall include the low side cooling components, refrigerant, thermal expansion valve, liquid line (insulated hot gas bypass line) (insulated hot gas line) and insulated suction line.
 - h. Unit shall include a factory holding charge of R-32 refrigerant and oil.
 - i. Unit shall include modulating capacity control of each circuit.
 - j. Each compressor shall be equipped with a 5 minute off, delay timer to prevent compressor short cycling.

- k. The unit shall be capable of stable cooling operation to a minimum of 35°F outdoor temperature.
 - 1) Unit shall include a variable capacity scroll compressor on each refrigeration circuit which shall be capable of modulation from 10-100% of its capacity.
 - 2) Each refrigeration circuit shall be provided with hot gas reheat capability to the coil in the mated air handler unit, modulating valves, electronic controller, supply air temperature sensor and a dehumidification control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.
 - 3) Unit shall be configured as an air-source heat pump. Each refrigeration circuit shall each be equipped with a liquid line filter drier with check valve, reversing valve, accumulator, and thermal expansion valves on both the indoor and outdoor coils. Reversing valve shall energize during the heat pump heating mode of operation.
 - 4) All refrigeration circuits shall be provided with external hot gas bypass to protect against evaporator frosting and to prevent excessive compressor cycling.
 - 5) Condensing unit shall be provided with adjustable on/off condenser fan cycling head pressure control and adjustable compressor lockout to allow cooling operation down to 35°F.
- 5. Condensers
 - a. Air-Cooled Condenser
 - 1) Condenser fans shall be vertical (horizontal) discharge, axial flow, direct drive fans.
 - 2) Fan motor shall be weather protected, single phase, direct drive, and open drip proof with inherent overload protection.
 - 3) Coils shall be designed for use with R-32 refrigerant and constructed of copper tubes with aluminum (copper) fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
 - 4) Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
 - 5) Coils shall be helium leak tested.
 - 6) Coil shall have a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 and 250 hours respectively (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing to no less than 6,000 hours salt spray per ASTM B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of the e-coat. Coating shall carry a 5 year non-prorated warranty.
- 6. Controls
 - a. Standard Terminal Block
 - 1) Unit shall be provided with a terminal block for field installation of controls.

PART 3 - EXECUTION

3.01 INSTALLATION, OPERATION, AND MAINTENANCE

- A. Installation, Operation and Maintenance manual shall be supplied with the unit.

- B. Installing contractor shall install unit, including field installed components, in accordance with Installation, Operation and Maintenance manual instructions.
- C. Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit.

END OF SECTION

SECTION 23 72 00
AIR TO AIR ENERGY RECOVERY UNITS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2011.
- B. UL 1812 - Ducted Heat Recovery Ventilators; Current Edition, Including All Revisions.
- C. UL 1995 - Heating and Cooling Equipment; Current Edition, Including All Revisions.

1.02 SUMMARY

- A. This section Energy Recovery Ventilators (ERV) or Heat Recovery Ventilators (HRV) (as applicable) units for indoor and outdoor applications.

1.03 SUBMITTALS

- A. Product Data: Submit product data for specified products with the following information.
 - 1. General layout drawing with plan and elevation views including all relevant dimensions.
 - 2. Performance schedule including airflow, heating and cooling capacities, electrical data, unit weight.
 - 3. Energy recovery wheel performance characteristics: sensible for HRV (and latent for ERV as applicable) recovery efficiency, frost point based on design conditions, speed range in RPM
 - 4. Fan energy consumption: KW of supply and exhaust fans at design condition and watts per CFM calculation defined as: (design condition supply fan watts + design condition exhaust fan watts) / supply fan airflow.
 - 5. Full fan curve.
 - 6. Sound power data by octave band for all openings and radiated through cabinet.
 - 7. Electrical schematics including field wiring connections.
 - 8. Component details including construction method and materials.
 - 9. Control point schematic and complete written sequence of operation.
 - 10. Curb mounting details.

1.04 QUALITY ASSURANCE

- A. Safety Listings
 - 1. 1. Entire unit shall be UL 1812 or UL 1995 certified and bear a certification label by ETL, UL or CSA.
- B. Performance
 - 1. 1 Unit shall meet ASHRAE Standard 90.1 performance requirements.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Storage and protection
 - 1. 1. Store equipment away from construction areas where it may be damage and protected from harmful weather conditions.
 - 2. 2. Keep factory shipping packaging in place until unit is ready to be installed.
- B. Rigging
 - 1. 1. Follow manufacturer's instructions for rigging and placement of equipment.

1.06 COORDINATION

- A. Coordinate all system connections and building penetrations including electrical, gas and duct connections.
- B. Coordinate curb placement, structural and roofing.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with project plans and specifications the following manufacturers are approved to supply products;
 - 1. Swegon.

2.02 ERV UNITS

- A. ERV units shall be factory assembled and tested. Units shall include insulated steel cabinet with steel base, sensible recovery or total recovery enthalpy wheel as indicated in the equipment schedule, fan and motor assembly, 2" pre-filter rack, 12" bag filter rack, and integral controls. Unit shall be designed based on a modular concept and allow inclusion of pre and post heating and cooling devices in modular sections that can be bolted to the main ERV components. Heating and cooling options shall include: electric, hydronic, DX, VRF integration, evaporative cooling, heat pipes, etc as required by the project design. Base ERV shall be single point power with options for multiple power sources for connection to back-up generator.

2.03 CABINET

- A. Cabinet shall be nominal 2 inch double wall panel with Rockwool R8, mineral fiber, acoustic and thermal insulation. Insulation shall have a flame spread rating not exceeding 25 and a smoke developed rating not exceeding 50. Cabinet exterior shall be 20 gauge pre-painted steel that meets or exceeds 650 hour salt spray test based on ASTM B117. Liners and other steel components shall be galvanized steel. All seams shall be sealed to provide air tight casing. Outdoor unit shall include a roof with standing seams and integral gutter.
- B. Doors shall be nominal 2 inch double wall panel with the same construction as cabinet. Doors shall be fitted with hinges and flush mounted door handles. The doors shall have one lockable handle as standard and the handles shall have a two position opening mechanism for improved safety. Position 1 shall open the door approximately 1" against a positive stop, allowing for pressure equalization. Position 2 shall allow the door to fully open. Otherwise, doors must be provided with factory installed positive stopping mechanism, preventing the door from fully opening against a positive or negative pressure.
- C. The unit will be designed as single side access, allowing service and maintenance to all be completed from one side and allow for compact installation.
- D. 3rd Party Certified Casing Performance: Units shall be tested in accordance with EN 1886 or equivalent and meet the following criteria:
 - 1. Casing air leakage = A (Airtightness: L2). Under 1.6 inch. wc air leakage rate shall be no more than 3 cfm/100 ft² and under 2.8 inch. wc air leakage rate shall be no more than 10 cfm/ft².
 - 2. Thermal transmittance = T2. The cabinet is a nominal 2 inch double wall panel with 1.5 lb. density Roxul R8 insulation
 - 3. Thermal bridging factor = TB2. The ratio between the lowest temperature difference between any point on the external surface and the mean air-to-air temperature difference. Unit shall meet 0.6 bridging
- E. Units shall be designed so they can be unbolted and broken down into sections for access to restricted locations. All interconnecting wiring shall have quick-connect Molex plugs at each section.
- F. Standard dampers shall have extruded heavy gauge 6063 aluminum frame that includes jamb seals. Blades shall be airfoil shaped extruded aluminum and include rubber blade seals. Linkage shall be installed in the frame outside of the airstream.

1. Corrosion resistant dampers shall be available as required by project application.
- G. All dampers shall include factory mounted, wired and tested actuators. Dampers shall be modulating or two position as required. Provide spring return dampers for outdoor air connections.

2.04 FILTERS

- A. Unit shall include side loaded cartridge filter rack suitable for 12" deep, 10 pocket MERV 13 bag filters for supply and return air. Filters will be held in position by an expanding locking device that provides a gasketed seal on all four sides of the filter.
 1. MERV 14 and MERV 15 bag filters shall be available if required by project details.
- B. Provide factory mounted pressure sensors to measure filter pressure drop across pre-filter and main bag filter. Pressure drop shall be digitally provided to unit controller for utilization in control and alarm sequencing. Unit controller shall monitor filter pressure level and report when filter changes are required. Pressure drop for all filter banks shall be displayed on the unit handheld, touchscreen controls interface panel and provided via BACnet output to the BMS.

2.05 FANS

- A. Fans shall be mixed flow plenum type with direct drive motor. Fan and motor assembly shall be mounted on common base with internal isolation and be factory balanced as a complete assembly. If not factory balanced as a complete unit then field balance is required, at the expense of the ERV supplier. Fan shall be connected to fan bulkhead by a canvas type flex connector. The fans will be capable of operating in ambient temperatures of up to 104°F.
- B. Fan motors shall be permanent magnet, synchronous motor type with integral digital motor controller. Fan bearings shall be serviceable type.
- C. All fans shall be equipped with integral airflow measuring system connected to the unit controller. Airflow quantity shall be displayed on the unit handheld, touchscreen controls interface panel.
- D. Provide factory installed fan removal rails in the fan section, and 6 point disconnect, to facilitate simple remove fan-motor assembly for service through standard ERV doors. Wiring must be quick connect fittings. Hard wiring will not be acceptable.

2.06 ENERGY RECOVERY DEVICE

- A. Units shall include rotary heat exchanger that transfers sensible or both sensible and latent energy. Recovery wheel shall be 10" thick, constructed of corrugated aluminum. ERV wheels less than 10" thick will not be acceptable.
- B. Recovery wheel shall be coated with Zeolite molecular sieve if designed for enthalpy transfer.
- C. Wheel supports shall be galvanized steel with a rigid steel hub.
- D. Wheel section shall be provided with a built in, fixed position, purge section. Rotary heat exchanger shall include face and peripheral brush seals.
- E. Drive motor shall be variable speed type integrated into unit controller and include torque sensing to provide wheel rotation sensing. Rotary Heat Exchangers without rotational speed control (constant speed wheels) are not acceptable.
- F. Rotary Heat Exchanger carry over must not exceed 0.45% tested in accordance with EN308:1997
- G. Rotary Heat Exchangers constructed of material other than aluminum (plastic, etc) are not acceptable.
- H. ERV wheel motor controller must be via DC stepper motor capable of controlling wheel speed between 0.5 and 20 RPM.
- I. ERV rotor shall be AHRI 1060 certified

- J. Manufacturer to provide 5 year parts only warranty on the ERV wheel.

2.07 CROSS CONTAMINATION (EATR) CONTROL

- A. Units shall include and utilize the following means to maintain cross contamination (EATR) at less than 0.5% of the supply airflow through the use of brush seals, rotor purge sector, variable speed rotor control to vary the rotor speed with supply airflow modulation, and return air opening pressure balance plates to ensure the correct pressure balance within the unit to ensure purge airflow from the outside airstream to the exhaust airstream:
1. Units shall include standard pressure balancing plates at return air opening. These plates are to be set at startup, based on the pressure differential between supply and return air, to ensure purge airflow moves from the supply airstream to the exhaust airstream. Pressure gradient across the rotor seal must be between 0 and 0.08" and deliver EATR less than 0.5% as certified by 3rd party verification.
 2. Unit controls shall include built-in Air Quality Control algorithms. This feature includes standard algorithms in the unit controller and an optional factory installed modulating damper on the return airstream. The unit controls shall constantly monitor the pressure differential between supply and return air and maintain the pressure differential between 0 and 0.08" over the entire operating airflow range.

2.08 CONTROLS

- A. Unit shall include an integrated microprocessor based unit controller. The controls shall be located in the integral controls cabinet. All controls shall operate off a transformer from the main power supply for single point power connection. All internal controls and sensors shall be factory prewired and tested. The microprocessor shall have dual Ethernet ports with an internal firewall to allow remote access via third party without compromising the clients internal Network.
- B. ERV units must utilize built-in controls and ERV wheel speed control algorithms that use wheel speed modulation to
- C. Control supply air temperature
- D. Prevent frost development
1. Modulate wheel speed as supply airflow modulates to ensure maximum purge efficiency and absolute minimum airflow cross-contamination at less than 0.45% EATR at all airflow conditions.
 2. Prevent frost development
 3. Modulate wheel speed as supply airflow modulates to ensure maximum purge efficiency and absolute minimum airflow cross-contamination at less than 0.45% EATR at all airflow conditions.
- E. Provide airflow monitor to measure outdoor airflow through enthalpy wheel. Monitor shall be integrated into unit controller. Airflow accuracy shall be minimum $\pm 5\%$ of design airflow.
- F. Provide temperature sensors at all 4 positions on the ERV wheel. Display outside air temperature and return air temperature on the unit handheld, touchscreen controls interface panel and provide all 4 temperature readings via BACnet output to the BMS.
- G. Include each unit with a touch pad type human interface that allows monitoring and control of all unit functions. Human interface shall communicate with unit controller by hardwire connection. Human interface shall be unit mounted.
- H. The control system will regulate temperatures, airflows and other functions as required. Unit controller shall be pre-programmed with factory tested software for all possible functions. Controller shall utilize a "plug and play" feature that will automatically load and operate any necessary algorithm based on components and accessories that are connected to the

- controller such as air flow monitors, damper actuators, fans, rotary energy recovery, water control valves, etc.
- I. The controller shall provide the following, refer to sequence of operation for specific unit control sequences;
 - 1. Control of fans correcting for both changes in total static pressure and air density in both VAV and constant airflow applications.
 - 2. Real time total unit power consumption (fans, ERV wheel motor and controls) as "watts/CFM" monitored through BMS.
 - 3. Fan performance monitoring.
 - 4. Ventilation airflow monitoring and control.
 - 5. Airflow density correction for winter and summer conditions.
 - 6. Energy recovery optimization including operation of rotary energy recovery device.
 - 7. Supplemental heating and cooling when included.
 - 8. Integration to VRF condensing units when included.
 - 9. Frost protection certified to meet the frost protection requirements of Passive House Institute
 - 10. Recirculation module when included.
 - 11. Monitoring alarms, faults and maintenance points including filter changeout.
 - 12. Time and date schedules.
 - 13. Building pressurization.
 - 14. Humidity control.
 - 15. Data logging and trending.
 - J. Include wireless capability via built-in WiFi connection that will allow the client to access remotely via Smart Phone, laptop, tablet, etc without supplemental software.
 - K. If non-factory controls are proposed as an option, a factory witness test is required to show integration and functionality. Controls vendor and manufacturer shall generate and agree upon a unit test plan to test all unit control functions and verify controls features as called out in these specifications.
 - L. Controller shall be BTL certified for BACnet IP and also include Modbus, Lon, and Metasys communication. Communication shall include monitoring, control, alarms, faults and maintenance information.
 - M. Provide factory installed and tested contactors, overloads, fusing, motor speed controllers for supply, exhaust and rotary energy recovery device. Include all necessary control transformers.
 - N. Provide unit mounted non-fused disconnect switch with single point power connection for main ERV.
 - O. Supply all necessary temperature and pressure sensors complete with plug in wiring harnesses for proper option of unit.

PART 3 EXECUTION

3.01 3.1 INSTALLATION

- A. Install equipment in accordance with manufacturer instructions, this specification, best practices and all applicable building codes.

3.2 START UP SERVICE

- A. Engage factory authorized service technician to start up and commission units. Provide start up report to owner.

END OF SECTION

SECTION 23 73 13
MODULAR INDOOR AIR HANDLER UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Indoor Air Handling Units.

1.02 REFERENCE STANDARDS

- A. AMCA 99 - Standards Handbook; 2010.
- B. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2007.
- C. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; 2014.
- D. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2011.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.
- G. NFPA 5000 - Building Construction and Safety Code; 2018.
- H. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Current Edition, Including All Revisions.
- I. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.
- J. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.
- K. UL 900 - Standard for Air Filter Units; Current Edition, Including All Revisions.

1.03 REFERENCES

- A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. AMCA 99 - Standards Handbook.
- C. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.
- D. AMCA 300 - Test Code for Sound Rating Air Moving Devices.
- E. AMCA 500 - Test Methods for Louver, Dampers, and Shutters.
- F. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
- G. AHRI 430 - Central-Station Air-Handling Units.
- H. AHRI 435 - Application of Central-Station Air-Handling Units.
- I. ASTM B117 - Standard Practice for Operating Salt Spray Apparatus.
- J. NEMA MG1 - Motors and Generators.
- K. NFPA 70 - National Electrical Code.
- L. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- M. UL 723 - Test for Surface Burning Characteristics of Building Materials.
- N. UL 900 - Test Performance of Air Filter Units.
- O. UL 60335-1 and 60335-2-40 - Standard for Heating and Cooling Equipment.
- P. UL 94 - Test for Flammability of Plastic Materials for Parts in Devices and Appliances.
- Q. IBC 2000, 2003 - International Building Code.
- R. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
- S. NFPA 5000 - Building Construction and Safety Code.
- T. ASHRAE 90.1 Energy Code.
- U. AHRI Standard 1060 - Rating Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment.
- V. GSA 2003 Facilities Standard - 5.9 HVAC Systems and Components.

1.04 SUBMITTALS

- A. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements. Computer generated fan curves for each air handling unit shall be submitted with specific design operating point noted. A computer generated psychometric chart shall be submitted for each cooling coil with design points and final operating point clearly noted. Sound data for discharge, radiated and return positions shall be submitted by octave band for each unit. Calculations for required baserail heights to satisfy condensate trapping requirements of cooling coil shall be included.
- B. Product Data:
 - 1. Provide literature that indicates dimensions, weights, capacities, ratings, fan performance, finishes of materials, electrical characteristics, and connection requirements.
 - 2. Provide data of filter media, filter performance data, filter assembly, and filter frames.
 - 3. Provide manufacturer's installation instructions.

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Air Handler products specified in this section must show a minimum five years documented experience and complete catalog data on total product.

1.06 SAFETY AGENCY LISTED & CERTIFICATION

- A. Air Handling units shall be cETLus safety listed to conform with UL Standard 60335-1 and 60335-2-40 and CAN/CSA Standard C22.2.
- B. Air handler furnished with double width, double inlet (DWDI) fans and/or plenum fans where applicable, shall be certified in accordance with the central station air handling units certification program, which is based on AHRI Standard 430. (NOTE: Above does not apply to fan array)
- C. Air handling unit water heating & cooling coils shall be certified in accordance with the forced circulation air cooling and air heating coils certification program, which is based on AHRI Standard 410.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site.
- B. Accept products on site on factory-furnished shipping skids. Inspect for damage.
- C. Store in clean dry place and protect from construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. The following manufacturers are approved for use. No substitutions will be permitted.
 - 1. Daikin Applied 'Vision' Air Handler shall be the basis of design.
 - 2. Miller-Picking
 - 3. Temtrol
 - 4. Racan-Carrier Company

2.02 GENERAL DESCRIPTION

- A. Configuration: Fabricate as detailed on drawings.
- B. Performance: Conform to AHRI 430. See schedules on prints. (NOTE: above does not apply to fan array)

- C. Acoustics: Sound power levels (dB) for the unit shall not exceed the specified levels shown on the unit schedule. The manufacturer shall provide the necessary sound treatment to meet these levels if required.

2.03 UNIT CONSTRUCTION

- A. Fabricate unit with heavy gauge channel posts and panels secured with mechanical fasteners. All panels, access doors, and ship sections shall be sealed with permanently applied bulb-type gasket. Shipped loose gasketing is not allowed.
- B. Panels and access doors shall be constructed as a 2-inch nominal thick; thermal broke double wall assembly, injected with foam insulation with an R-value of not less than R-13.
 - 1. The inner liner shall be constructed of G90 galvanized steel.
 - 2. The outer panel shall be constructed of G90 galvanized steel.
 - 3. The floor plate shall be constructed as specified for the inner liner.
 - 4. Unit will be furnished with solid inner liners.
- C. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, maximum 5 inches of positive or 6 inches of negative static pressure. Deflection shall be measured at the panel midpoint.
- D. The casing leakage rate shall not exceed 0.50 cfm per square foot of casing surface area at design static pressure up to a maximum of +5" w.c. in positive pressure sections and -6" w.c. in negative pressure sections (.0025 m3/s per square meter of cabinet area at 0 psi static pressure)
- E. Module to module field assembly shall be accomplished with an overlapping, full perimeter internal splice joint that is sealed with bulb type gasketing on both mating modules to minimize on-site labor and meet indoor air quality standards.
- F. Access doors shall be flush mounted to cabinetry, with minimum of two six inch long stainless steel piano-type hinges, latch and full size handle assembly. Access doors shall swing outward for unit sections under negative pressure. Access doors on positive pressure sections, shall have a secondary latch to relieve pressure and prevent injury upon access.
- G. A 6-inch formed G60 galvanized steel base rail shall be provided by the unit manufacturer for structural rigidity and condensate trapping.. The base rail shall be constructed with 12-gauge nominal for unit sizes 003 - 035 and 10-gauge nominal for unit sizes 040 - 090. The following calculation shall determine the required height of the baserail to allow for adequate drainage. Use the largest pressure to determine base rail height. (Negative)(Positive) static pressure (in) (2) + 4" = required baserail height. Should the unit baserail not be factory supplied at this height, the contractor is required to supply a concrete housekeeping pad to make up the difference.

2.04 FAN ASSEMBLIES

- A. Provide ECM, motorized impeller fan(s). Fan assembly shall include fan, fan base, and a motor and shall be dynamically balanced by the fan manufacturer.
 - 1. Fan array shall be equipped with piezometer points to measure airflow. One piezometer point shall be supplied on each fan in the fan array.
 - 2. Unit shall come equipped with an isolation backdraft damper upstream of each fan in the array. Damper shall be equipped with an adjustable, weighted counter balance to minimize static pressure loss.
 - 3. Motor control panel shall come with a low voltage terminal strip and shall include terminals for Fan ON/OFF, 0-10V signal, and fan fault.
 - 4. Motor control panel shall come equipped with a fused disconnect.

5. Fan section shall come equipped with a motor control panel mounted on the fan section. Both line voltage and low voltage wiring shall be done by the factory. Each fan shall have an isolation switch.
6. Motor shall be brushless DC type with a permanent magnet rotor.
7. Inverter shall be integral to the motor and come as an assembly from the fan manufacturer.

2.05 BEARINGS, SHAFTS, AND DRIVES

- A. Shafts shall be solid, hot rolled steel, ground and polished, keyed to shaft, and protectively coated with lubricating oil. Hollow shafts are not acceptable.

2.06 ELECTRICAL

- A. The air handler(s) shall be ETL and ETL-Canada listed by Intertek Testing Services, Inc. Units shall conform to bi-national standard ANSI/UL Standard 60335-1 and 60335-2-40/CSA Standard C22.2 No. 236.
- B. All air handler control panels shall be certified by UL 508A.
- C. Wiring Termination: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclosed terminal lugs in terminal box sized to NFPA 70.
- D. Manufacturer shall provide ASHRAE 90.1 Energy Efficiency equation details for individual equipment to assist Building Engineer for calculating system compliance.
- E. Installing contractor shall provide GFI receptacle within 25 feet of unit to satisfy National Electrical Code requirements.
- F. Evaporator shall include an A2L refrigerant detection control panel.
 1. Refrigerant detection system includes A2L control board, refrigerant sensor(s) and A2L mitigation dry contacts.

2.07 COOLING AND HEATING COILS

- A. Certification: Acceptable water cooling, water heating, steam, and refrigerant coils shall be certified in accordance with AHRI Standard 410 and bear the AHRI label. Coils exceeding the scope of the manufacturer's certification and/or the range of AHRI's standard rating conditions will be considered provided the manufacturer is a current member of the AHRI Forced Circulation Air-Cooling and Air-Heating Coils certification programs and that the coils have been rated in accordance with AHRI Standard 410. Manufacturer must be ISO 9002 certified.
- B. Water heating coil shall be provided. Provide access to coil(s) for service and cleaning. Enclose coil headers and return bends fully within unit casing. Unit shall be provided with coil connections that extend a minimum of 5" beyond unit casing for ease of installation. Drain and vent connections shall be provided exterior to unit casing. Coil connections must be factory sealed with grommets on interior and exterior panel liners to minimize air leakage and condensation inside panel assembly. If not factory packaged, Contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.
 1. Headers shall consist of seamless copper tubing to assure compatibility with primary surface. Headers to have intruded tube holes to provide maximum brazing surface for tube to header joint, strength, and inherent flexibility. Header diameter should vary with fluid flow requirements.
 2. Fins shall have a minimum thickness of 0.0095 inch aluminum plate construction. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned

- length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.
3. Fins shall have a minimum thickness of 0.0075 inch aluminum plate construction. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.
 4. Coil tubes shall be 5/8 inch OD seamless copper, 0.035 inch nominal tube wall thickness, expanded into fins, brazed at joints.
 5. Coil tubes shall be 5/8 inch OD seamless copper, 0.020 inch nominal tube wall thickness, expanded into fins, brazed at joints.
 6. Coil connections shall be carbon steel, threaded connection. Connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain fittings shall be furnished on the connections, exterior to the air handler. Vent connections provided at the highest point to assure proper venting. Drain connections shall be provided at the lowest point to insure complete drainage and prevent freeze-up.
 7. Coil shall be furnished as an uncased galvanized steel to allow for thermal movement and slide into a pitched track for fluid drainage.
- C. Direct expansion refrigerant cooling coil shall be provided. Provide access to coil(s) for service and cleaning. Enclose coil headers and return bends fully within unit casing. Unit shall be provided with coil connections that extend a minimum of 3" beyond unit casing for ease of installation. Coil connections must be factory sealed with grommets on interior and exterior panel liners to minimize air leakage and condensation inside panel assembly. If not factory packaged, Contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.
1. Sweat type copper suction headers shall be provided.
 2. Fins shall have a minimum thickness of 0.0075 inch aluminum plate construction. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.
 3. Coil tubes shall be 5/8 inch OD seamless copper, 0.020 inch nominal tube wall thickness, expanded into fins on 1 1/2-inch centers, brazed at joints.
 4. Sweat type copper suction connections located at the bottom of the suction headers for gravity oil drainage. Coils shall be uniformly circuited in a counterflow manner for either single circuit, row, face, interlaced, or interlaced face split capacity reduction as shown on unit schedule. Pressure type liquid distributors used. Coils shall be tested with 315 pounds air pressure under warm water, and suitable for 250 psig working pressure.
 5. Coil casing shall be a formed channel frame of galvanized steel.

2.08 FILTERS

- A. Furnish flat filter in mixing box section with 2-inch pleated MERV 8 filter. Provide side loading and removal of filters.

- B. Furnish combination filter section with 2-inch pleated MERV 8 flat pre-filter and 4-inch final filter. Provide side loading and removal of filters.
- C. Filter media shall be UL 900 listed, Class I or Class II.
- D. Filter Magnehelic gauge(s) shall be furnished and mounted by equipment manufacturer.

2.09 ADDITIONAL SECTIONS

- A. Access section shall be provided for access between components.
- B. Plenum section shall be provided and properly sized for inlet and/or discharge air flow (between 600 and 1500 feet per minute). The plenum shall provide single or multiple openings as shown on drawings and project schedule.
- C. Mixing box section shall be provided with end outside air opening and top return air opening with or without parallel low leak airfoil damper blades. Dampers shall be hollow core galvanized steel airfoil blades, fully gasketed and have continuous vinyl seals between damper blades in a galvanized steel frame. Dampers shall have stainless steel jamb seals along end of dampers. Connecting linkage and ABS plastic end caps shall be provided when return and outside air dampers are each sized for full airflow. Return and outside air dampers of different sizes must be driven separately. Damper Leakage: Leakage rate shall be less than two tenths of one percent leakage at 2 inches static pressure differential. Leakage rate tested in accordance with AMCA Standard 500.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's Installation & Maintenance instructions.

3.02 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

3.03 EXTRA MATERIALS

- A. Provide one, two, etc. extra set(s) fan belts, filters, etc. for each unit as shown on project schedule.

END OF SECTION

SECTION 23 73 13
SECTION INCLUDES

1.01

A.

1.02

A.
B.
C.
D.
E.
F.
G.
H.
I.
J.
K.
L.
M.
N.
O.
P.
Q.
R.
S.
T.
U.
V.

1.03

A.
B.
1.
2.
3.

1.04

A.

1.05

A.
B.
C.

1.06

A.
B.
C.

2.01

A.

SECTION INCLUDES

- B.
- C.
- D.
- E.
- F.
- G.
- H.
- I.
- J.
- K.

2.02

- A.
 - 1.
 - 2.
 - 3.
 - 4.

2.03

- A.
- B.
- C.

2.04

- A.
- B.
 - 1.
 - 2.
 - 3.
 - 4.

- C.
- D.
- E.
- F.
- G.

2.05

- A.
 - 1.
 - 2.
 - 3.
 - 4.
 - 5.
 - 6.
 - 7.

2.06

- A.

2.07

- A.
- B.
- C.

- D.
- E.
- F.
- 1.

2.08

- A.
- B.
 - 1.
 - 2.
 - 3.
 - 4.
 - 5.
 - 6.
 - 7.
- C.
 - 1.
 - 2.
 - 3.
 - 4.
 - 5.

2.09

- A.
- B.
- C.
- D.

2.10

- A.
- B.
- C.

3.01

- A.

3.02

- A.

3.03

- A.

SECTION 23 82 16
AIR COILS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Water heating coils.
- B. Hose Kits.

1.02 RELATED REQUIREMENTS

- A. Section 23 07 19 - HVAC Piping Insulation.
- B. Section 232113 - Hydronic Piping.
- C. Section 23 21 14 - Hydronic Specialties.
- D. Section 23 31 00 - HVAC Ducts and Casings: Installation of duct coils.

1.03 REFERENCE STANDARDS

- A. AHRI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils; 2001 (R2011).
- B. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.

1.04 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions. Arranged to facilitate the design engineer's review, submit a schedule identifying every air coil, with tag numbers in numerical order corresponding to those on the drawings, along with all pertinent physical and performance data.
 - 1. Solely grouping the coils by size and rating, not in numerical order, requiring the engineer to search through the list to find a specific coil will not be acceptable.
 - 2. It will also not be acceptable to list coil manufacturing data (sizes, fins per foot, rows, etc.) in separate locations from the coil performance data.
 - 3. It will be acceptable to furnish such formatted product data as noted in 1.4.B.1 and/or 1.4.B.2, however, only in conjunction with the schedule noted above in 1.4.B. In that case, the submitted schedule data is what will primarily be reviewed.
- C. For any submitted coil that does not have the required AHRI Standard 410 certification due to being outside of the scope of the Standard, please clarify in the submittal what coil characteristic(s) is/are beyond the scope of the AHRI program. Manufacturer shall have AHRI laboratory tested coils across the range of coil sizes required for the project. Coil size alone will not be an acceptable exemption from the AHRI certification requirement.
- D. Product data: Hose kit component data. Submit a schedule identifying every hose kit, with hydronic coil tag numbers corresponding to those on the drawings.
- E. Shop Drawings: Indicate coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
- F. Certificates: Certify that coil capacities, pressure drops, and selection procedures meet or exceed specified requirements.
- G. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors.
- B. Protect coils from entry of dirt and debris with pipe caps or plugs.

1.07 WARRANTY

- A. See Section 017839 - Project Record Documents, for additional warranty requirements.
- B. Provide five year manufacturer warranty for all coils.

PART 2 PRODUCTS

2.01 WATER HEATING COILS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Heatcraft by Modine Manufacturing Co. (Basis of Design)
 - 2. Capital Coil & Air
 - 3. Daikin Industries
 - 4. USA Coil & Air
 - 5. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Tubes: 5/8 inch OD seamless copper (UNS12200) conforming to ASTM B75, ASTM B251, and ASTM B743, light annealed temper, arranged in parallel or staggered pattern, expanded into fin collars, silver brazed joints, spaced 1.5 inch equilaterally.
- C. Tube Thickness: 0.035 inches
- D. Fins: Aluminum _____ continuous plate type with full fin collars. Sine wave fins are also acceptable.
- E. Fin Thickness: 0.0095 inch for duct mounted reheat coils.
- F. Casing: Die formed channel frame of 16 gage, 0.0598 inch or 14 gage, ASTM A653 G90 galvanized steel with mounting holes on 3 inch centers. Provide tube supports for coils longer than 36 inches. Casing air leakage at 1.0 in wg shall not exceed 2 percent of coil scheduled airflow. Coils with apparent casing air leakage in operation shall have leakage addressed by the contractor field applying an appropriate air sealant.
- G. Headers: Seamless copper tube with silver brazed joints, UNS12200 conforming to ASTM B75, ASTM B88 and ASTM B251.
- H. Pipe Connections:
 - 1. Male Pipe Thread (MPT) and constructed from red brass conforming to ASTM B43 (for sizes 2" and under) or schedule 40 steel (for sizes 2-1/2" and above.)
 - 2. Male Pipe thread (MPT) or Female pipe thread (FPT) and constructed from copper (for sizes 2" and under.)
 - 3. Sweat Connection constructed from UNS 12200 seamless copper conforming to ASTM B75 and ASTM B251 (for sizes 2" and under.)
- I. Duct Connections: Furnish flanged type, suitable for desired duct mate connection.
- J. Testing: Dry Nitrogen or Helium test under water to 450 psi for design (working) pressure of 250 psi and 300 degrees F.
- K. Configuration: Drainable, with threaded plugs for drain and vent in headers.
- L. Air velocity: 425 fpm maximum, unless another velocity limit is indicated in drawing schedule, or implied by scheduled coil dimensions.
- M. Duct mounted reheat coils are to be one row coils.

- N. Water velocity to be between 1 and 6 feet per second. Water pressure drop to be not greater than 3 ft w.g.
- O. Coils to have AHRI Standard 410 certification and bear the AHRI symbol.
- P. Air pressure drop 0.11" w.g. maximum, unless lower pressure drop indicated in drawing schedule.

2.02 HOSE KITS AND VALVES

- A. 24 inches long. Minimum diameter, equal to hydronic coil connection size. Tag hose kit components to equipment designation.
- B. Stainless steel braided flexible hose, 2-1/2" and smaller. Reinforced, EPDM liner, maximum working pressure 400 psig (1/2" thru 1") and 300 psig (1-1/4" and larger), swivel connectors, nickel-plated brass OT58 fittings, and UL 94 rated. Furnish on supply and return.
- C. Provide ball valve and union. Forged brass, 600 psig WOG. Furnish with stainless steel balls and shafts, Teflon ball seals, and handle extension kits. Furnish on supply and return.
- D. Y-pattern strainer. Bronze or brass, 600 psig WOG, 304 stainless steel screen, 20 mesh.
- E. Manual balance valve, "Y pattern globe valve, brass body with digital hand wheel and memroy stop, soldered or threaded ends. "Victaulic" series TA or approved equal.
- F. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Griswold Controls
 - 2. Hays Fluid Controls, Basis of design.
 - 3. Nexus, Coil Pak N2Y with (2) 12" hoses.
 - 4. Oventrop
 - 5. Price Industries, Piping Package
 - 6. Victaulic Company
 - 7. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's written instructions.
- B. Install in ducts and casings in accordance with SMACNA (DCS).
 - 1. Support coil sections independent of piping on steel channel or double angle frames and secure to casings.
 - 2. Arrange supports to avoid piercing drain pans.
 - 3. Provide airtight seal between coil and duct or casing.
 - 4. Refer to Section 23 31 00.
- C. Protect coils to prevent damage to fins and flanges. Comb out bent fins.
- D. Install coils level. _____.
- E. Make connections to coils with unions and flanges.
- F. Hydronic Coils:
 - 1. Hydronic Coils: Connect water supply to leaving air side of coil (counterflow arrangement).
 - 2. Locate water supply at bottom of supply header and return water connection at top.
 - 3. Provide manual air vents at high points complete with stop valve.
 - 4. Ensure water coils are drainable and provide drain connection at low points.
 - 5. Refer to Section 23 21 14.

6. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
 - a. Connect supply and return hydronic piping to each hydronic coil with unions or flanges and shutoff valve hose kits.
- G. Cooling Coils:
 1. Provide drain pan and drain connection; fabricate from 20 gauge, 0.0359 inch galvanized steel, extend 3 inches from face of entering air side, 6 inches from face of leaving air side, and 4 inches from face of eliminators. Pipe drain pans individually to floor drain with water seal trap.
- H. Insulate headers located outside air flow as specified for piping. Refer to Section 23 07 19.

END OF SECTION

SECTION 25 00 00
HVAC INSTRUMENTATION AND CONTROLS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 07 8413 - Penetration Firestopping: Through-penetration firestop systems. Also comply with firestopping requirements of Division 23 Section "Mechanical General Provisions."
- C. Section 26 0533.13 - Conduit for Electrical Systems.
- D. Section 26 0533.16 - Boxes for Electrical Systems.
- E. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.
- F. Section 28 4600 - Fire Detection and Alarm.

1.02 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

1.03 DEFINITIONS

- A. DDC: Direct-digital controls.
- B. LAN: Local area network.
- C. MS/TP: Master-slave/token-passing.
- D. PICS: Protocol Implementation Conformance Statement.

1.04 REFERENCE STANDARDS

- A. NFPA 70-2020 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.05 SYSTEM DESCRIPTION

- A. Control system consists of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems.
- B. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- C. Provide control systems consisting of thermostats, control valves and actuators, dampers and actuators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.
- D. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.
- E. Control system includes the following:
 - 1. Fire alarm system specified in Division 28 Section "Fire Detection and Alarm."

1.06 SEQUENCE OF OPERATION

- A. As specified in the drawings

1.07 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. Each control device labeled with setting or adjustable range of control.
- C. Firestopping materials.
- D. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 1. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
 2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
 3. Details of control panel faces, including controls, instruments, and labeling.
 4. Written description of sequence of operation.
 5. Schedule of dampers including size, leakage, and flow characteristics.
 6. Schedule of valves including leakage and flow characteristics.
 7. Trunk cable schematic showing programmable control unit locations and trunk data conductors.
 8. Listing of connected data points, including connected control unit and input device.
 9. System graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
 10. System configuration showing peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
- E. Coordination Drawings: Detail major elements, components, and systems of HVAC controls equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
 1. Planned layout, including panels, actuators, and specialty locations.
 2. Clearances for installing and maintaining insulation.
 3. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
 4. Equipment and accessory service connections and support details.
 5. Exterior wall and foundation penetrations.
 6. Fire-rated wall and floor penetrations.
 7. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 8. Reflected ceiling plans to coordinate and integrate installation of ceiling-mounted items.
- F. Prior to the purchasing of materials or the start of work, prepare a $\frac{1}{2}'' = 1'-0''$ scale coordination drawing showing size, size and location of mechanical controls items relative to other trades. Distribute drawing to other trades, and Submit drawing to Design Professional for review and approval. No demolition or new work shall proceed until all trades have indicated their respective services on the coordination drawing, and the Engineer has reviewed and approved the coordination drawings. Coordination drawings shall not be utilized as the final as built drawings required in this specification.
- G. Samples: For each color required, of each type of thermostat cover.
- H. Software Upgrade Kit: For Owner to use in modifying software to suit future power system revisions or monitoring and control revisions.
- I. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

- J. Maintenance Data: For systems to include in maintenance manuals specified in Division 1. Include the following:
 - 1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
 - 2. Interconnection wiring diagrams with identified and numbered system components and devices.
 - 3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
 - 4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 - 5. Calibration records and list of set points.
- K. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- L. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors. Revise Shop Drawings to reflect actual installation and sequence of operations.

1.08 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is a certified installer of the automatic control system manufacturer for both installation and maintenance of units required for this Project.
- B. Manufacturer Qualifications: A firm experienced in manufacturing automatic temperature-control systems similar to those indicated for this Project and with a record of successful in-service performance.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70-2017, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Mechanical contractor shall verify the mechanical equipment, including motor controllers and variable frequency drives furnished under the mechanical contract, short circuit current rating (SCCR) is selected and coordinated to accommodate the minimum available fault current at the location it is installed. This shall be based on the Power System Study results performed under the electrical contract. Where the Power System Study is not available prior to the equipment submission process, it shall be assumed that any equipment rated 10 horsepower and above shall have an SCCR rating of no less than 10,000 amperes. Equipment shall be provided with an SCCR label as required by the National Electrical Code.
- E. Perform work in accordance with NFPA 70-2017, or latest edition adopted.
- F. Comply with NFPA 90A-2015, "Installation of Air Conditioning and Ventilation Systems."

1.09 DRAWINGS USE AND INTERPRETATION

- A. It is not the intention of the drawings to show every item, piece of equipment, and detail related to the project.
- B. The drawings are diagrammatical and indicate the general arrangement of systems and equipment, unless indicated otherwise by dimension or Detail Drawings. For exact locations of building elements, refer to dimensioned Architectural/Structural Drawings. However, field measurements take precedence over dimensioned drawings. The installation of all systems and equipment is subject to clarification as indicated in reviewed shop drawings and field coordination drawing requirements specified in Division 1 – General Requirements, and the General Conditions.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

1.11 COORDINATION

- A. Refer to Division 1 Section "Facilities Services Coordination" for additional coordination required, to include meetings, field survey, and preparation and submittal of coordination drawings and schedules.
- B. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- C. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.
- D. Coordinate supply of conditioned electrical circuits for control units and operator workstation.
- E. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.
- F. Coordinate equipment with Division 26 Section "Variable-Frequency Motor Controllers" to achieve compatibility with variable frequency drives, and annunciation devices.
- G. Coordinate contract work with other work specified in other Sections. Relocate work if required for proper installation and functioning of other systems, at no extra cost to the Owner.
- H. In general, air duct, heating and sprinkler piping, and drainage lines take precedence over water, gas, and electrical conduits. The design professional will make final decisions regarding the arrangement of work which cannot be agreed upon by the contractors.

1.12 PRE-INSTALLATION MEETING

- A. Convene one week before starting work of this Section.
- B. Require attendance of parties directly affecting the work of this Section.

1.13 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.
- B. Replacement Materials: One replacement diaphragm or relay mechanism for each unique controller, thermostat, and positioning relay.

1.14 MAINTENANCE SERVICE

- A. Provide service and maintenance of energy management and control systems for one year(s) from Date of Substantial Completion.
- B. Provide two complete inspections per year, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.

1.15 PROTECTION OF SOFTWARE RIGHTS

- A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:
 - 1. Limiting use of software to equipment provided under these specifications.
 - 2. Limiting copying.
 - 3. Preserving confidentiality.
 - 4. Prohibiting transfer to a third party.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers. No other manufacturer's products will be considered.
 - 1. Electric, Electronic, and DDC Systems:
 - a. Control Technologies, Distech Controls.
 - b. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
 - c. Any authorized dealer / system integrator and manufacturer's series other than those noted above shall not be carried by any bidder.

2.02 DDC EQUIPMENT

- A. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
 - 1. Units monitor or control each input/output point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator station.
 - 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse input/output.
 - c. Monitoring, controlling, or addressing data points.
 - d. Testing and developing control algorithms without disrupting field hardware and controlled environment.
 - e. WEB Based.
 - f. BACnet Compatible
 - 3. Local operator interface provides for download from or upload to mobile operator station.
 - 4. Controller to controller communications "bus" shall not operate at speeds below 156kbps.
 - 5. Controllers shall have the ability to retain commissioning notes in non-volatile memory.
 - 6. Controllers shall retain their own schedules and set points in non-volatile on board memory, and shall not look to, poll, or be polled by any global controller to accomplish said functionality.
 - 7. Controller shall have the ability to put analog and digital outputs into "hand-auto-off" mode and monitor the status of said switches for alarming purposes and graphical display.
 - 8. Controllers shall have built-in 24 VDC power supplies.
 - 9. All controllers shall have published PICS BACnet conformance.
- B. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
 - 1. Units monitor or control each input/output point; process information; and download from or upload to operator station.
 - 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse input/output.

- c. Monitoring, controlling, or addressing data points.
 - d. WEB Based.
 - e. BACnet Compatible
- 3. Local operator interface provides for download from or upload to mobile operator station.
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- 6. Controllers shall retain their own schedules and set points in non-volatile on board memory, and shall not look to, poll, or be polled by any global controller to accomplish said functionality.
- 7. Controller shall have the ability to put analog and digital outputs into "hand-auto-off" mode and monitor the status of said switches for alarming purposes and graphical display.
- 8. Controllers shall have built-in 24 VDC power supplies.
- 9. All controllers shall have published PICS BACnet conformance.
- C. LAN Gate: Shall establish seamless interconnection between other electrical and mechanical subsystems. Shall provide communications between local control units and the graphical user interface.
- D. System Work Station: Provide a local work station with monitor for operator interface. Monitor shall be flat screen, minimum 20", 1920 x 1080 resolution, CPU to be minimum 3.0 Giga hertz operating speed, minimum 8 GB RAM with all required drivers and network cards required. Hard drive shall be 7,200 RPM with a minimum 750 GB for storage of data and trending. Provide with operating system and all required software with licenses.
 - 1. Work station location shall be coordinated with owner (may be located off site).
- E. System Software: Provide latest version of all software at Project completion. Include site licenses for all software. Include and implement the following capabilities from the control units:
 - 1. Units of Measure: Inch-pound and SI.
 - 2. WEB Based. The building system interface shall be capable of being accessed via a web based interface.
- F. Site Development Tools: Provide all site development tools including system graphics and logic programming software. Include site licenses for all software.
- G. Furnish all programming, database configuration, and complete equipment graphics and tables into a communication network and web-based graphical user interface software. Verify proper operation of system inputs, outputs, and sequence of operations.
- H. Controls sequences, including Automatic Fault Detection and Diagnostics (AFDD) routines, shall be fully implemented and be in accordance with the standardized advanced sequences of operation within ASHRAE Guideline 36-2024 "High-Performance Sequences of Operation for HVAC Systems."
 - 1. In the case of any differences between ASHRAE Guideline 36 and the controls work shown on the bid documents, contractor shall submit an RFI for direction in writing from the Engineer of Record, however, if not resolved in time for bidding, contractor shall carry the cost for worst case (highest cost).
 - 2. As-builts are to include actual sequence of operations.
 - 3. The primary BAS manufacturer shall agree to fully program and perform functional testing of all utilized ASHRAE Guideline 36 sequences for their authorized installer

bidding this project at no direct cost to these installers. The cost of ASHRAE Guideline 36 programming and functional testing shall not be a direct cost to this project. The primary BAS manufacturer shall furnish documentation the ASHRAE Guideline 36 sequences have been programmed and functionally tested by the controls vendor to meet ASHARE Guideline 36.

4. Controls equipment, such as older or existing unitary controllers, that are not capable of supporting Guideline 36 sequence of operations will not be accepted and must be replaced.

2.03 CONTROL PANELS

- A. Central (Master) Control Panels: Fully enclosed, steel-rack-type cabinet with locking doors or locking removable backs. Match finish of panels and provide multicolor graphic displays, schematically showing system being controlled.
- B. Local Control Panels: Unitized cabinet with suitable brackets for wall or floor mounting, located adjacent to each system under automatic control. Provide common keying for all panels.
 1. Fabricate panels of 0.06-inch thick, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish.
 2. Panel-Mounted Equipment: Temperature and humidity controllers, relays, and automatic switches; except safety devices. Mount devices with adjustments accessible through front of panel.
 3. Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, including damper-positioning switches, changeover switches, thermometers, and gages.
 4. Graphics: Color-coded graphic, laminated-plastic displays on doors, schematically showing system being controlled, with protective, clear plastic sheet bonded to entire door.
- C. Alarm Panels: Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted in hinged-cover enclosure.
 1. Alarm Condition: Indicating light flashes and horn sounds.
 2. Acknowledge Switch: Horn is silent and indicating light is steady.
 3. Second Alarm: Horn sounds and indicating light is steady.
 4. Alarm Condition Cleared: System is reset and indicating light is extinguished.
 5. Contacts in alarm panel allow remote monitoring by independent alarm company.

2.04 SENSORS

- A. Electronic Sensors: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
 1. Thermistor temperature sensors as follows:
 - a. Accuracy: Plus or minus 0.36 deg F at calibration point.
 - b. Wire: Twisted, shielded-pair cable.
 2. Resistance Temperature Detectors: Platinum.
 - a. Accuracy: Plus or minus 0.2 percent at calibration point.
 - b. Wire: Twisted, shielded-pair cable.
 - c. Room Sensors: Match room thermostats, locking cover.
 - d. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
 3. Humidity Sensors: Bulk polymer sensor element.
 - a. Accuracy: 5 percent full range with linear output.

- b. Room Sensors: With locking cover matching room thermostats, span of 25 to 90 percent relative humidity.
 - c. Duct and Outside-Air Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.
- 4. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
 - a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
 - b. Output: 4 to 20 mA.
 - c. Building Static-Pressure Range: 0 to 0.25 inch wg.
 - d. Duct Static-Pressure Range: 0 to 5 inches wg.
- 5. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; proportional output 4 to 20 mA.
- B. Equipment operation sensors as follows:
 - 1. Status Inputs for Fans: Differential-pressure switch with adjustable range of 0 to 5 inches wg.
 - 2. Status Inputs for Pumps: Differential-pressure switch piped across pump with adjustable pressure-differential range of 8 to 60 psig.
 - 3. Status Inputs for Electric Motors: Current-sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.
- C. Electronic Valve/Damper Position Indication: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- D. Water-Flow Switches: Pressure-flow switches of bellows-actuated mercury or snap-acting type, with appropriate scale range and differential adjustment, with stainless-steel or bronze paddle. For chilled-water applications, provide vaporproof type.
- E. Refrigerant Detectors: Dual-level detectors, using solid-state sensors, with alarm preset for 300 ppm, alarm indicator light, alarm silence light and button, alarm test light and button, and trouble light. Provide auxiliary relay preset for 150 ppm.
- F. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment, for flush mounting.

2.05 THERMOSTATS

- A. Room Thermostats: Electronic, microcomputer-based room thermostat with digital readout.
 - 1. 10K ohm thermistor w/ 0.36°F standard accuracy and 0.18°F drift over a ten year space.
 - 2. Concealed communications port for laptop access.
 - 3. Multiple units can be daisy chained to one controller.
 - 4. LCD display capable of indicating zone temperature, heating set point, cooling set point and outdoor air temperature.
 - 5. Occupancy override switch with adjustable override time.
 - a. Display indicates override time when activated.
 - b. Override time rate and maximum override time shall be fully programmable.
 - 6. Mounting: Standard 2x4 box.
- B. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature, with copper capillary and bulb, unless otherwise indicated.
 - 1. Bulbs in water lines with separate wells of same material as bulb.
 - 2. Bulbs in air ducts with flanges and shields.
 - 3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit, adequately supported.

4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
5. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument
- C. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.
- D. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type, with adjustable set point in middle of range and adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.
- E. Electric Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or below set point.
 1. Bulb Length: Minimum 20 feet.
 2. Quantity: One thermostat for every 20 sq. ft. of coil surface.
- F. Electric High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or above set point.
 1. Bulb Length: Minimum 20 feet.
 2. Quantity: One thermostat for every 20 sq. ft. of coil surface.
- G. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig, and cast housing with position indicator and adjusting knob.

2.06 HUMIDISTATS

- A. Duct-Mounted Humidistats: Electric insertion, 2-position type with adjustable 2 percent throttling range, 20 to 80 percent operating range, single- or double-pole contacts.
- B. Room Humidistats:
 1. Wall mounted, proportioning type.
 2. Throttling range: Adjustable 2 percent relative humidity.
 3. Operating range: 30 to 80 percent.
 4. Maximum temperature: 110 degrees F.
 5. Cover: Set point indication.

2.07 INPUT/OUTPUT SENSORS

- A. Temperature Sensors:
- B. Humidity Sensors:
 1. Elements: Accurate within 5 percent full range with linear output.
 2. Room Sensors: With locking cover , span of 30 to 80 percent relative humidity.
 3. Duct and Outside Air Sensors: With element guard and mounting plate, range of 0 - 100 percent relative humidity.
- C. Static Pressure Sensors:
 1. Unidirectional with ranges not exceeding 150 percent of maximum expected input.
 2. Temperature compensate with typical thermal error or 0.06 percent of full scale in temperature range of 40 to 100 degrees F.
 3. Accuracy: One percent of full scale with repeatability 0.3 percent.
 4. Output: 0 - 5 vdc with power at 12 to 28 vdc.
- D. Equipment Operation Sensors:

1. Status Inputs for Fans: Differential pressure switch with adjustable range of 0 to 5 inches wg.
2. Status Inputs for Pumps: Differential pressure switch piped across pump with adjustable pressure differential range of 8 to 60 psi.
3. Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.
- E. Digital to Pneumatic Transducers:
 1. Convert plus or minus 12 vdc pulse width modulation outputs to 0 to 20 psi.
- F. Damper Position Indication: Potentiometer mounted in enclosure with adjustable crank arm assembly connected to damper to transmit 0 - 100 percent damper travel.
- G. Carbon Monoxide Detectors:
 1. Single or multichannel dual level detectors, using solid state sensors with three year minimum life. Sensor replacement shall take maximum 15 minutes. Suitable over temperature range of 23 to 130 degrees F.
 2. Provide individual indicators and contractors for each level, initially calibrated for 50 ppm and 100 ppm.
 3. Maximum response time to 100 ppm CO calibration gas: Two minutes.

2.08 TRANSMITTERS

- A. Building Static Pressure Transmitter:
 1. One pipe, direct acting, double bell, scale range 0.01 to 6.0 inch wg positive or negative, and sensitivity of 0.0005 inch wg. Transmit electronic signal to receiver with matching scale range.
- B. Differential Pressure Transmitters:
 1. Two pipe direct acting indicating type for gas, liquid, or steam service, range suitable for system, proportional electronic output.
- C. Pressure Transmitters:
 1. One pipe direct acting indicating type for gas, liquid, or steam service, range suitable for system, proportional electronic output.
- D. Temperature Transmitters:
 1. One pipe, directly proportional output signal to measured variable, linearity within plus or minus 1/2 percent of range for 200 degree F span and plus or minus 1 percent for 50 degree F span, with 50 degrees F temperature range, compensated bulb, averaging capillary, or rod and tube operation on 20 psig input pressure and 3 to 15 psig output.
- E. Humidity Transmitters:
 1. One pipe, directly proportioned output signal to measured variable, linearity within plus or minus 1 percent for 70 percent relative humidity span, capable of withstanding 95 percent relative humidity without loss of calibration.

2.09 ACTUATORS

- A. Available Manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated into the Work include only those listed below. The following shall occur for any manufacturer's series, other than the Basis of Design manufacturer's series noted below, to be proposed as a substitution: (1) A bidder RFI shall be submitted by the controls or mechanical contractor expressing such desire. For Engineer of Record review, furnish a preliminary submittal including any additional requested supporting documentation not later than one week in advance of the RFI deadline (to allow additional time for the review.) The controls or mechanical contractor's desire shall not be carried by any bidder unless approved via Addendum. (2) Be submitted as a substitution to not only

- demonstrate manufacturer's series compliance with the requirements, but also demonstrate equivalency to the Basis of Design series.
1. Belimo, model/series suitable for actuating commercial quality control valves and dampers (Basis of Design.)
 2. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
1. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
 2. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
 3. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
 4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
 5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft: Size for running and breakaway torque of 150 in. x lbf.
- C. Electronic Damper and Large-Valve Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
1. Valves: Size for torque required for valve close-off at maximum pump differential pressure.
 2. Dampers: Size for running torque calculated as follows:
 - a. Opposed-Blade Damper with Edge Seals: 5 inch-pounds/sq. ft. of damper.
 3. Coupling: V-bolt and V-shaped, toothed cradle.
 4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
 6. Power Requirements Two-Position Spring Return: 120-V ac.
 7. Temperature Rating: Minus 22 to plus 122 deg F.
 8. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
 9. Run Time: 12 seconds open, 5 seconds closed.

2.10 CONTROL VALVES

- A. Hydronic system control valves, including those at terminal units, shall have the following characteristics:
1. Available Manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated into the Work include only those listed below. The following shall occur for any manufacturer's series, other than the Basis of Design manufacturer's series noted below, to be proposed as a substitution: (1) A bidder RFI shall be submitted by the controls or mechanical contractor expressing such desire. For Engineer of Record review, furnish a preliminary submittal including any additional requested supporting documentation not later than one week in advance of the RFI deadline (to allow additional time for the review.) The controls or mechanical contractor's desire shall not be carried by any bidder unless approved via Addendum. (2) Be submitted as a substitution to not only demonstrate manufacturer's series

compliance with the requirements, but also demonstrate equivalency to the Basis of Design series.

- a. Belimo (Characterized Control Valve - CCV: B2 Series Two-way ½" to 3", B3 Series Three-way ½" to 2" Mixing/Diverting, B6 Series Two-way Flanged 2½" to 6"; Basis of Design.)
 - b. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
2. Characterized Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
- a. Belimo B2 Series Two-way, NPS ½" to 3" (Basis of Design, to include a Belimo suitable actuator.)
 - 1) Service: Hydronic applications up to 60% glycol and up to 50 psig steam
 - 2) End connection: female NPT
 - 3) VS Body: B584-C84400 bronze (hydronic applications and up to 35 psig steam)
 - (a) Pressure rating: 600 psig WOG
 - (b) Maximum temperature: 280°F
 - 4) VSS Body: A351-CF8M stainless steel (36-50 psig steam)
 - (a) Pressure rating: 1500 psig WOG (1/2" to 1") and 2000 psig WOG (2")
 - (b) Maximum temperature: 298°F
 - 5) Characterized disk: 316 stainless steel
 - 6) Seats: MPTFE, RPTFE
 - 7) Leakage rating: ANSI Class VI
 - b. Belimo B3 Series Three-way, NPS ½" to 2" Mixing/Diverting (Basis of Design, to include a Belimo suitable actuator.)
 - 1) Service: Hydronic applications up to 60% glycol and up to 50 psig steam
 - 2) End connection: female NPT
 - 3) VS Body: B584-C84400 bronze (hydronic applications and up to 35 psig steam)
 - (a) Pressure rating: 600 psig WOG
 - (b) Maximum temperature: 280°F
 - 4) VSS Body: A351-CF8M stainless steel (36-50 psig steam)
 - (a) Pressure rating: 1500 psig WOG (1/2" to 1") and 2000 psig WOG (2")
 - (b) Maximum temperature: 298°F
 - 5) Characterized disk: 316 stainless steel
 - 6) Seats: MPTFE, RPTFE
 - 7) Leakage rating: ANSI Class VI
 - c. Belimo B6 Series Two-way, Flanged 2½" to 6" (Basis of Design, to include a Belimo suitable actuator.)
 - 1) Service: Hydronic applications up to 60% glycol
 - 2) End connection: Flanged, End fitting ANSI Class 125 flange, flat face. ANSI 250 alternatively required where noted and wherever bolted to raised flange.
 - 3) Body: Cast iron GG25
 - (a) Pressure rating: 600 psig WOG
 - (b) Maximum temperature: 250°F
 - 4) Close-off pressure: 175 psid, 310 psid (Class 250)
 - 5) Maximum differential pressure (ΔP): 50 psid
 - 6) Characterized disk: Stainless steel

- 7) Seats: Teflon PTFE
- 8) Leakage: 0% for A to AB
- 3. Sizing: 3-psig maximum pressure drop at design flow rate.
- 4. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics. Actuators shall close valves against pump shutoff head.
 - a. Two-way valves shall have equal percentage flow characteristics, accomplishing best control stability due to required linear relationship between the position of the valve stem and the heat output from controlled equipment (coil, etc.) The coil characteristic (Btuh vs. valve percentage open) is "convex" and the required equal percentage valve characteristic is to be "concave" (logarithmic deep response curve.) The two shall complement and counteract each other to provide a linear Btuh output.
 - b. Valves intended for two position (on/off) applications, shall not be used for modulating, temperature control applications. An example would be the Schneider Electric Erie PopTop two position valves.
 - c. Three-way valves shall have similar linear Btuh output characteristics.
 - d. Actuators shall close valves against pump shutoff head.
- B. Cast Iron Butterfly Valves
 - 1. These are to be used only for two position (on/off) application. Alternatively, the above Belimo Characterized Control Valve - CCV may be used for two position (on/off) application.
 - 2. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Milwaukee Valve (Basis of Design, to include a Belimo two position suitable actuator.)
 - 1) ML223E series Rev. D for NPS 2-1/2 thru NPS 4 (lever operated)
 - 2) ML323E series Rev D for NPS 6 thru NPS 12 (gear operated)
 - b. Watts Industries, Inc.; Water Products Div.
 - c. Hammond Valve
 - d. Bray International, Inc., Series 31H
 - e. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
 - 3. Body Style: Lug pattern. Suitable for installation between Class 125 or Class 150 flanges, although Class 150 is preferred where possible.
 - 4. Specifications: API-609 MSS SP-67 Type 1
 - 5. 200 psi Non-Shock WOG. Bi-Directional Dead End Service to 200 psi maximum. Bubble tight shut off.
 - 6. Body Material: ASTM A126 Cl. B cast iron.
 - 7. Disc Material: Aluminum/Bronze ASTM B148
 - 8. Packing: High Density, High Purity Graphite
 - 9. Stem: Type 416 Stainless Steel
 - 10. Liner Material, Seals: EPDM

2.11 DAMPERS

- A. Generally dampers are to be furnished under Division 23 and installed by the Mechanical Contractor. The Controls Contractor is to provide actuators for each damper.

- B. Actuators to be "Belimo" style and rating to suit the damper and control sequence.

2.12 AIR FLOW MEASURING STATIONS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Ebtron, Inc. (C probe sensor density, GTC116e-PC or GTM116e-PC, Gold Series, Advantage IV, Basis of design.)
 - 2. Paragon Controls
 - 3. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Airflow monitoring system to use thermal dispersion technology relating the power dissipated by a self-heated thermistor to the airflow rate at one or more sensor nodes in an airstream.
- C. Installed Airflow Accuracy
 - 1. Ducts/Plenums: Installed system accuracy $\pm 3\%$ of airflow reading from 0-5,000 fpm; sensor probe accuracy $\pm 2\%$ of airflow reading to NIST-traceable airflow standards
 - 2. Non-ducted OA Intakes: better than or equal to $\pm 5\%$ of reading
- D. Temperature: Independent, velocity weighted average
- E. Listings & Compliance
 - 1. UL: 60730-1
 - 2. CE: Yes
 - 3. BACnet International: BTL Listed (GTC116e and GTM116e transmitters)
 - 4. FCC: This device complies with Part 15 of the FCC rules
- F. Environmental Limits
 - 1. Probes Temperature: -20 to 160 °F
 - 2. Transmitter Temperature: -20 to 120 °F
 - 3. Probes Humidity: (non-condensing): 0 to 100%
 - 4. Transmitter Humidity: (non-condensing): 5 to 95%
- G. Sensing Node Sensors
 - 1. Self-heated sensor: Precision, hermetically sealed, bead-in-glass thermistor probe
 - 2. Temperature sensor: Precision, hermetically sealed, bead-in-glass thermistor probe
- H. Sensing Node Housing
 - 1. Material: Glass-filled Polypropylene (Kynar® with /SS option)
 - 2. Sensor Potting Materials: Waterproof marine epoxy
- I. Sensing Node Internal Wiring
 - 1. Type: Kynar® coated copper
- J. Temperature Measurement
 - 1. Type: Velocity-weighted average
 - 2. Accuracy: $\pm 0.15^\circ\text{F}$ [0.08°C] to NIST-traceable temperature standards
- K. Sensor Probe Tube: Material: Gold anodized 6063 aluminum
- L. User Interface: 2 line x16-character backlit LCD display and 4 button interface
- M. B.A.S. Connectivity Options
 - 1. All Transmitters: Three field selectable (0-5/0-10 VDC or 4-20mA), scalable and isolated analog output signals (AO1=airflow, AO2=temperature or alarm, AO3=%RH, enthalpy or dew point when /H option is provided).

2. GTC116e Transmitter: One additional field selectable (BACnet MS/TP or Modbus RTU) and isolated RS-485 network connection – Individual sensor node airflow rates and temperatures are available via the network
3. GTM116e Transmitter: One additional isolated Ethernet (simultaneously supported BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP) network connection - Individual sensor node airflow rates and temperatures are available via the network
4. EB-Link Bluetooth® low energy Interface for Android® and iPhone®

PART 3 EXECUTION

3.01 HVAC CONTROLS DEMOLITION

- A. Disconnect, demolish, and remove HVAC controls systems, equipment, and components indicated to be removed.
 1. Piping, tubing, and conduit to Be Removed: Remove portion of piping, tubing, and conduit indicated to be removed and cap or plug that remaining with same or compatible material. Demolish any existing associated wall sleeves except as noted below.
 2. Piping, tubing, and conduit to Be Abandoned in Place: Drain piping, tubing, and conduit and cap or plug same with compatible material.
 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 6. Whenever piping, ductwork, equipment, and appurtenances are indicated to be removed, resulting in a hole, opening, void, or other discontinuity in the adjacent architectural features, these features shall be infilled and restored to a continuous appearance and function as indicated or to match existing materials of construction. Waterproofing is to be repaired, where it existed before, or where indicated. If the resulting hole is indicated to be reused, any required wall sleeve shall be replaced unless in excellent condition.
 7. Do not abandon in place any unused components.
- B. If pipe, tubing, conduit, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
- C. Disconnect, demolish, and remove Work specified in Division 22 and 23 Drawings and Sections.
- D. If pipe, tubing, conduit, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.
- E. Accessible Work: Remove indicated exposed pipe, tubing, conduit in its entirety.
- F. Work Abandoned in Place: Cut and remove underground pipe a minimum of 2 inches beyond face of adjacent construction. Cap and patch surface to match existing finish.
- G. Removal: Remove indicated equipment from Project site.
- H. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

3.02 ARRANGEMENT OF WORK

- A. Install work as closely as possible to layouts shown on contract drawings. Modify work as necessary to provide maximum possible headroom and space clearance on each side, and as found necessary during the course of preparing coordination drawings. Provide adequate clearance and ready access to all parts of the work, for inspection operation, safe maintenance and repair, and code conformance. Coordinate and arrange work to avoid conflicts with other trades and as needed for satisfactory space conditions shown on coordination drawing submittals. Where space appears to be inadequate consult Design Professional before proceeding with installation.

3.03 COORDINATION

- A. Examine Contract Documents and coordinate with contractor and other trades as necessary to facilitate the progress of work.
- B. Furnish services of experienced electrical superintendent who shall be constantly in charge of electrical work, together with skilled laborers required to unload, transfer, erect, connect, adjust, start, operate, and test each system.
- C. Do not install a system until critical components of systems and related systems have been coordinated and applicable shop drawings have been approved.

3.04 PROTECTION

- A. The Controls Contractor shall be responsible for work and equipment until fully inspected, tested and accepted. Carefully store materials and equipment, which is not immediately installed after delivery to site. Close open ends of work with temporary covers or plug during construction to prevent entry of obstructing material or damaging water.

3.05 LUBRICATION

- A. Equipment shall be furnished and installed so that lubrication points are conveniently and readily accessible for maintenance. Make these provisions by whatever means is appropriate: extended fittings, access doors, equipment location, etc. Provide lube sites for grease fittings.

3.06 TESTING AND BALANCING

- A. Provide controls systems operations during the mechanical systems adjustment period at the completion of each phase of the project, and during the final testing and balancing procedures. Document all issues encountered during the mechanical systems adjustment period. Submit three copies of issues to Owner's Construction Supervisor.

3.07 EXAMINATION

- A. Verify that conditioned power supply is available to control units and operator workstation.
- B. Verify that duct-, pipe-, and equipment-mounted devices and wiring and pneumatic piping are installed before proceeding with installation.

3.08 INSTALLATION

- A. Install equipment level and plumb.
- B. Install software in control units and operator workstation. Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- C. Connect and configure equipment and software to achieve sequence of operation specified.
- D. Verify location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation. Coordinate location with owner.
 - 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- E. Install guards on thermostats in the following locations:
 - 1. Entrances.
 - 2. Public areas.

3. Where indicated.
- F. Install duct volume control dampers according to Division 23 Section "Air Duct Accessories."
- G. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- H. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- I. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."
- J. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."
- K. Sleeve conduits passing through concrete and masonry walls, gypsum-board partitions, elevated floors, and roof penetrations. Comply with Pipe Sleeves requirements of Articles 2.7 and 3.2.M of Division 23 Section "Mechanical General Provisions" (requirements therein for pipe shall apply to Division 25 conduits.)

3.09 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Controls contractor shall be responsible for all costs for controls wiring and conduit to include providing necessary power and data to the mechanical control system components.
- B. All controls conductors shall be installed in conduit.
 1. Minimum conduit size shall be ½" EMT.
- C. Install raceways, boxes, and cabinets according to Division 26 Sections "Conduit" and "Boxes."
- D. Install building wire and cable according to Division 26 Section "Wiring Connections."
 1. Install controls conductors in minimum ½" EMT
 2. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
- E. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- F. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.
- G. Any required duct smoke detectors are to be furnished by the fire alarm contractor. Where noted on the controls drawings, provide for fan shutdown from the fire alarm system.

3.10 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
 1. Install piping adjacent to machine to allow service and maintenance.
- B. Ground equipment.
 1. 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.

3.11 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.
4. Pressure test control air piping at 30 psig or 1.5 times the operating pressure for 24 hours, with maximum 5-psig loss.
5. Pressure test high-pressure control air piping at 150 psig and low-pressure control air piping at 30 psig for 2 hours, with maximum 1-psig loss.
6. Calibration test pneumatic and electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
- B. Replace damaged or malfunctioning controls and equipment.
 1. Start, test, and adjust control systems.
 2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
 3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.
- C. Verify DDC as follows:
 1. Verify software including automatic restart, control sequences, scheduling, reset controls, and occupied/unoccupied cycles.
 2. Verify operation of operator workstation.
 3. Verify local control units including self-diagnostics.

3.12 COMMISSIONING

- A. Refer to notes on mechanical drawings regarding commissioning requirements.
- B. Commissioning work shall include any work needed to the system graphics.

3.13 DECOMMISSION

- A. Decommission the existing controls system as it pertains to the mechanical demolition project scope. As appropriate, this shall include hiring the existing controls contractor to properly decommission the following:
 1. Graphics
 2. Trending
 3. Network dependencies (data being passed in/out of space to AHU's and water systems.)
 4. Network topology (any devices the network is expecting to poll in the area.)
 5. Hardware.
 6. Modifying any system requiring values from the existing system to respond correctly in their absence.

3.14 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain control systems and components.
 1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
 2. Provide operator training on data display, alarm and status descriptors, requesting data, executing commands, calibrating and adjusting devices, resetting default values, and requesting logs. Include a minimum of 40 hours of dedicated instructor time on-site.
 3. Review data in maintenance manuals. Refer to Division 1 Section "Closeout Procedures."
 4. Schedule training with Owner, through Architect, with at least seven days advance notice.

3.15 ON-SITE ASSISTANCE

- A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project site visits, when requested by Owner, to adjust and calibrate components and to assist Owner's personnel in making program changes and in adjusting sensors and controls to suit actual conditions.

END OF SECTION

SECTION 26 05 00
ELECTRICAL GENERAL PROVISIONS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following: Adjust list below to suit Project. If Division 16 Section "Conductors and Cables," "Raceways and Boxes," or "Electrical Identification" is included in Project Specifications, delete corresponding items below.
 - 1. Cutting and patching for electrical construction.
 - 2. Touchup painting.

1.03 DEFINITIONS

- A. The use of the word "Provide": Whenever the word "Provide" is used in the specifications and/or on the drawings, it shall mean "furnish and install", "connect", "apply", "erect", "construct", or similar terms, unless otherwise indicated.
- B. The use of the word "Piping": "Piping" shall include but not be limited to, in addition to piping or mains, all fittings, flanges, unions, valves, strainers, drains, traps, insulation, vents, hangers and other accessories relative to such piping.
- C. The use of the word "Material": Whenever the word material is used in the specifications and/or on the drawings, it shall mean any "product", "equipment", "device", "assembly", or "item" required under the contract, as indicated by trade or brand name, manufacturer's name, standard specification reference or other description.
- D. The term "Electrical Contractor" or "Contractor" refer to the Sub Contractor or his Sub Contractors responsible for the furnishing and installation of all work indicated on the Electrical drawings and in the Electrical Specifications.
- E. The term "Accessible" indicates ease of access with or without the use of ladders and without requiring extensive removal of other equipment, such as ductwork, piping, conduit, etc to gain access. "accessible ceiling" indicates acoustical tile type hung ceilings. Concealed spline or sheetrock ceilings with access panes shall not be considered accessible ceilings.

1.04 CODES, STANDARDS, REFERENCES, AND PERMITS

- A. All material and workmanship shall comply with all the latest editions of all applicable Codes, Specifications, Local and State Ordinances, Industry Standards and Utility Company Regulations.
- B. In case of differences between the Building Codes, State Law, Local Ordinances, Industry Standards and Utility Company Regulations and the Contract Documents, the contractor shall promptly notify the Engineer in writing of any such difference.
- C. In case of conflict between the Contract Documents and the requirements of any Code or Authorities having jurisdiction, the most stringent requirements of the aforementioned shall govern for budgetary and bid purposes. However, no work will proceed until the Engineer determines the correct method of installation.
- D. Should the contractor perform any work that does not comply with the requirements of the applicable Building Codes, State Laws, Local Ordinances, Industry Standards and Utility Company Regulations, the contractor shall bear all costs arising in correcting the deficiencies, as approved by the Engineer.

- E. Coordinate with NMC any requirements of the hospital not indicated in the Construction Documents. It is understood all contractors approved for work at NMC are familiar with all NMC Standards and work related requirements.

1.05 SUBMITTALS

- A. Shop Drawings: Dimensioned plans and sections or elevation layouts of electrical equipment and devices. All clearance requirements for electrical equipment shall be included.
- B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Provide factory representation for supervision of equipment installation and commissioning (start-up) where requested by drawings and/or specifications. The factory representative shall provide approval of adequate installation completion.
- C. Provide documentation that structural supports for stacking transformers is adequate to accommodate weights.

1.06 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.

1.07 SYSTEM DESCRIPTION

- A. Furnish and install all materials in order to provide functioning systems, upon completion, in compliance with all applicable codes, authorities having jurisdiction, manufacturer's requirements, performance requirements specified, and any modifications resulting from reviewed shop drawings and the field coordination drawings.

1.08 SCOPE OF WORK

- A. The contractor is responsible for furnishing and installing all the devices and equipment shown indicated the Electrical Drawings including materials and equipment required to create fully operational systems.
- B. The contractor shall be responsible for reviewing all the Construction Document Plans. In addition to all mechanical equipment, light fixtures fixtures, and devices indicated on the Electrical Plans, the contractor is responsible for electrical installation of all the equipment and devices shown on the Construction Document Plans.
- C. The contractor shall be responsible for reviewing all the Construction Document Plans. Prior to bid, the contractor shall notify the Engineer of any discrepancies between the Architectural, Electrical, Mechanical, Plumbing, Structural, Kitchen, Fire Protection or any other relevant plans associated with this project regarding equipment locations, equipment quantities, conduit routing, device locations, light locations, chase locations, etc. otherwise it will be assumed the contractor is responsible for the electrical installation of all the equipment and devices shown on these plans regardless of whether they are indicated on the Electrical Plans.

1.09 DRAWING INTERPRETATION

- A. The project drawings are schematic in nature and indicate general arrangement of equipment. It is not the intent of the drawings to substitute for shop drawings. In many instances, equipment and devices are sized on one manufacturers product. In the event of a field verification or coordination issue, report issue to Owners construction supervisor.
- B. Install work as closely as possible to layouts shown on drawings. Modify work as necessary to meet job conditions and to clear other equipment. Offsets, transitions and changes of direction in all systems shall be made as required to maintain proper headroom and pitch of sloping lines, to avoid existing field conditions as well as to maintain clearances to equipment

whether or not indicated on the drawings. The contractor shall provide all pull boxes and accessories as required for his work to effect these offsets, transitions and changes in direction. Consult Design Professional before making changes that effect the function or appearance of systems.

- C. Do not install equipment, devices or conduit in a non-code compliant fashion due to drawing interpretation. Provide modification of illustrated work in order to accommodate job conditions at no cost to Owner.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver conduit with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored conduit and equipment from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.
- C. Protect electrical specialties from moisture and dirt.
- D. Store plastic conduit protected from direct sunlight. Support to prevent sagging and bending.

1.11 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
 - 1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
- B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.
- C. Coordinate electrical service connections to components furnished by utility companies.
 - 1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.
 - 2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.
- D. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Access doors and panels are specified in Division 8 Section "Access Doors."
- E. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.
- F. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.
- G. Coordinate all Division 26 work with all other divisions.
- H. Coordinate supporting electrical equipment and devices with all other divisions.
- I. Coordinate mounting heights of all devices with architectural details and shop drawings.

1.12 SEQUENCING AND SCHEDULING

- A. Coordinate electrical equipment installation with other building components.
- B. Arrange for conduit spaces, chases, slots, and openings in building structure during progress of construction to allow for electrical installations.
- C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.
- D. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.

- E. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- F. Coordinate requirements for access panels and doors if electrical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors."
- G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

1.13 "AS-BUILT" RECORD DRAWINGS

- A. Record daily progress on one set of construction documents. Utilize a permanent black or blue marking media. All progress of record drawings shall be provided in a neat and accurate fashion.
- B. As-built drawing reviews will be completed on a monthly basis by the engineer of record. Release of requisitions will be based on the regular progress of As-built drawings. The latest As-built drawings shall be submitted for review with each requisition for payment.
- C. Formal As-built drawings shall be submitted for review at the completion of each phase of the work. The as-built drawings shall be 1/4" scale and created in electronic format utilizing AUTOCAD 2014. At the completion of each phase of work, the electrical contractor shall submit to the Engineer the original field progress as-built drawings, the electronic files of the formal as-built drawings, and four sets of final as-built drawings plotted on sheets the same size as the Construction Documents. Final payment for the phase of work and the start of the next phase shall be dependant of approval of the as-built drawings.

1.14 GUARANTEE

- A. Provide written guarantee of all completed/installed work. Materials, equipment and workmanship shall be guaranteed for a minimum period of one year after Owners acceptance of work. Any failure due to defective material, equipment or workmanship shall be corrected at no additional cost to owner. This shall include damage completed to other areas of construction or facility resulting from this failure. Provide correction of any failure within an acceptable/reasonable time period.
- B. Provide all equipment and material manufacturers guarantees and/or warranties to owner after acceptance of installation.

1.15 OPERATING AND MAINTENANCE MANUALS

- A. Provide operating and maintenance information for all equipment, devices, systems, and materials. This shall include all maintenance and operations procedures, recommendations, and service requirements. All submitted data must include minimum equipment/device operations and maintenance requirements to fulfill manufacturers warranties.
- B. Submit all engineering selection and specification documentation with operating and maintenance information for all equipment, devices, systems, and materials.
- C. Submit all data media in a detailed, organized, and complete manner. Provide a minimum of three copies to Owners construction supervisor for engineer/architect review. Submit in 3 ring bound enclosure.

PART 2 PRODUCTS

2.01 TOUCHUP PAINT

- 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 EQUIPMENT INSTALLATION

- A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.
- B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- D. Right of Way: Give to raceways and piping systems installed at a required slope.
- E. Provide $\frac{3}{4}$ " exterior grade, group 3, fire resistive plywood for surface mounted equipment installation. Paint plywood with battleship grey finish which meets fire resistive building requirements. Provide where indicated on drawings or where equipment is to be mounted on masonry or concrete walls.
- F. Mounting heights indicated on drawings are to be measured from the center of the device to the finished floor elevation. Submit a request for unidentified mounting heights of equipment to Owners construction supervisor.
- G. Coordinate all device mounting heights with Architectural documents and ADA requirements. If discrepancy is detected, contact design professional so as to limit delay to construction.
- H. The mounting heights indicated on architectural details and shop drawings take precedence over mounting heights indicated on drawings. In the event of a mounting issue, consult Owners construction supervisor.

3.02 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.03 FIELD QUALITY CONTROL

- A. Inspect installed components for damage and faulty work, including the following:
 - 1. Raceways.
 - 2. Building wire and connectors.
 - 3. Supporting devices for electrical components.
 - 4. Electricity-metering components.
 - 5. Concrete bases.
 - 6. Electrical demolition.
 - 7. Cutting and patching for electrical construction.
 - 8. Touchup painting.

3.04 REFINISHING AND TOUCHUP PAINTING

- A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 9 Section "Painting."
 - 1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.

2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.05 CLEANING AND PROTECTION

- A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
- B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION

**SECTION 26 05 05
ELECTRICAL DEMOLITION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical demolition.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that abandoned wiring and equipment serve only abandoned facilities.
- B. Demolition drawings are based on casual field observation and existing record documents.
- C. Report discrepancies to Architect before disturbing existing installation.
- D. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Coordinate utility service outages with utility company.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Obtain permission from Owner at least 24 hours before partially or completely disabling system.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.
- E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Notify Owner before partially or completely disabling system.
 - 2. Notify local fire service.
 - 3. Make notifications at least 24 hours in advance.
 - 4. Make temporary connections to maintain service in areas adjacent to work area.
 - 5. Coordinate work with Fire Station to transfer fire alarm system off Library.
- F. Existing Telephone System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Notify Owner at least 24 hours before partially or completely disabling system.
 - 2. Notify telephone utility company at least 24 hours before partially or completely disabling system.
 - 3. Make temporary connections to maintain service in areas adjacent to work area.
 - 4. Coordinate work with Fire Station to transfer telecom service off Library.

- G. Existing public address and security System: Maintain existing system in service until all work is complete. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Obtain permission from Owner at least 24 hours before partially or completely disabling system.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Remove, relocate, and extend existing installations to accommodate new construction.
- B. Remove abandoned wiring to source of supply.
- C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- E. Disconnect and remove abandoned panelboards and distribution equipment.
- F. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- G. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- H. Repair adjacent construction and finishes damaged during demolition and extension work.
- I. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- J. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.04 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment that remain or that are to be reused.
- B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
- C. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

END OF SECTION 26 05 05

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Single conductor building wire.
- B. Metal-clad cable.
- C. Wiring connectors.
- D. Electrical tape.
- E. Heat shrink tubing.
- F. Oxide inhibiting compound.
- G. Wire pulling lubricant.
- H. Cable ties.

1.02 RELATED REQUIREMENTS

- A. Division 7 - Penetration Firestopping: Through-penetration firestop systems.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 28 46 00 - Fire Detection and Alarm: Fire alarm system conductors and cables.

1.03 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011.
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).
- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2014).
- E. ASTM B800 - Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes - Annealed and Intermediate Tempers; 2005 (Reapproved 2011).
- F. ASTM B801 - Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy Wire for Subsequent Covering of Insulation; 2007 (Reapproved 2012).
- G. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2010.
- H. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2013.
- I. FS A-A-59544 - Cable and Wire, Electrical (Power, Fixed Installation); Federal Specification; Revision A, 2008.
- J. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- K. NECA 104 - Recommended Practice for Installing Aluminum Building Wire and Cable; 2012.
- L. NECA 120 - Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC); 2012.
- M. NEMA WC 70 - Nonshielded Power Cable 2000 V or Less for the Distribution of Electrical Energy; 2009.
- N. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.

- O. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- P. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
- Q. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
- R. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.
- S. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
- T. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.
- U. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.
- V. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.
- W. UL 2277 - Outline of Investigation for Flexible Motor Supply Cable and Wind Turbine Tray Cable; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- B. Field Quality Control Test Reports.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 32 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Nonmetallic-sheathed cable is not permitted.
- D. Underground feeder and branch-circuit cable is not permitted.
- E. Service entrance cable is not permitted.
- F. Metal-clad cable is permitted only as follows:
 - 1. Where not otherwise restricted, may be used:
 - a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.
 - 1) Maximum Length: 6 feet.
 - b. Where concealed above accessible ceilings and in walls for branch circuits.
 - 1) Exception: Provide single conductor building wire in raceway for circuit homerun from accessible ceiling space above panelboard to the panelboard.
 - 2. In addition to other applicable restrictions, may not be used:
 - a. Unless approved by Owner.
 - b. Where not approved for use by the authority having jurisdiction.
 - c. Where exposed to view, except in dedicated electrical, communications, and mechanical rooms where not subject to damage.
 - d. Where exposed to damage.
 - e. For damp, wet, or corrosive locations, unless provided with a PVC jacket listed as suitable for those locations.
 - f. For life safety circuits..

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Provide conductors and cables with lead content less than 300 parts per million.
- D. Provide new conductors and cables manufactured not more than one year prior to installation.
- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- F. Comply with NEMA WC 70.
- G. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- H. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- I. Conductors for Grounding and Bonding: Also comply with Section 26 05 26.
- J. Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum rated, listed and labeled as suitable for use in return air plenums.
- K. Conductor Material:
 - 1. Provide copper conductors except where aluminum conductors are specifically indicated or permitted for substitution. Conductor sizes indicated are based on copper unless specifically indicated as aluminum. Conductors designated with the abbreviation "AL" indicate aluminum.

- a. Substitution of aluminum conductors for copper is permitted, when approved by Owner and authority having jurisdiction, only for the following:
 - 1) Services: Copper conductors size 1/0 AWG and larger.
 - 2) Feeders: Copper conductors size #3 or higher.
 - 3) Where not specifically indicated to use copper only..
 - b. Where aluminum conductors are substituted for copper, comply with the following:
 - 1) Size aluminum conductors to provide, when compared to copper sizes indicated, equivalent or greater ampacity and equivalent or less voltage drop.
 - 2) Increase size of raceways, boxes, wiring gutters, enclosures, etc. as required to accommodate aluminum conductors.
 - 3) Provide aluminum equipment grounding conductor sized according to NFPA 70.
 - 4) Equip electrical distribution equipment with compression lugs for terminating aluminum conductors.
- 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
- 3. Tinned Copper Conductors: Comply with ASTM B33.
- 4. Aluminum Conductors (only where specifically indicated or permitted for substitution): AA-8000 series aluminum alloy conductors recognized by ASTM B800 and compact stranded in accordance with ASTM B801 unless otherwise indicated.
- L. Minimum Conductor Size:
 - 1. Branch Circuits: 12 AWG.
 - a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 100 feet: 10 AWG, for voltage drop.
 - 2) 20 A, 277 V circuits longer than 200 feet: 10 AWG, for voltage drop.
 - 2. Control Circuits: 14 AWG.
- M. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- N. Conductor Color Coding:
 - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 - 2. Color Coding Method: Integrally colored insulation.
 - a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
 - 3. Color Code:
 - a. 480Y/277 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral/Grounded: Gray.
 - b. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.

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- c. Equipment Ground, All Systems: Green.
- d. For control circuits, comply with manufacturer's recommended color code.

2.03 SINGLE CONDUCTOR BUILDING WIRE

- A. Description: Single conductor insulated wire.
- B. Conductor Stranding:
 - 1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: Stranded.
 - b. Size 8 AWG and Larger: Stranded.
 - 2. Control Circuits: Stranded.
- C. Insulation Voltage Rating: 600 V.
- D. Insulation:
 - 1. Copper Building Wire: Type THHN/THWN, THHN/THWN-2, or XHHW-2, except as indicated below.
 - a. Size 4 AWG and Larger: Type XHHW-2 or THHN/THWN-2.
 - b. Installed Underground: Type XHHW-2.
 - c. Fixture Wiring Within Luminaires: Type TFFN/TFN for luminaires with labeled maximum temperature of 90 degrees C; Approved suitable type for luminaires with labeled maximum temperature greater than 90 degrees C.
 - 2. Aluminum Building Wire (only where specifically indicated or permitted for substitution): Type XHHW-2.

2.04 METAL-CLAD CABLE

- A. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.
- B. Conductor Stranding:
 - 1. Size 10 AWG and Smaller: Stranded.
 - 2. Size 8 AWG and Larger: Stranded.
- C. Insulation Voltage Rating: 600 V.
- D. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.
- E. Grounding: Full-size integral equipment grounding conductor.
 - 1. Provide additional isolated/insulated grounding conductor where indicated or required.
- F. Armor: Steel, interlocked tape.
- G. Provide PVC jacket applied over cable armor where indicated or required for environment of installed location.

2.05 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Connectors for Grounding and Bonding: Comply with Section 26 05 26.
- C. Wiring Connectors for Splices and Taps:
 - 1. Copper Conductors : Use mechanical connectors or compression connectors.
 - 2. Connectors for Aluminum Conductors: Use compression connectors or mechanical connectors.
- D. Wiring Connectors for Terminations:
 - 1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
 - 2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.

3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
6. Aluminum Conductors: Use compression connectors or mechanical connectors for all connections.
7. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.
8. Conductors for Control Circuits: Use crimped terminals for all connections.
- E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.
- G. Mechanical Connectors: Provide bolted type or set-screw type.
- H. Compression Connectors: Provide circumferential type or hex type crimp configuration.
- I. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.

2.06 WIRING ACCESSORIES

- A. Electrical Tape:
 1. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
 2. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
 3. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
 4. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.
 5. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil; suitable for continuous temperature environment up to 221 degrees F.
 6. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.
- B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
- C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
- D. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
- E. Cable Ties: Material and tensile strength rating suitable for application.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as indicated.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

- A. Circuiting Requirements:
 - 1. Unless dimensioned, circuit routing indicated is diagrammatic.
 - 2. When circuit destination is indicated without specific routing, determine exact routing required.
 - 3. Arrange circuiting to minimize splices.
 - 4. Include circuit lengths required to install connected devices within 10 ft of location indicated.
 - 5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
 - 6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
 - 7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is not permitted.
 - 8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
- B. Install products in accordance with manufacturer's instructions.
- C. Perform work in accordance with NECA 1 (general workmanship).
- D. Install aluminum conductors in accordance with NECA 104.
- E. Install metal-clad cable (Type MC) in accordance with NECA 120.
- F. Installation in Raceway:
 - 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 - 2. Pull all conductors and cables together into raceway at same time.
 - 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 - 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- G. Exposed Cable Installation (only where specifically permitted):
 - 1. Route cables parallel or perpendicular to building structural members and surfaces.
 - 2. Protect cables from physical damage.
- H. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- I. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent

- support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
- J. Terminate cables using suitable fittings.
 - 1. Metal-Clad Cable (Type MC):
 - a. Use listed fittings.
 - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
 - K. Install conductors with a minimum of 12 inches of slack at each outlet.
 - L. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.
 - M. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
 - N. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
 - O. Make wiring connections using specified wiring connectors.
 - 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
 - 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 - 3. Do not remove conductor strands to facilitate insertion into connector.
 - 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
 - 5. Connections for Aluminum Conductors: Fill connectors with oxide inhibiting compound where not pre-filled by manufacturer.
 - 6. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 7. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
 - P. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
 - 1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
 - 2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
 - b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
 - 3. Wet Locations: Use heat shrink tubing.
 - Q. Insulate ends of spare conductors using vinyl insulating electrical tape.
 - R. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.

- S. Identify conductors and cables in accordance with Section 26 05 53.
- T. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- U. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Perform inspection, testing, and adjusting in accordance with Section .
- C. Inspect and test in accordance with NETA ATS, except Section 4.
- D. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
 - 1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
- E. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION 26 05 19

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 33.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.
- B. Section 26 05 33.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.
- C. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.
- D. Section 26 51 00 - Interior Lighting: Additional support and attachment requirements for interior luminaires.
- E. Section 26 56 00 - Exterior Lighting: Additional support and attachment requirements for exterior luminaires.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2013.
- D. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position; 2014.
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- F. MFMA-4 - Metal Framing Standards Publication; 2004.
- G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. NFPA 101 - Life Safety Code; 2015.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

1.05 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.
 1. Fiberglass Channel (Strut) Framing Systems: Include requirements for strength derating according to ambient temperature.
- B. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with applicable building code.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 1.5. Include consideration for vibration, equipment operation, and shock loads where applicable.
 4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.

1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
2. Conduit Clamps: Bolted type unless otherwise indicated.
- C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
- D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 1. Comply with MFMA-4.
 2. Channel Material:
 - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
- E. Fiberglass Channel (Strut) Framing Systems: Factory-fabricated continuous-slot fiberglass channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 1. Channel Material: Use polyester resin or vinyl ester resin.
 2. Flammability: Fire retardant with NFPA 101, Class A flame spread index (maximum of 25) when tested in accordance with ASTM E84; self-extinguishing in accordance with ASTM D635.
- F. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2-inch diameter.
 - b. Busway Supports: 1/2-inch diameter.
 - c. Single Conduit up to 1-inch (27 mm) Trade Size: 1/4-inch diameter.
 - d. Single Conduit Larger than 1-inch (27 mm) Trade Size: 3/8-inch diameter.
 - e. Trapeze Support for Multiple Conduits: 3/8-inch diameter.
 - f. Outlet Boxes: 1/4-inch diameter.
 - g. Luminaires: 1/4-inch diameter.
- G. Nonpenetrating Rooftop Supports for Low-Slope Roofs:
 1. Description: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane, not requiring attachment to roof structure and not penetrating roofing assembly, with support fixtures as specified.
 2. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 3. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
 4. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.
- H. Anchors and Fasteners:
 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
 2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
 3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
 4. Hollow Masonry: Use toggle bolts.
 5. Hollow Stud Walls: Use toggle bolts.
 6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
 7. Wood: Use wood screws.
 8. Plastic and lead anchors are not permitted.
 9. Powder-actuated fasteners are not permitted.

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10. Hammer-driven anchors and fasteners are not permitted.
11. Preset Concrete Inserts: Continuous metal channel/strut and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Manufacturer: Same as manufacturer of metal channel/strut framing system.
 - b. Comply with MFMA-4.
 - c. Channel Material: Use galvanized steel.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Provide required vibration isolation and/or seismic controls; see Section 26 05 48.
- H. Equipment Support and Attachment:
 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- I. Conduit Support and Attachment: Also comply with Section 26 05 33.13.
- J. Box Support and Attachment: Also comply with Section 26 05 33.16.
- K. Interior Luminaire Support and Attachment: See Section 26 51 00 for additional requirements.
- L. Exterior Luminaire Support and Attachment: See Section 26 56 00 for additional requirements.
- M. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- N. Secure fasteners according to manufacturer's recommended torque settings.
- O. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

- A. Inspect support and attachment components for damage and defects.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

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- C. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 26 05 33.13
CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. Aluminum rigid metal conduit (RMC).
- C. Galvanized steel intermediate metal conduit (IMC).
- D. PVC-coated galvanized steel rigid metal conduit (RMC).
- E. Flexible metal conduit (FMC).
- F. Liquidtight flexible metal conduit (LFMC).
- G. Galvanized steel electrical metallic tubing (EMT).
- H. Rigid polyvinyl chloride (PVC) conduit.
- I. Conduit fittings.
- J. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
- C. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 1. Includes additional requirements for fittings for grounding and bonding.
- D. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- E. Section 26 05 33.16 - Boxes for Electrical Systems.
- F. Section 26 05 33.23 - Surface Raceways for Electrical Systems.
- G. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.
- H. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- I. Section 26 21 00 - Low-Voltage Electrical Service Entrance: Additional requirements for electrical service conduits.
- J. Section 27 05 33.13 - Conduit for Communications Systems.

1.03 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2005.
- B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); 2005.
- C. ANSI C80.5 - American National Standard for Electrical Rigid Aluminum Conduit (ERAC); 2005.
- D. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC); 2005.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- F. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2013.
- G. NECA 102 - Standard for Installing Aluminum Rigid Metal Conduit; 2004.
- H. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2003.
- I. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.
- J. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; 2005.
- K. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2013.
- L. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2015.

- M. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- N. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.
- O. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
- P. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.
- Q. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.
- R. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.
- S. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- T. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.
- U. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
- V. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.
- W. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
 - 4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.05 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.

- B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
- C. Underground:
 - 1. Exterior, Direct-Buried: Use rigid PVC conduit.
- D. Embedded Within Concrete:
 - 1. Within Slab on Grade: Not permitted.
 - 2. Within Slab Above Ground: Not permitted.
- E. Exposed, Exterior: Use galvanized steel rigid metal conduit.
- F. Connections to Vibrating Equipment:
 - 1. Dry Locations: Use liquidtight flexible metal conduit.
 - 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
 - 3. Maximum Length: 6 feet unless otherwise indicated.
 - 4. Vibrating equipment includes, but is not limited to:
 - a. Transformers.
 - b. Motors.
 - c. Generators.

2.02 CONDUIT REQUIREMENTS

- A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling a mandrel through them.
- B. Electrical Service Conduits: Also comply with Section 26 21 00.
- C. Fittings for Grounding and Bonding: Also comply with Section 26 05 26.
- D. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
- E. Provide products listed, classified, and labeled as suitable for the purpose intended.
- F. Minimum Conduit Size, Unless Otherwise Indicated:
 - 1. Branch Circuits: 1/2 inch (16 mm) trade size.
 - 2. Control Circuits: 1/2-inch trade size.
 - 3. Flexible Connections to Luminaires: 3/8-inch trade size.
 - 4. Underground, Interior: 3/4-inch trade size.
 - 5. Underground, Exterior: 3/4-inch trade size.
- G. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- B. Fittings:
 - 1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
 - 2. Hazardous/Classified Locations: Use fittings listed and labeled as complying with UL 1203 for classification of installed location.
 - 3. Material: Use steel or malleable iron.
 - 4. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.04 ALUMINUM RIGID METAL CONDUIT (RMC)

- A. Description: NFPA 70, Type RMC aluminum rigid metal conduit complying with ANSI C80.5 and listed and labeled as complying with UL 6A.
- B. Fittings:
 - 1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6A.
 - 2. Material: Use aluminum.
 - 3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.05 GALVANIZED STEEL INTERMEDIATE METAL CONDUIT (IMC)

- A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.
- B. Fittings:
 - 1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.
 - 2. Material: Use steel or malleable iron.
 - 3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.06 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.
- B. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil, 0.040 inch.
- C. PVC-Coated Boxes and Fittings:
 - 1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
 - 2. Nonhazardous Locations: Use boxes and fittings listed and labeled as complying with UL 514A, UL 514B, or UL 6.
 - 3. Material: Use steel or malleable iron.
 - 4. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil, 0.040 inch.
- D. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil, 0.015 inch.

2.07 FLEXIBLE METAL CONDUIT (FMC)

- A. Description: NFPA 70, Type FMC standard-wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems.
- B. Fittings:
 - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.

2.08 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- B. Fittings:
 - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.

2.09 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

- A. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- B. Fittings:
 - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.
 - 3. Connectors and Couplings: Use compression/gland or set-screw type.
 - a. Do not use indenter type connectors and couplings.
 - 4. Damp or Wet Locations (where permitted): Use fittings listed for use in wet locations.

2.10 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.
- B. Fittings:
 - 1. Manufacturer: Same as manufacturer of conduit to be connected.
 - 2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Install aluminum rigid metal conduit (RMC) in accordance with NECA 102.
- E. Install intermediate metal conduit (IMC) in accordance with NECA 101.
- F. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by manufacturer.
- G. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- H. Conduit Routing:
 - 1. Unless dimensioned, conduit routing indicated is diagrammatic.
 - 2. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Mechanical equipment rooms.
 - 3. Unless otherwise approved, do not route exposed conduits:
 - a. Across floors.
 - b. Across roofs.
 - c. Across top of parapet walls.
 - d. Across building exterior surfaces.
 - 4. Conduits installed underground may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.

5. Arrange conduit to maintain adequate headroom, clearances, and access.
 6. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
 7. Arrange conduit to provide no more than 150 feet between pull points.
 8. Route conduits above water and drain piping where possible.
 9. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
 10. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
 11. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
 - a. Heaters.
 - b. Hot water piping.
 - c. Flues.
- I. Conduit Support:
1. Secure and support conduits in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
 2. Provide required vibration isolation and/or seismic controls; see Section 26 05 48.
 3. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
 4. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
 5. Use conduit strap to support single surface-mounted conduit.
 - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
 6. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
 7. Use conduit clamp to support single conduit from beam clamp or threaded rod.
 8. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
 9. Use nonpenetrating rooftop supports to support conduits routed across rooftops, where approved.
 10. Use of spring steel conduit clips for support of conduits is not permitted.
 11. Use of wire for support of conduits is not permitted.
 12. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.
- J. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
 2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
 3. Use suitable adapters where required to transition from one type of conduit to another.
 4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
 5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.

6. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
 7. Secure joints and connections to provide maximum mechanical strength and electrical continuity.
- K. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
 4. Conceal bends for conduit risers emerging above ground.
 5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
 6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
 7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
 8. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- L. Underground Installation:
1. Minimum Cover, Unless Otherwise Indicated or Required:
 - a. Underground, Exterior: 24 inches unless indicated otherwise on drawings.
 2. Provide underground warning tape in accordance with Section 26 05 53 along entire conduit length _____.
- M. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
 3. Where conduits are subject to earth movement by settlement or frost.
- N. Conduit Sealing:
1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
 - a. Where conduits enter building from outside.
 - b. Where service conduits enter building from underground distribution system.
 - c. Where conduits enter building from underground.
 - d. Where conduits may transport moisture to contact live parts.
 2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
 - a. Where conduits pass from outdoors into conditioned interior spaces.

- b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- 3. Where conduits cross boundaries of hazardous/classified locations, provide identified/listed sealing fittings or conduit mechanical seals as approved by authorities having jurisdiction; locate as indicated or in accordance with NFPA 70.
- O. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
 - 1. Where conduits pass from outdoors into conditioned interior spaces.
 - 2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- P. Provide pull string in each empty conduit and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.
- Q. Provide grounding and bonding in accordance with Section 26 05 26.
- R. Identify conduits; see Section 26 05 53.

3.03 FIELD QUALITY CONTROL

- A. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- B. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.
- C. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING

- A. Clean interior of conduits to remove moisture and foreign matter.

3.05 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Ground bars.
- E. Ground rod electrodes.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
- B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- C. Section 26 56 00 - Exterior Lighting: Additional grounding and bonding requirements for pole-mounted luminaires.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2007.
- C. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify exact locations of underground metal water service pipe entrances to building.
 - 2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.05 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
- B. Shop Drawings:
 - 1. Indicate proposed arrangement for signal reference grids. Include locations of items to be bonded and methods of connection.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Field quality control test reports.
- E. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

- A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
- B. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- E. Grounding Electrode System:
 - 1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
 - a. Provide continuous grounding electrode conductors without splice or joint.
 - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
 - 2. Metal Underground Water Pipe(s):
 - a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
 - b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
 - c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
 - 3. Metal In-Ground Support Structure:
 - a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.
 - 4. Concrete-Encased Electrode:
 - a. Provide connection to concrete-encased electrode consisting of not less than 20 feet of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.

5. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
 - a. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
 - b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
 - c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
- F. Service-Supplied System Grounding:
 1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
 2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.
- G. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:
 1. Provide grounding electrode system for each separate building or structure.
 2. Provide equipment grounding conductor routed with supply conductors.
 3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.
 4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.
- H. Separately Derived System Grounding:
 1. Separately derived systems include, but are not limited to:
 - a. Transformers (except autotransformers such as buck-boost transformers).
 - b. Uninterruptible power supplies (UPS), when configured as separately derived systems.
 - c. Generators, when neutral is switched in the transfer switch.
 2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
 3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
 4. Where common grounding electrode conductor ground riser is used for tap connections to multiple separately derived systems, provide bonding jumper to connect the metal building frame and metal water piping in the area served by the derived system to the common grounding electrode conductor.
 5. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with NFPA 70.
 6. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor

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SYSTEMS

- connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
7. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.
- I. Bonding and Equipment Grounding:
1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
 2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
 3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
 4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
 5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
 6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
 7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
 - a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
 - b. Metal gas piping.
 8. Provide bonding for metal building frame.
- J. Communications Systems Grounding and Bonding:
1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.
 2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
 - a. Bonding Jumper Size: #3/0 copper, unless otherwise indicated..
 - b. Raceway Size: 3/4 inch trade size unless otherwise indicated or required.
 - c. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
 - d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

2.02 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
1. Provide products listed, classified, and labeled as suitable for the purpose intended.
 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26:
1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.

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- 2) Use bare copper conductors where directly encased in concrete (not in raceway).
- C. Connectors for Grounding and Bonding:
 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
 2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
 3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
- D. Ground Bars:
 1. Description: Copper rectangular ground bars with mounting brackets and insulators.
 2. Size: 1/4" x 2" x 24" unless otherwise indicated or required.
 3. Holes for Connections: As indicated or as required for connections to be made.
- E. Ground Rod Electrodes:
 1. Comply with NEMA GR 1.
 2. Material: Copper-bonded (copper-clad) steel.
 3. Size: 5/8 inch diameter by 8 feet length, unless otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as indicated.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
 1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
- D. Make grounding and bonding connections using specified connectors.
 1. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 2. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 3. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 4. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- E. Identify grounding and bonding system components in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.13.

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

- C. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- D. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION

SECTION 26 05 33.16
BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Boxes and enclosures for integrated power, data, and audio/video.
- D. Boxes for hazardous (classified) locations.
- E. Floor boxes.
- F. Underground boxes/enclosures.
- G. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 33.13 - Conduit for Electrical Systems:
 - 1. Conduit bodies and other fittings.
- D. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.
- E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- F. Section 26 27 26 - WIRING DEVICES:
 - 1. Wall plates.
 - 2. Floor box service fittings.
 - 3. Poke-through assemblies.
 - 4. Additional requirements for locating boxes for wiring devices.
- G. Section 27 10 00 - Structured Cabling: Additional requirements for communications systems outlet boxes.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
- C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.
- D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013.
- E. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. SCTE 77 - Specification for Underground Enclosure Integrity; 2013.
- H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- J. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.
- K. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.
- L. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
 - 4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
 - 5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
 - 6. Coordinate the work with other trades to preserve insulation integrity.
 - 7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
 - 8. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.
 - 1. Underground Boxes/Enclosures: Include reports for load testing in accordance with SCTE 77 certified by a professional engineer or an independent testing agency upon request.
- B. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- C. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground boxes/enclosures.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Keys for Lockable Enclosures: Two of each different key.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 BOXES

- A. General Requirements:
 - 1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.

2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
 3. Provide products listed, classified, and labeled as suitable for the purpose intended.
 4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
 5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
 2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
 3. Use nonmetallic boxes where exposed rigid PVC conduit is used.
 4. Use raised covers suitable for the type of wall construction and device configuration where required.
 5. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 6. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
 7. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 2. NEMA EN 10250 Environment Type, Unless Otherwise Indicated:
 3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide hinged-cover enclosures unless otherwise indicated.
 - b. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.
 4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
 - a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
 - b. Back Panels: Painted steel, removable.
 5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
- D. Boxes and Enclosures for Integrated Power, Data, and Audio/Video: Size and configuration as indicated or as required with partitions to separate services; field-connected gangable boxes may not be used.
- E. Boxes for Hazardous (Classified) Locations: Listed and labeled as complying with UL 1203 for the classification of the installed location.
- F. Floor Boxes:
1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 26 27 26; with partitions to separate multiple services; furnished with all components, adapters, and trims required for complete installation.
 2. Manufacturer: Same as manufacturer of floor box service fittings.
- G. Underground Boxes/Enclosures:
1. Description: In-ground, open bottom boxes furnished with flush, non-skid covers with legend indicating type of service and stainless steel tamper resistant cover bolts.

2. Size: As indicated on drawings.
3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 12 inches.
4. Provide logo on cover to indicate type of service.
5. Applications:
 - a. Sidewalks and Landscaped Areas Subject Only to Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77 Tier 8 load rating.
 - b. Parking Lots, in Areas Subject Only To Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77 Tier 15 load rating.
 - c. Do not use polymer concrete enclosures in areas subject to deliberate vehicular traffic.
6. Polymer Concrete Underground Boxes/Enclosures: Comply with SCTE 77.
 - a. Combination fiberglass/polymer concrete boxes/enclosures are acceptable.

2.02 ACCESSORIES

- A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for boxes and facade materials to be installed.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- E. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
- F. Box Locations:
 1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 31 00 as required where approved by the Architect.
 2. Unless dimensioned, box locations indicated are approximate.
 3. Locate boxes as required for devices installed under other sections or by others.
 4. Locate boxes so that wall plates do not span different building finishes.
 5. Locate boxes so that wall plates do not cross masonry joints.
 6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
 7. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
 8. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.

9. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
 - a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
 - b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.
- G. Box Supports:
 1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
 2. Provide required seismic controls in accordance with Section 26 05 48.
 3. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
 4. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
 5. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.
- H. Install boxes plumb and level.
- I. Flush-Mounted Boxes:
 1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- J. Install boxes as required to preserve insulation integrity.
- K. Underground Boxes/Enclosures:
 1. Install enclosure on gravel base, minimum 6 inches deep.
 2. Flush-mount enclosures located in concrete or paved areas.
 3. Mount enclosures located in landscaped areas with top at 1 inch above finished grade.
 4. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.
- L. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- M. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- N. Close unused box openings.
- O. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- P. Provide grounding and bonding in accordance with Section 26 05 26.

Q. Identify boxes in accordance with Section 26 05 53.

3.03 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.04 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION

SECTION 26 05 48
SEISMIC CONTROLS FOR ELECTRICAL WORK

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes seismic restraints and other earthquake-damage-reduction measures for electrical components. It complements optional seismic construction requirements in the various electrical component Sections.

1.03 DEFINITIONS

- A. IBC: International Building Code.
- B. SBC: Standard Building Code.
- C. UBC: Uniform Building Code.
- D. Seismic Restraint: A fixed device (a seismic brace, an anchor bolt or stud, or a fastening assembly) used to prevent vertical or horizontal movement, or both vertical and horizontal movement, of an electrical system component during an earthquake.
- E. Mobile Structural Element: A part of the building structure such as a slab, floor structure, roof structure, or wall that may move independent of other mobile structural elements during an earthquake.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data:
 - 1. Provide manufacturer's product literature documenting compliance with PART 2 PRODUCTS.
 - 2. Include seismic rating documentation for each isolator and restraint component accounting for horizontal, vertical, and combined loads.
- C. Shop Drawings:
 - 1. Clearly indicate the load and capacity assumptions selected. Include copies of any calculations.
 - 2. Include the calculations that indicate compliance with the applicable building code for seismic controls and the vibration isolator manufacturer's requirements.
 - 3. Include the seal of the Professional Structural Engineer registered in the State of Vermont in which the Project is located, on the drawings and calculations which at a minimum include the following:
 - a. Seismic Restraint Details: Detailed drawings of seismic restraints and snubbers including anchorage details that indicate quantity, diameter, and depth of penetration, edge distance, and spacing of anchors.
 - b. Equipment Seismic Qualification Certification: Certification by the manufacturer or responsible party that each piece of equipment provided will withstand seismic force levels as specified in the applicable building code for seismic controls.
 - 1) Basis for Certification: Indicate whether the withstand certification is based on actual testing of assembled components, on calculations, or on historic data.
 - 2) Indicate equipment to be sufficiently durable to resist design forces and or remain functional after the seismic event.

- c. Dimensioned outline drawings of equipment identifying center of gravity, locations, and provisions for mounting and anchorage.
 - d. Detailed description of the equipment anchorage devices on which the certifications are based.
 - e. Statement of Special Inspections: Prepared by the registered design professional in responsible charge.
 - 1) See Section 01 45 33 for additional requirements.
- D. Product Data:
 - 1. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES, OSHPD, or an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
- E. Delegated-Design Submittal: For vibration isolation and seismic-restraint details 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. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators, seismic restraints, and for designing vibration isolation bases.
 - a. For each seismic restraint calculation, utilize appropriate component importance factor, component response modification factor, and component amplification factor. Where vibration pad isolators are utilized, recommend and provide appropriate pad thickness and quantity. Where vibration isolators are utilized, recommend appropriate minimum deflection, and provide vibration isolators meeting this recommendation.
 - b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
 - 2. Seismic- Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES, OSHPD, an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
- F. Coordination Drawings: Show coordination of seismic bracing for Plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

- G. Manufacturer's Instructions: Indicate installation instructions with special procedures and setting dimensions.

1.05 QUALITY ASSURANCE

- A. Perform design and installation in accordance with applicable codes.
- B. Designer Qualifications: Perform design under direct supervision of a Professional Engineer experienced in design of this type of work and registered and licensed in the State in which the Project is located.
- C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
 - 1. Member of Vibration Isolation and Seismic Control Manufacturers Association (VISCMA).
- D. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.
 - 1. See Section 01 45 33 for additional requirements.
- E. Comply with seismic-restraint requirements in the International Building Code unless requirements in this Section are more stringent.

1.06 PERFORMANCE REQUIREMENTS

- A. Seismic Restraint Loading:
 - 1. Site Class as defined in International Building Code: Site Class D
 - 2. Seismic Design Category, SDC, is D.
 - 3. Component Importance Factor as defined in ASCE7: 1.5
 - 4. Risk Category as defined in ASCE7 and International Building Code: IV
- B.

1.07 COORDINATION

- A. Coordinate layout and installation of seismic bracing with building structural system and architectural features, and with mechanical, fire-protection, electrical, and other building features in the vicinity.
- B. Coordinate concrete bases with building structural system.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. B-Line Systems, Inc.
 - 2. Erico, Inc.
 - 3. Mason Industries, Inc.
 - 4. Unistrut Corporation.

2.02 MATERIALS

- A. Use the following materials for restraints:
 - 1. Indoor Dry Locations: Galvanized steel.
 - 2. Outdoors and Damp Locations: Galvanized steel.
 - 3. Corrosive Locations: Stainless steel.

2.03 ANCHORAGE AND STRUCTURAL ATTACHMENT COMPONENTS

- A. Strength: Defined in reports by ICBO Evaluation Service or another agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.
- B. Concrete and Masonry Anchor Bolts and Studs: Steel-expansion wedge type.
- C. Concrete Inserts: Steel-channel type.
- D. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.
- E. Welding Lugs: Comply with MSS SP-69, Type 57.
- F. Beam Clamps for Steel Beams and Joists: Double sided. Single-sided type is not acceptable.
- G. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.
- H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.

2.04 SEISMIC BRACING COMPONENTS

- A. Slotted Steel Channel: 1-5/8-by-1-5/8-inch cross section, formed from 0.1046-inch- thick steel, with 9/16-by-7/8-inch slots at a maximum of 2 inches o.c. in webs, and flange edges turned toward web.
 1. Materials for Channel: ASTM A 570, GR 33.
 2. Materials for Fittings and Accessories: ASTM A 575, ASTM A 576, or ASTM A 36.
 3. Fittings and Accessories: Products of the same manufacturer as channels and designed for use with that product.
 4. Finish: Baked, rust-inhibiting, acrylic-enamel paint applied after cleaning and phosphate treatment, unless otherwise indicated.
- B. Channel-Type Bracing Assemblies: Slotted steel channel, with adjustable hinged steel brackets and bolts.
- C. Cable-Type Bracing Assemblies: Zinc-coated, high-strength steel wire rope cable attached to steel thimbles, brackets, and bolts designed for cable service.
 1. Arrange units for attachment to the braced component at one end and to the structure at the other end.
 2. Wire Rope Cable: Comply with ASTM 603. Use 49- or 133-strand cable with a minimum strength of 2 times the calculated maximum seismic force to be resisted.
- D. Hanger Rod Stiffeners: Slotted steel channels with internally bolted connections to hanger rod.

PART 3 EXECUTION

3.01 APPLICATION

- A. Generator Sets: Comply with Division 23 Section "Mechanical Vibration Controls and Seismic Restraints."

3.02 INSTALLATION

- A. Install seismic restraints according to applicable codes and regulations and as approved by authorities having jurisdiction, unless more stringent requirements are indicated.

3.03 STRUCTURAL ATTACHMENTS

- A. Use bolted connections with steel brackets, slotted channel, and slotted-channel fittings to spread structural loads and reduce stresses.
- B. Attachments to New Concrete: Bolt to channel-type concrete inserts or use expansion anchors.
- C. Attachments to Existing Concrete: Use expansion anchors.

- D. Holes for Expansion Anchors in Concrete: Drill at locations and to depths that avoid reinforcing bars.
- E. Attachments to Solid Concrete Masonry Unit Walls: Use expansion anchors.
- F. Attachments to Hollow Walls: Bolt to slotted steel channels fastened to wall with expansion anchors.
- G. Attachments to Wood Structural Members: Install bolts through members.
- H. Attachments to Steel: Bolt to clamps on flanges of beams or on upper truss chords of bar joists.

3.04 ELECTRICAL EQUIPMENT ANCHORAGE

- A. Anchor rigidly to a single mobile structural element or to a concrete base that is structurally tied to a single mobile structural element.
- B. Anchor panelboards, controls panels, paralleling gear, motor-control centers, motor controls, switchboards, switchgear, transformers, unit substations, fused power-circuit devices, transfer switches, busways, battery racks, static uninterruptible power units, power conditioners, capacitor units, communication system components, and electronic signal processing, control, and distribution units as follows:
 - 1. Size concrete bases so expansion anchors will be a minimum of 10 bolt diameters from the edge of the concrete base.
 - 2. Concrete Bases for Floor-Mounted Equipment: Use female expansion anchors and install studs and nuts after equipment is positioned.
 - 3. Bushings for Floor-Mounted Equipment Anchors: Install to allow for resilient media between anchor bolt or stud and mounting hole in concrete.
 - 4. Anchor Bolt Bushing Assemblies for Wall-Mounted Equipment: Install to allow for resilient media where equipment or equipment-mounting channels are attached to wall.
 - 5. Torque bolts and nuts on studs to values recommended by equipment manufacturer.

3.05 SEISMIC BRACING INSTALLATION

- A. Install bracing according to spacings and strengths indicated by approved analysis.
- B. Expansion and Contraction: Install to allow for thermal movement of braced components.
- C. Cable Braces: Install with maximum cable slack recommended by manufacturer.
- D. Attachment to Structure: If specific attachment is not indicated, anchor bracing to the structure at flanges of beams, upper truss chords of bar joists, or at concrete members.

3.06 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Make flexible connections in raceways, cables, wireways, cable trays, and busways where they cross expansion and seismic control joints, where adjacent sections or branches are supported by different structural elements, and where they terminate at electrical equipment anchored to a different mobile structural element from the one supporting them.

3.07 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform the following field quality-control testing:
 - 1. Provide necessary test equipment required for reliable testing.
 - 2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
 - 4. Obtain Architect's approval before transmitting test loads to the structure. Provide temporary load-spreading members.

5. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
6. Test to 90 percent of rated proof load of device.
7. If a device fails the test, modify all installations of same type and retest until satisfactory results are achieved.
8. Record test results.

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Voltage markers.
- E. Underground warning tape.
- F. Floor marking tape.
- G. Warning signs and labels.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables:
- B. Section 26 27 26 : Device and wallplate finishes; factory pre-marked wallplates.

1.03 REFERENCE STANDARDS

- A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2011.
- B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- B. Sequencing:
 - 1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
 - 2. Do not install identification products until final surface finishes and painting are complete.

1.05 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.07 FIELD CONDITIONS

- A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

- A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.
- B. Identification for Equipment:
 - 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Enclosed switches and circuit breakers:

- 1) Identify voltage and phase.
 - 2) Identify power source and circuit number. Include location.
 - 3) Identify load(s) served. Include location.
2. Use voltage marker to identify highest voltage present for each piece of electrical equipment.
3. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
 - a. Minimum Size: 3.5 by 5 inches.
- C. Identification for Conductors and Cables:
 1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
 2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
 3. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
 - a. At each source and load connection.
- D. Identification for Raceways:
 1. Use voltage markers or color-coded bands to identify systems other than normal power system for accessible conduits at maximum intervals of 20 feet.
 - a. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches wide.
 - 1) Color Code:
 - (a) Emergency Power System: Red.
 - 2) Field-Painting: Comply with Section 09 91 23 and 09 91 13.
 - 3) Vinyl Color Coding Electrical Tape: Comply with Section 26 05 19.
- E. Identification for Boxes:
 1. Use voltage markers to identify highest voltage present.
 2. Use voltage markers or color coded boxes to identify systems other than normal power system.
 - a. Color-Coded Boxes: Field-painted per the same color code used for raceways.
 - 1) Fire Alarm System: Red.
 3. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
- F. Identification for Devices:
 1. Wiring Device and Wallplate Finishes: Comply with Section 26 27 26.
 2. Use identification label to identify fire alarm system devices.
 3. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.
 4. Use identification label or engraved wallplate to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.
 5. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.
- G. Identification for Luminaires:

1. Use permanent red dot on luminaire frame to identify luminaires connected to emergency power system.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

- A. Identification Nameplates:
 1. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
 2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
 3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
 4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
 5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
- B. Identification Labels:
 1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
 2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
- C. Format for Equipment Identification:
 1. Minimum Size: 1 inch by 2.5 inches.
 2. Legend:
 - a. Equipment designation or other approved description.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height:
 - a. Equipment Designation: 1/2 inch.
 5. Color:
 - a. Normal Power System: White text on black background.
 - b. Emergency Power System: White text on red background.
 - c. Fire Alarm System: White text on red background.
- D. Format for Caution and Warning Messages:
 1. Minimum Size: 2 inches by 4 inches.
 2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height: 1/2 inch.
 5. Color: Black text on yellow background unless otherwise indicated.
- E. Format for Receptacle Identification:
 1. Minimum Size: 3/8 inch by 1.5 inches.
 2. Legend: Power source and circuit number or other designation indicated.
 - a. Include voltage and phase for other than 120 V, single phase circuits.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height: 3/16 inch.
 5. Color: Black text on clear background.

- F. Format for Control Device Identification:
 - 1. Minimum Size: 3/8 inch by 1.5 inches.
 - 2. Legend: Load controlled or other designation indicated.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height: 3/16 inch.
 - 5. Color: Black text on clear background.
- G. Format for Fire Alarm Device Identification:
 - 1. Minimum Size: 3/8 inch by 1.5 inches.
 - 2. Legend: Designation indicated and device zone or address.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height: 3/16 inch.
 - 5. Color: Red text on white background.

2.03 WIRE AND CABLE MARKERS

- A. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
- B. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
- C. Legend: Power source and circuit number or other designation indicated.
- D. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
- E. Minimum Text Height: 1/8 inch.
- F. Color: Black text on white background unless otherwise indicated.

2.04 VOLTAGE MARKERS

- A. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.
- B. Minimum Size:
 - 1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
 - 2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
 - 3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
 - 4. Markers for Junction Boxes: 1/2 by 2 1/4 inches.
- C. Legend:
 - 1. Markers for Voltage Identification: Highest voltage present.
 - 2. Markers for System Identification:
- D. Color: Black text on orange background unless otherwise indicated.

2.05 FLOOR MARKING TAPE

- A. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with overlamine, 3 inches wide, with alternating black and white stripes.

2.06 WARNING SIGNS AND LABELS

- A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- B. Warning Signs:
 - 1. Materials:
 - a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
 - b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
 - 2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.

3. Minimum Size: 7 by 10 inches unless otherwise indicated.
- C. Warning Labels:
 1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
 - a. Do not use labels designed to be completed using handwritten text.
 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
 3. Minimum Size: 2 by 4 inches unless otherwise indicated.
- D. Floor Signs:
 1. Materials: Use factory preprinted, self-adhesive vinyl, polyester, or rubber labels with protective overlamine; removable.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 1. Surface-Mounted Equipment: Enclosure front.
 2. Flush-Mounted Equipment: Inside of equipment door.
 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 4. Elevated Equipment: Legible from the floor or working platform.
 5. Interior Components: Legible from the point of access.
 6. Conduits: Legible from the floor.
 7. Boxes: Outside face of cover.
 8. Conductors and Cables: Legible from the point of access.
 9. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
 1. Do not use adhesives on exterior surfaces except where substrate cannot be penetrated.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Secure rigid signs using stainless steel screws.
- G. Mark all handwritten text, where permitted, to be neat and legible.

3.03 FIELD QUALITY CONTROL

- A. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION

SECTION 26 05 83 EQUIPMENT WIRING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical connections to equipment.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
- B. Section 26 05 33.13 - Conduit for Electrical Systems.
- C. Section - .
- D. Section 26 05 33.16 - Boxes for Electrical Systems.
- E. Section 26 27 26 - WIRING DEVICES.
- F. Section 26 28 16.16 - Enclosed Switches.
- G. Section 26 2923 - VARIABLE FREQUENCY MOTOR CONTROLLERS

1.03 REFERENCE STANDARDS

- A. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (R 2010).
- B. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2012.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
 - 2. Determine connection locations and requirements.
- B. Sequencing:
 - 1. Install rough-in of electrical connections before installation of equipment is required.
 - 2. Make electrical connections before required start-up of equipment.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
 - 1. Colors: Conform to NEMA WD 1.

2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
 3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
- B. Disconnect Switches: As specified in Section 26 2817 and 26 2818 .
 - C. Wiring Devices: As specified in Section 26 27 26.
 - D. Flexible Conduit: As specified in Section 26 05 33.13.
 - E. Wire and Cable: As specified in Section 26 05 19.
 - F. Boxes: As specified in Section 26 05 33.16.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.
- J. Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.

END OF SECTION 26 05 83

SECTION 26 09 23
LIGHTING CONTROLS

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Lighting control system and components:
 - 1. Low voltage wall stations
 - 2. Power interfaces
 - 3. Wired sensors

1.02 RELATED DOCUMENTS

- A. Section 262726 Wiring Devices
- B. Section 265100 Interior Lighting Fixtures

1.03 SUMMARY

- A. The lighting control system specified in this section shall provide time-based, sensor-based (both occupancy and daylight), and manual lighting control
- B. The system shall be capable of turning lighting loads on/off as well as dimming lights (if lighting load is capable of being dimmed). Specific dimmers will be capable of “dimming lights to off”
- C. The system shall not require any centrally hardwired switching equipment.

1.04 SUBMITTALS

- A. Product Datasheets (general device descriptions, dimensions, electrical specifications, wiring details, nomenclature)
- B. Riser Diagrams – typical per room type (detailed drawings showing device interconnectivity of devices)
- C. Other Diagrams – as needed for special operation or interaction with other system(s)
- D. Example Contractor Startup/Commissioning Worksheet – must be completed prior to factory start-up
- E. Hardware and Software Operation Manuals
- F. "Quick Start" operation, diagnostic and troubleshooting reference guide including instructions for common issues, with references to more in-depth information in the O&M manual provided for Owner training.
- G. Other operational descriptions as needed

1.05 PROJECT CLOSEOUT DOCUMENTATION

- A. Provide a factory published manual
 - 1. Warranty
 - 2. Technical support contact
 - 3. Electronic manual on manufacturer’s website for free download

1.06 QUALITY ASSURANCE

- A. All steps in sensor manufacturing process shall occur in North America; including population of all electronic components on circuit boards, soldering, programming, wiring, and housing.
- B. All components and the manufacturing facility where product was manufactured must be RoHS compliant.
- C. In high humidity or cold environments, the sensors shall be conformably coated and rated for condensing humidity and -40 degree Fahrenheit (and Celsius) operation.
- D. All applicable products must be UL / CUL Listed or other acceptable national testing organization.

1.07 PROJECT CONDITIONS

- A. Only install equipment after the following site conditions are maintained:
 - 1. Ambient Temperature 14 to 105 degrees F (-10 to 40 degrees C)
 - 2. Relative Humidity less than 90% non-condensing
 - 3. Standard electrical enclosures are permanently installed
 - 4. Equipment is protected from dust, debris and moisture

1.08 WARRANTY

- A. Products to be free from defect in material and workmanship for a period of five years (5) from the date from shipment from facilities. Products may include: wall stations, remotes, control devices, powerpacks, sensors, network communication gear, gateways, nodes, Cat5 or Cat6 cables, relay panels, dimming panels, and photocontrols.
- B. Lighting control manufacturer shall verify installation complies with Warranty requirements prior to system start-up.

1.09 MAINTENANCE & SUSTAINABILITY

- A. Provide new parts, upgrades, and/or replacements available for a minimum of 5 years available to the end user
- B. Provide free telephone technical support

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Basis of controls design Manufacturer: Acuity Brands, One Lithonia Way, Conyers GA 30012, www.acuitycontrols.com
- B. Other Acceptable Manufacturers, subject to Owner approval:
 - 1. Hubbell (equal system).
 - 2. Eaton (equal system).
 - 3. Other substitute equal systems per Substitutions below.
- C. Substitutions:
 - 1. All proposed substitutions (clearly delineated as such) must be submitted in writing for approval by Architect a minimum of 10 working days prior to the bid date and must be made available to all bidders. Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.
 - 2. By using pre-approved substitutions, Contractor accepts responsibility and associated costs for all required modifications to related equipment and wiring. Provide complete engineered shop drawings (including power wiring) with deviations from the original design highlighted in an alternate color for review and approval by Architect prior to rough-in.
- D. Source Limitations: Where possible, furnish products produced by a single manufacturer and obtained from a single supplier.

2.02 SYSTEM REQUIREMENTS

- A. System shall have an architecture that is based upon two main concepts; 1) intelligent lighting control devices 2) standalone lighting control zones
- B. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, dimming outputs, manual switch stations, and manual dimming stations. Combining one or more of these components into a single device enclosure should be permissible so as to minimize overall device count of system.

- C. Intelligent lighting control devices shall communicate digitally, require <7 mA of current to function (Graphic wall stations excluded), and possess RJ-45 style connectors.
- D. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher level network backbone.
- E. Devices within a lighting control zone shall be connected with CAT-5e low voltage cabling in any order.
- F. Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.
- G. All switching and dimming for a specific lighting zone shall take place within the devices located in the zone itself (i.e. not in remotely located devices such as panels) to facilitate system robustness and minimize wiring requirements. Specific applications that require centralized or remote switching shall be capable of being accommodated.
- H. Individual lighting zones shall be capable of being segmented into several "local" channels of occupancy, photocell, and switch functionality for more advanced configurations and sequences of operation.
 - 1. Individual lighting zones shall be capable of being set at a maximum output below the actual full lumen output.
 - 2. Each lighting zone shall have an "eco" mode that brings lights on at the target light level below full lumen output. Users will have option to raise or lower light output via dimmer switch.
- I. System shall be capable of operating a lighting control zone according to several sequences of operation. System shall be able to change a spaces sequence of operation according to a time schedule so as to enable customized time-of-day, day-of-week, utilization of a space. Note: Operating modes should be utilized only in manners consistent with local energy codes.
 - 1. Auto-On / Auto-Off (via occupancy sensors)
 - a. • Zones with occupancy sensors automatically turn lights on when occupant is detected.
 - b. • Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
 - c. • Pressing a switch will turn lights off. The lights will remain off regardless of occupancy until switch is pressed again, restoring the sensor to Automatic On functionality.
 - 2. Manual-On / Auto-Off (also called Semi-Automatic)
 - a. • Pushing a switch will turn lights on.
 - b. • Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
 - 3. Manual-On to Auto-On/Auto-Off
 - a. • Pushing a switch will turn lights on.
 - b. • After initial lights on, zones with occupancy and/or photocell sensors turn lights on/off according to occupancy/vacancy and/or daylight conditions.
 - c. • Sequence can be reset via scheduled (ex. daily each morning) events.
 - 4. Auto-to-Override On
 - a. • Zones with occupancy sensors automatically turn lights on when occupant is detected.
 - b. • Zone lighting then goes into an override on state, for a set amount of time, or until the next time event returns the lighting to an auto-off style of control.

- c. • Sequence can be reset via scheduled (ex. daily each morning) events.
- 5. Manual-to-Override On
 - a. • Pushing a switch will turn lights on.
 - b. • Zone lighting then goes into an override on state for a set amount of time or until the next time event returns the lighting to an auto-off style of control.
 - c. • Sequence can be reset via scheduled (ex. daily each morning) events.
- 6. Auto On / Predictive Off
 - a. • Zones with occupancy sensors automatically turn lights on when occupant is detected.
 - b. • Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
 - c. • Pressing the switch will turn the lights off and a short “exit timer” begins. After the timer expires, sensor scans the room to detect whether occupant is still present. If no occupancy is detected, zone returns to auto-on. If occupancy is detected, lights must be turned on via the switch.
- 7. Multi-Level Operation (multiple lighting levels per manual button press)
 - a. • Operating mode designed specifically for bi-level applications.
 - b. • Enables the user to cycle through up to four potential on/off/dim low/dim high lighting states using only a single button.
 - c. • Eliminates user confusion as to which of two buttons controls which load
 - d. • Three different transition sequences are available in order to comply with energy codes or user preference).
 - e. • Mode available as a setting on all devices that have single manual on/off switch (ex. nPODM, nPODM-DX, nWSX LV).
 - f. • Depending on the sequence selected, every button push steps through relay/dimming states according to below table
 - g. • In addition to achieving bi-level lighting control by switching loads with relays, the ability to command dimming outputs to “step” in a sequence that achieves bi-level operation is present.
- J. A taskbar style desktop application shall be available for personal lighting control.
- K. An application that runs on “smart” handheld devices (such as an Apple® iPhone®) shall be available for personal lighting control.
- L. System shall provide the option of having pre-terminated plenum rated CAT-5e cabling supplied with hardware.

2.03 INDIVIDUAL DEVICE SPECIFICATIONS

- A. Occupancy sensors
 - 1. Occupancy sensors shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
 - 2. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.
 - 3. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional “dual” technology shall be used.
 - 4. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for

- sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) shall not be acceptable.
5. All sensing technologies shall be acoustically passive, meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.
 6. Sensors shall be available with zero or one integrated dry contact switching relays, capable of switching 1 amp at 24 VAC/VDC (resistive only).
 7. Sensors shall be available with one or two occupancy "poles", each of which provides a programmable time delay.
 8. Sensors shall be available in multiple lens options which are customized for specific applications.
 9. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
 10. All sensors shall have two RJ-45 ports or capable of utilizing a splitter.
 11. All sensors shall have the ability to detect when it is not receiving valid communication (via CAT-5 connections) and blink its LED in a pattern to visually indicate of a potential wiring issue
 12. Every sensor parameter shall be available and configurable remotely from the software and locally via the device push-button.
 13. Sensors shall be able to function together with other sensors in order to provide expanded coverage areas by simply daisy-chain wiring together the units with CAT-5 cabling.
 14. Sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements.
 15. Wall switch sensors shall recess into single-gang switch box and fit a standard GFI opening.
 16. Wall switch sensors must meet NEC grounding requirements by providing a dedicated ground connection and grounding to mounting strap. Line and load wire connections shall be interchangeable. Sensor shall not allow current to pass to the load when sensor is in the unoccupied (Off) condition.
 17. Wall switch sensors shall have optional features for photocell/daylight override, and low temperature/high humidity operation.
 18. Wall switch sensors shall be available in four standard colors (Ivory, White, Light Almond, Gray)
 19. Wall switch sensors shall be available with optional raise/lower dimming adjustment controls.
 20. Wall switch sensors shall be the following nLight model numbers, with device color and optional features as specified:
 - a. nWSX (PIR, 1 Relay)
 - b. nWSX PDT (Dual Tech, 1 Relay)
 - c. nWSX LV (PIR, No Relay)
 - d. nWSX PDT LV (Dual Tech, No Relay)
 - e. nWSX LV NL (PIR w/ Night Light, No Relay)
 - f. nWSX PDT LV NL (Dual Tech w/ Night Light, No Relay)

- g. nWSX LV DX (PIR, No Relay, Raise/Lower Dim Ctrl)
h. nWSX PDT LV DX (Dual Tech, No Relay, Raise/Lower Dim Ctrl)
21. Sensors shall have optional features for photocell/daylight override, dimming control, and low temperature/high humidity operation.
22. Sensors shall be the following nLight model numbers, with device options as specified:
- | Model # | Series | Occ | Poles | # of Relays | Lens Type | Detection Technology |
|-------------------|--------|-----|-------|-------------|-----------|----------------------|
| nCM(B) 9 | 1 | - | | Standard | PIR | |
| nCM(B) 9 2P | 2 | - | | Standard | PIR | |
| nCM 9 RJB | 1 | - | | Standard | PIR | |
| nCM 9 2P RJB | 2 | - | | Standard | PIR | |
| nCM(B) PDT 9 | 1 | - | | Standard | Dual | |
| nCM(B) PDT 9 2P | 2 | - | | Standard | Dual | |
| nCM PDT 9 RJB | 1 | - | | Standard | Dual | |
| nCM PDT 9 2P RJB | 2 | - | | Standard | Dual | |
| nCM(B) 10 | 1 | - | | Extended | PIR | |
| nCM(B) 10 2P | 2 | - | | Extended | PIR | |
| nCM 10 RJB | 1 | - | | Extended | PIR | |
| nCM 10 2P RJB | 2 | - | | Extended | PIR | |
| nCM(B) PDT 10 | 1 | - | | Extended | Dual | |
| nCM(B) PDT 10 2P | 2 | - | | Extended | Dual | |
| nCM PDT 10 RJB | 1 | - | | Extended | Dual | |
| nCM PDT 10 2P RJB | 2 | - | | Extended | Dual | |
| nRM 9 | 1 | - | | Standard | PIR | |
| nRM PDT 9 | 1 | - | | Standard | Dual | |
| nRM 10 | 1 | - | | Extended | PIR | |
| nRM PDT 10 | 1 | - | | Extended | Dual | |
| nRM 6 | 1 | - | | High Bay | PIR | |
| nRM 50 | 1 | - | | Aisle Way | PIR | |
| nWV 16 | 1 | - | | Wide View | PIR | |
| nWV PDT 16 | 1 | - | | Wide View | Dual | |
| nHW13 | 1 | - | | Hallway | PIR | |
| nCM(B) 6 | 1 | - | | High Bay | PIR | |
| nCM 6 RJB | 1 | - | | High Bay | PIR | |
- B. Daylight (photocell and/or dimming) sensors
1. Photocell shall provide for an on/off set-point, and a deadband to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.
 2. Photocell and dimming sensor's set-point and deadband shall be automatically calibrated through the sensor's microprocessor by initiating an "Automatic Set-point Programming" procedure. Min and max dim settings as well as set-point may be manually entered.
 3. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
 4. Photocell and dimming sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp

- replacements. (Note: This function should be performed prior to any dimming of the lamps including the "auto set-point" setting.)
5. Combination units that have all features of on/off photocell and dimming sensors shall also be available.
 6. A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The second zone shall be capable of being controlled as an "offset" from the primary zone.
 7. Sensor shall be the following nLight model numbers, with device options as specified:
 - a. nCM(B) PC (RJB) (on/off)
 - b. nCM(B) PC DZ (RJB) (on/off control, dual zone)
 - c. nCM(B) ADCX (RJB) (remote automatic dimming control photocell)
 - d. nCM(B) ADCX DZ (RJB) (remote automatic dimming control photocell, dual zone)
 - e. nRM PC (on/off)
 - f. nRM PC DZ (on/off, dual zone)
 - g. nRM ADCX (remote automatic dimming control photocell)
 - h. nRM ADCX DZ (remote automatic dimming control photocell, dual zone)
- C. Power (Relay) Packs
1. Power Packs shall incorporate one Class 1 relay, a 0-10 VDC dimming output, and contribute low voltage power to the rest of the system. Secondary Packs shall incorporate the relay and 0-10 VDC or line voltage dimming output, but shall not be required to contribute system power. Power Supplies shall provide system power only, but are not required to switch line voltage circuit. Auxiliary Relay Packs shall switch low voltage circuits only.
 2. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC), be plenum rated, and provide Class 2 power to the system.
 3. All devices shall have two RJ-45 ports.
 4. Every Power Pack parameter shall be available and configurable remotely from the software and locally via the device push-button.
 5. Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
 6. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
 7. Power Packs and Power Supplies shall be available that are WiFi enabled.
 8. Power Packs (Secondary) shall be available that provide up to 16 Amp switching of all lighting load types.
 9. Power Packs shall be available that provide up to 5 Amps switching of all lighting load types as well as 0-10 VDC dimming or fluorescent ballasts/LED drivers.
 10. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).

11. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120/277 VAC magnetic low voltage transformers.
 12. Specific Secondary Packs shall be available that provide up to 4 Amps of switching and can dim 120 VAC electronic low voltage transformers.
 13. Specific Power/Secondary Packs shall be available that are UL924 listed for switching of Emergency Power circuits.
 14. Specific Secondary Packs shall be available that control louver/damper motors for skylights.
 15. Specific Secondary Packs shall be available that provide a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.
 16. Power (Secondary) Packs shall be available that provide up to 20 Amps switching of general purposed receptacle (plug-load) control.
 17. Power (Relay) Packs and Supplies shall be the following nLight model numbers:
 - a. nPP16 (Power Pack w/ 16A relay)
 - b. nPP16 D (Power Pack w/ 16A relay and 0-10VDC dimming output)
 - c. nPP16 WIFI (Power Pack w/ 16A relay, WIFI enabled)
 - d. nEPP5 D (Power Pack w/ 5A relay and 0-10VDC dimming output)
 - e. nSP16 (Secondary Pack w/ 16A relay)
 - f. nPP16 ER (UL924 Listed Secondary Pack w/ 16A relay for switching emergency power circuits)
 - g. nPP16 D ER UL924 Listed Secondary Pack w/ 16A relay and 0-10VDC dimming output for switching/dimming emergency power circuits)
 - h. nSP5 PCD 2W (Secondary Pack w/ 5A relay and incandescent dimming or 2-wire line voltage fluorescent dimming output)
 - i. nSP5 PCD 3W (Secondary Pack w/ 5A relay and 3-wire line voltage fluorescent dimming output)
 - j. nSP5 PCD MLV (Secondary Pack w/ 5A relay and magnetic low voltage dimming output)
 - k. nSP5 PCD ELV 120 (Secondary Pack w/ 4A relay and electronic low voltage dimming output)
 - l. nSP5 2P LVR (Louver/Damper Control Pack)
 - m. nSHADE (Pulse On/Off Control Pack)
 - n. nPP20 PL (Secondary Pack w/ 20A relay for general purpose receptacle load)
 - o. nPS 80 (Auxiliary Bus Power Supply)
 - p. nPS 80 WIFI (Auxiliary Bus Power Supply, WiFi enabled)
 - q. nAR 40 (Low voltage auxiliary relay pack)
- D. Auxiliary Input / Output (I/O) Devices
1. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½" knockout.
 2. Devices shall have two RJ-45 ports
 3. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
 4. Specific I/O devices shall have a dimming control output that can control 0-10 VDC dimmable ballasts or LED drivers by sinking up to 20 mA of current.
 5. Specific I/O devices shall have an input that reads a 0-10 VDC signal from an external device.

6. Specific I/O devices shall have a switch input that can interface with either a maintained or momentary switch and run a switch event (toggle the lighting load) or run a local/remote control profile.
 7. Specific I/O devices shall sense state of low voltage outdoor photocells.
 8. Specific I/O devices shall enable RS-232 communication between lighting control system and Touch Screen based A/V control systems.
 9. Specific I/O devices shall sense momentary and maintained contact closures, and either toggle a connected load after a momentary contact or ramp the load high/low during a maintained contact (stopping when the contact releases).
 10. Auxiliary Input/Output Devices shall be the following nLight model numbers:
 - a. nIO D (I/O device with 0-10 dimming output)
 - b. nIO 1S or nIO RLX (I/O device with contact closure or 0-10VDC dimming input)
 - c. nIO NLI (Input device for detecting state of low voltage outdoor photocell; sold in nIO PC KIT only)
 - d. nIO X (Interface device for communicating with RS-232 enabled AV Touch Screens)
- E. Wall Switches & Dimmers
1. Devices shall recess into single-gang switch box and fit a standard GFI opening.
 2. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
 3. All devices shall have two RJ-45 ports.
 4. All devices shall provide toggle switch control. Dimming control and low temperature/high humidity operation are available options.
 5. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).
 6. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
 7. Devices with mechanical push-buttons shall be made available with custom button labeling
 8. Devices with a single "on" button shall be capable of selecting all possible lighting combinations for a bi-level lighting zone such that the user confusion as to which of two buttons (as is present in multi-button scenarios) controls which load is eliminated.
 9. Wall switches & dimmers shall be the following nLight model numbers, with device options as specified:
 - a. nPODM (single on/off, push-buttons, LED user feedback)
 - b. nPODM DX (single on/off, single dimming raise/lower, push-buttons, LED user feedback)
 - c. nPODM 2P (dual on/off, push-buttons, LED user feedback)
 - d. nPODM 2P DX (dual on/off, dual dimming raise/lower, push-buttons, LED user feedback)
 - e. nPODM 4P (quad on/off, push-buttons, LED user feedback)
 - f. nPODM 4P DX (quad on/off, quad dimming raise-lower, push-buttons, LED user feedback)

2.04 START-UP & SUPPORT FEATURES

- A. To facilitate start-up, all devices daisy-chained together (using CAT-5) shall automatically be grouped together into a functional lighting control zone.
- B. All lighting control zones shall be able to function according to default settings once adequate power is applied and before any system software is installed.
- C. All sensor devices shall have the ability to detect improper communication wiring and blink it's LED in a specific cadence as to alert installation/startup personnel.

PART 3- EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that ratings and configurations of system components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive system components.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, except for mounting heights specified in those standards.
- B. Install products in accordance with manufacturer's instructions.
- C. Provide dedicated network between lighting management system computer and lighting management hubs.
- D. Define each dimmer/relay load type, assign each load to a zone, and set control functions.
- E. Sensor Locations:
 - 1. Locate sensors in accordance with layout provided by Lighting Control Manufacturer. Lighting Control Manufacturer may direct Contractor regarding sensor relocation should conditions require a deviation from locations indicated. Where Lighting Control Manufacturer Sensor Layout and Tuning service is not specified, locate sensors in accordance with Drawings.
 - 2. Sensor locations indicated are diagrammatic. Within the design intent, reasonably minor adjustments to locations may be made in order to optimize coverage and avoid conflicts or problems affecting coverage, in accordance with manufacturer's recommendations.
- F. Mount exterior daylight sensors to point due north with constant view of daylight.
- G. Ensure that daylight sensor placement minimizes sensor view of electric light sources. Locate ceiling-mounted and luminaire-mounted daylight sensors to avoid direct view of luminaires.
- H. LED Light Engine/Array Lead Length: Do not exceed 100 feet.
- I. Identify system components in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

- A. Manufacturer's Startup Services:
 - 1. Conduct Pre-Installation visit to review requirements with installer as specified in Part 1 under "Administrative Requirements".
 - 2. Conduct second site visit upon completion of lighting control system to perform system startup and verify proper operation:
 - a. Verify connection of power wiring and load circuits.
 - b. Verify connection and location of controls.
 - c. Energize lighting management hubs and download system data program.
 - d. Address devices.
 - e. Verify proper connection of panel links (low voltage/data) and address panel.
 - f. Verify system operation control by control.
 - g. Verify proper operation of manufacturer's interfacing equipment.
 - h. Configure initial groupings of drivers for wall controls, daylight sensors and occupancy sensors.
 - i. Provide initial rough calibration of sensors; fine-tuning of sensors is responsibility of Contractor unless provided by Lighting Control Manufacturer as part of Sensor Layout and Tuning service where specified in Part 2 under "DIGITAL-NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS".

- j. Train Owner's representative on system capabilities, operation, and maintenance, as specified in Part 3 under "Closeout Activities".
- k. Obtain sign-off on system functions.
- 3. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

3.04 ADJUSTING

- A. On-Site Scene and Level Tuning: Include as part of the base bid additional costs for Lighting Control Manufacturer to visit site to conduct meeting with Engineer to make required lighting adjustments to the system for conformance with original design intent.
- B. Sensor Fine-Tuning: Lighting Control Manufacturer to provide up to two additional post-startup on-site service visits for fine-tuning of sensor calibration. Where Lighting Control Manufacturer Sensor Layout and Tuning service is not specified, Contractor to provide fine-tuning of sensor calibration.

3.05 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.06 SYSTEM DELIVERY AND ACCEPTANCE

- A. Perform in accordance with the manufacturer's recommendations.
- B. Upon completion of installation, conduct an operating test to show that equipment operates in accordance with requirements of this section.
- C. Test for full range of dimming ballast and dimming controls capability. Observe for visually detectable flicker over full dimming range.
- D. Test occupancy sensors for proper operation. Observe for light control over entire area being covered.
 - 1. Upon completion of the installation, the system shall be commissioned by the manufacturer's factory-authorized technician who will verify all adjustments and sensor placements.
- E. The contractor is responsible for complete installation of the entire system according to strict factory standards and requirements. The following items shall constitute factory standards and requirements:
 - 1. All system equipment shall operate in accordance with specification and industrial standard procedures.
 - 2. An operational user program shall exist in the control system. The program shall execute and perform all functions required to effectively operate the site according to the requirements.
 - 3. Demonstration of program integrity during normal operation and pursuant to a power outage.

3.07 PROTECTION

- A. Protect installed products from subsequent construction operations.

3.08 FACTORY COMMISSIONING

- A. Upon completion of the installation, the system shall be commissioned by the manufacturer's factory authorized representative who will verify a complete fully functional system.
 - 1. The site visit shall occur after the system has been verified by manufacturer and installer to be functioning in accordance with the specified sequence of operation.
- B. The electrical contractor shall provide both the manufacturer, owner, commissioning agent and the electrical engineer with twenty one working days written notice of the system startup and adjustment date.

- C. Upon completion of the system commissioning the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.

3.09 FOLLOW-UP VERIFICATION

- A. Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that the lighting control devices are in good operating condition and properly performing the intended function in the presence of Owner.

3.10 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
- B. See Section 01 79 00 - Demonstration and Training, for additional requirements.
- C. Demonstration:
 - 1. On-Site Performance-Verification Walkthrough: Include as part of the base bid additional costs for lighting control manufacturer to provide on-site demonstration of system functionality to commissioning agent.
 - a. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
 - b. Review data in maintenance manuals. Refer to Division 01 Section "Operation and Maintenance Data."
 - c. Schedule training with Owner, through Architect, with at least seven days' advance notice.
 - 2. Demonstrate proper operation of lighting control devices to Engineer, and correct deficiencies or make adjustments as directed.
 - 3. Provide short (20 minute) video of training for future staff use.
- D. Training:
 - 1. Include services of manufacturer's authorized Service Representative to perform on-site training of Owner's personnel on operation, adjustment, and maintenance of lighting control system as part of standard system start-up services.

END OF SECTION 26 09 23

SECTION 26 24 16
PANELBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Power distribution panelboards.
- B. Lighting and appliance panelboards.
- C. Overcurrent protective devices for panelboards.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 05 73 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.
- F. Section 26 43 00 - Surge Protective Devices.

1.03 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision E, 2013.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- C. NECA 407 - Standard for Installing and Maintaining Panelboards; 2009.
- D. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- E. NEMA BS 31047 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013 (Reaffirmed 2023).
- F. NEMA PB 1 - Panelboards; 2011.
- G. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; 2013.
- H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- K. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- L. UL 67 - Panelboards; Current Edition, Including All Revisions.
- M. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- N. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.
- O. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.
- P. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.
- Q. UL 1699 - Arc-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
- B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 1. Include dimensioned plan and elevation views of panelboards and adjacent equipment with all required clearances indicated.
 2. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
 3. Identify mounting conditions required for equipment seismic qualification.
- C. Manufacturer's equipment seismic qualification certification.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
- F. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. Panelboard Keys: Two of each different key.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain ambient temperature within the following limits during and after installation of panelboards:

1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

1.09 MANUFACTURERS

- A. Siemens Industry, Inc: www.usa.siemens.com.
- B. Eaton Corporation: www.eaton.com/#sle.
- C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
- D. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.
- E. Substitutions: As approved by Engineer
- F. Provide products listed, classified, and labeled as suitable for the purpose intended.
- G. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 1. Altitude: Less than 6,600 feet.
 2. Ambient Temperature:
 - a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
- H. Short Circuit Current Rating:
 1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
- I. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- J. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- K. Bussing: Sized in accordance with UL 67 temperature rise requirements.
 1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
 2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- L. Conductor Terminations: Suitable for use with the conductors to be installed.
- M. Enclosures: Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E.
 1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
 - b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.
 3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
 4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- N. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
- O. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.

1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
- P. Load centers are not acceptable.
- Q. Provide the following features and accessories where indicated or where required to complete installation:
 1. Feed-through lugs.
 2. Sub-feed lugs.
- R. The panelboard shall meet or exceed the seismic requirements for the project area as stated within the IBC.

1.10 POWER DISTRIBUTION PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
 1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
 1. Phase and Neutral Bus Material: Aluminum or copper.
 2. Ground Bus Material: Aluminum or copper.
- D. Circuit Breakers:
 1. Provide bolt-on type _____.
 2. Provide thermal magnetic circuit breakers for circuit breaker frame sizes less than 400 amperes.
 3. Provide electronic trip circuit breakers for circuit breaker frame sizes 400 amperes and above.
- E. Enclosures:
 1. Provide surface-mounted enclosures unless otherwise indicated.
 2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
 3. Provide clear plastic circuit directory holder mounted on inside of door.

1.11 LIGHTING AND APPLIANCE PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
 1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
 1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
 2. Phase and Neutral Bus Material: Aluminum or copper.
 3. Ground Bus Material: Aluminum or copper.
- D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.
- E. Enclosures:

1. Provide surface-mounted or flush-mounted enclosures as indicated.
2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide clear plastic circuit directory holder mounted on inside of door.
- F. Molded Case Circuit Breakers:
 1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
 2. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - 1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
 - 2) 14,000 rms symmetrical amperes at 480 VAC.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 3. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 100 amperes and larger.
 - b. Provide interchangeable trip units for circuit breaker frame sizes 100 amperes and larger.
 5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - a. Provide the following field-adjustable trip response settings:
 - 1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
 - 2) Long time delay.
 - 3) Ground fault pickup and delay where ground fault protection is indicated.
 6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
 7. Provide the following circuit breaker types where indicated:
 - a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
 8. Do not use tandem circuit breakers.
 9. Do not use handle ties in lieu of multi-pole circuit breakers.
 10. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.
 11. Provide the following features and accessories where indicated or where required to complete installation:
 - a. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
 - b. Handle Pad-Lock Provision: For locking circuit breaker handle in OFF position.

- c. Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
- d. Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.
- e. Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.

1.12 SOURCE QUALITY CONTROL

- A. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

2.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive panelboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.

2.02 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E. Provide required seismic controls in accordance with Section 26 05 48.
- F. Install panelboards plumb.
- G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- I. Mount floor-mounted power distribution panelboards on properly sized 3 inch high concrete pad constructed in accordance with Section 03 30 00.
- J. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.
- K. Install all field-installed branch devices, components, and accessories.
- L. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- M. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.
- N. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 05 73.
- O. Set field-adjustable ground fault protection pickup and time delay settings as indicated.
- P. Provide filler plates to cover unused spaces in panelboards.
- Q. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads. Also provide for the following:
 - 1. Emergency and night lighting circuits.
 - 2. Fire detection and alarm circuits.
- R. Identify panelboards in accordance with Section 26 05 53.

2.03 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers. Tests listed as optional are not required.
- C. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70 and local authority.
- D. Test GFCI circuit breakers to verify proper operation.
- E. Test shunt trips to verify proper operation.
- F. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.
- G. Correct deficiencies and replace damaged or defective panelboards or associated components.

2.04 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.
- C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

2.05 CLEANING

- A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wall switches.
- B. Receptacles.
- C. Wall plates.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Manufactured wiring systems for use with access floor boxes with compatible pre-wired connectors.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 33.16 - Boxes for Electrical Systems.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 09 23 - Lighting Control Devices: Devices for automatic control of lighting, including occupancy sensors.

1.03 REFERENCE STANDARDS

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for; Federal Specification; Revision G, 2001.
- B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification); Federal Specification; Revision F, 1999.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- D. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
- E. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (R 2010).
- F. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2012.
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.
- I. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.
- J. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.
- K. UL 1310 - Class 2 Power Units; Current Edition, Including All Revisions.
- L. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
 - 3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
 - 4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
 - 5. Coordinate the core drilling of holes for poke-through assemblies with the work covered under other sections.

6. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.
- B. Sequencing:
 1. Do not install wiring devices until final surface finishes and painting are complete.

1.05 SUBMITTALS

- A. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
- B. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- C. Operation and Maintenance Data:
 1. GFCI Receptacles: Include information on status indicators.
- D. Project Record Documents: Record actual installed locations of wiring devices.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. Extra Wall Plates: One of each style, size, and finish.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Products: Listed, classified, and labeled as suitable for the purpose intended.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND PROTECTION

- A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Hubbell Incorporated: www.hubbell-wiring.com.
- B. Leviton Manufacturing Company, Inc: www.leviton.com.
- C. Lutron Electronics Company, Inc: www.lutron.com.
- D. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us
- E. Substitutions:
- F. Source Limitations: Where possible, provide products for each type of wiring device produced by a single manufacturer and obtained from a single supplier.

2.02 WIRING DEVICE APPLICATIONS

- A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
- B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
- C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.
- D. Provide tamper resistant receptacles for receptacles installed in all publically accessible spaces.
- E. Provide GFCI protection for receptacles installed within 6 feet of sinks.

2.03 WIRING DEVICE FINISHES

- A. Provide wiring device finishes as described below unless otherwise indicated.
- B. Wiring Devices, Unless Otherwise Indicated: White with white nylon wall plate.

- C. Wiring Devices Installed in Wet or Damp Locations: White with specified weatherproof cover.
- D. Wiring Devices Connected to Emergency Power: Red with red nylon wall plate.

2.04 ALL WIRING DEVICES

- A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.05 WALL SWITCHES

- A. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable FS W-S-896; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
- B. Standard Wall Switches: Commercial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw or double throw as indicated on the drawings.
- C. Locking Momentary Contact Wall Switches: Commercial specification grade, 20 A, 120/277 V with lever type keyed three position switch actuator and momentary contacts; switches keyed alike; single pole double throw, off with switch actuator in center position.

2.06 RECEPTACLES

- A. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498 and where applicable FS W-C-596; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
 - 2. NEMA configurations specified are according to NEMA WD 6.
- B. Convenience Receptacles:
 - 1. Standard Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
 - 2. Tamper Resistant Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.
 - a. All receptacles shall be tamper resistant.
- C. GFCI Receptacles:
 - 1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
 - 2. Standard GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
 - 3. Tamper Resistant GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.
- D. USB Charging Devices:
 - 1. USB Charging Devices - General Requirements: Listed as complying with UL 1310.
 - a. Charging Capacity - Two-Port Devices: 2.1 A, minimum.
 - 2. USB Charging/Tamper Resistant Receptacle Combination Devices: Two-port (Type A & Type C) USB charging device and receptacle, commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; rectangular decorator style.

2.07 WALL PLATES

- A. Wall Plates: Comply with UL 514D.
 - 1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
 - 2. Size: Standard.
 - 3. Screws: Metal with slotted heads finished to match wall plate finish.
- B. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.

2.08 POKE-THROUGH ASSEMBLIES

- A. Description: Assembly comprising floor service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination; fire rating listed to match fire rating of floor and suitable for floor thickness where installed.
- B. Flush Floor Service Fittings:
 - 1. Single Service Flush Convenience Receptacles:
 - a. Configuration: One standard convenience duplex receptacle(s) with duplex flap opening(s).
 - 2. Single Service Flush Communications Outlets:
 - a. Voice and Data Jacks:
 - 3. Dual Service Flush Combination Outlets:
 - a. Cover: Hinged door(s).
 - b. Configuration:
 - 1) Power: One standard convenience duplex receptacle(s).
 - 2) Voice and Data Jacks:
 - 4. Dual Service Flush Furniture Feed:
 - a. Configuration:
 - 1) Power: One 3/4 inch threaded opening(s).
 - 2) Communications: One 1-12/4 inch threaded opening(s).
 - 5. Accessories:
 - a. Closure Plugs: Size and fire rating as required to seal unused core hole and maintain fire rating of floor.
 - 6. For configurations above, verify boxes accommodate actual conduit sizes connecting to box.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- F. Verify that core drilled holes for poke-through assemblies are in proper locations.
- G. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of wiring devices provided under this section.
 - 1. Mounting Heights: As indicated on the drawings.
 - 2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
 - 3. Where multiple receptacles are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
 - 4. Locate receptacles for electric drinking fountains concealed behind drinking fountain accessible panels, according to manufacturer's instructions.
- C. Install wiring devices in accordance with manufacturer's instructions.
- D. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- E. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- F. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- G. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
- H. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- I. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- J. Identify wiring devices in accordance with Section 26 05 53.
- K. Install poke-through closure plugs in each unused core holes to maintain fire rating of floor.

3.04 FIELD QUALITY CONTROL

- A. Perform field inspection, testing, and adjusting in accordance with Section .
- B. Inspect each wiring device for damage and defects.
- C. Test each receptacle to verify operation and proper polarity.
- D. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- E. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.05 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.06 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

SECTION 26 28 13
FUSES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fuses.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- B. Section 26 28 16.16 - Enclosed Switches: Fusible switches.
- C. Section 26 29 13 - Enclosed Controllers: Fusible switches.

1.03 REFERENCE STANDARDS

- A. NEMA FU 1 - Low Voltage Cartridge Fuses; 2012.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements; Current Edition, Including All Revisions.
- D. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses; Current Edition, Including All Revisions.
- E. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
 - 2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
 - 3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Bussmann, a division of Eaton Corporation; _____: www.cooperindustries.com/#sle.
- B. Littelfuse, Inc; _____: www.littelfuse.com/#sle.
- C. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 APPLICATIONS

- A. General Purpose Branch Circuits: Class RK1, time-delay.
- B. Individual Motor Branch Circuits: Class RK1, time-delay.
- C. Primary Protection for Control Transformers: Class CC, time-delay.

2.03 FUSES

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.

- B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.
- C. Provide fuses of the same type, rating, and manufacturer within the same switch.
- D. Comply with UL 248-1.
- E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.
- F. Voltage Rating: Suitable for circuit voltage.
- G. Class R Fuses: Comply with UL 248-12.
- H. Class CC Fuses: Comply with UL 248-4.
- I. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.
- B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Do not install fuses until circuits are ready to be energized.
- B. Install fuses with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION

SECTION 26 28 16.13
ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Enclosed circuit breakers.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision E, 2013.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- C. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- I. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for circuit breakers, enclosures, and other installed components and accessories.
 - 1. Include characteristic trip curves for each type and rating of circuit breaker upon request.
- B. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Include dimensioned plan and elevation views of enclosed circuit breakers and adjacent equipment with all required clearances indicated.
 2. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
 3. Include documentation of listed series ratings upon request.
- C. Field Quality Control Test Reports.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- E. Project Record Documents: Record actual installed locations of enclosed circuit breakers.
- F. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed circuit breaker internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain ambient temperature between 23 degrees F and 104 degrees F during and after installation of enclosed circuit breakers.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Eaton Corporation: www.eaton.com/#sle.
- B. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
- C. Siemens Industry, Inc: www.usa.siemens.com/#sle.
- D. Substitutions: See Section 01 60 00 - Product Requirements.
- E. Source Limitations: Furnish enclosed circuit breakers and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 ENCLOSED CIRCUIT BREAKERS

- A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
1. Altitude: Less than 6,600 feet.
 2. Ambient Temperature: Between 23 degrees F and 104 degrees F.

- D. Short Circuit Current Rating:
 - 1. Provide enclosed circuit breakers with listed short circuit current rating as indicated on the drawings.
- E. Conductor Terminations: Suitable for use with the conductors to be installed.
- F. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.
- G. Enclosures: Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 - 2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
 - 3. Provide surface-mounted enclosures unless otherwise indicated.
- H. Provide externally operable handle with means for locking in the OFF position.

2.03 MOLDED CASE CIRCUIT BREAKERS

- A. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
- B. Interrupting Capacity:
 - 1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - a. 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
 - b. 14,000 rms symmetrical amperes at 480 VAC.
 - 2. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
- C. Conductor Terminations:
 - 1. Provide mechanical lugs unless otherwise indicated.
 - 2. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
- D. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - 1. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
 - 2. Provide interchangeable trip units for circuit breaker frame sizes 225 amperes and larger.
- E. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - 1. Provide the following field-adjustable trip response settings:
 - a. Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
 - b. Short time pickup and delay.
 - c. Instantaneous pickup.
 - d. Ground fault pickup and delay where ground fault protection is indicated.
- F. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
- G. Provide the following circuit breaker types where indicated:

1. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
 2. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
- H. Provide the following features and accessories where indicated or where required to complete installation:
1. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
 2. Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings of the enclosed circuit breakers are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed circuit breakers.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 26 05 29.
- E. Provide required seismic controls in accordance with Section 26 05 48.
- F. Install enclosed circuit breakers plumb.
- G. Install flush-mounted enclosed circuit breakers so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- H. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- I. Provide grounding and bonding in accordance with Section 26 05 26.
- J. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- K. Set field-adjustable circuit breaker tripping function settings as directed.

3.03 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with manufacturer's instructions and NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers used for service entrance and for circuit breakers larger than 100 amperes. Tests listed as optional are not required.
- C. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
 1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.
- D. Test GFCI circuit breakers to verify proper operation.
- E. Test shunt trips to verify proper operation.
- F. Correct deficiencies and replace damaged or defective enclosed circuit breakers.

3.04 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

- A. Clean dirt and debris from circuit breaker enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

**SECTION 26 28 16.16
ENCLOSED SWITCHES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Enclosed safety switches.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 28 13 - Fuses.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- C. NEMA BS 31047 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013 (Reaffirmed 2023).
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 - 1. Include dimensioned plan and elevation views of enclosed switches and adjacent equipment with all required clearances indicated.
 - 2. Include wiring diagrams showing all factory and field connections.

- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- E. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain ambient temperature between -22 degrees F and 104 degrees F during and after installation of enclosed switches.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Eaton Corporation; _____: www.eaton.com/#sle.
- B. Schneider Electric; Square D Products; _____: www.schneider-electric.us/#sle.
- C. Siemens Industry, Inc; _____: www.usa.siemens.com/#sle.
- D. Substitutions: See Section 01 60 00 - Product Requirements.
- E. Source Limitations: Furnish enclosed switches and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 ENCLOSED SAFETY SWITCHES

- A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature: Between -22 degrees F and 104 degrees F.
- D. Horsepower Rating: Suitable for connected load.
- E. Voltage Rating: Suitable for circuit voltage.
- F. Short Circuit Current Rating:
 - 1. Minimum Ratings:
 - a. Switches Protected by No Fuses: 10,000 rms symmetrical amperes.
 - b. Heavy Duty Single Throw Switches Protected by Class R, Class J, Class L, or Class T Fuses: 200,000 rms symmetrical amperes.
- G. Provide with switch blade contact position that is visible when the cover is open.
- H. Fuse Clips for Fusible Switches: As required to accept fuses indicated.
 - 1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.

- I. Conductor Terminations: Suitable for use with the conductors to be installed.
- J. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.
- K. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.
- L. Enclosures: Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 - 2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
- M. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
- N. Heavy Duty Switches:
 - 1. Comply with NEMA BS 31047.
 - 2. Conductor Terminations:
 - a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.
 - a. Provide means for locking handle in the ON position where indicated.
- O. Provide the following features and accessories where indicated or where required to complete installation:
 - 1. Hubs: As required for environment type; sized to accept conduits to be installed.
 - 2. Auxiliary Switch: SPDT switch suitable for connection to system indicated, with auxiliary contact operation before switch blades open and after switch blades close.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed safety switches.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required supports in accordance with Section 26 05 29.
- E. Install enclosed switches plumb.
- F. Except where indicated to be mounted adjacent to the equipment they serve, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 26 05 26.

- H. Provide fuses complying with Section 26 28 13 for fusible switches as indicated or as required by equipment manufacturer's recommendations.
- I. Identify enclosed switches in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
- D. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.04 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

- A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 29 23
VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Variable frequency controllers.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- B. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 28 13 - Fuses.

1.03 REFERENCE STANDARDS

- A. NEMA IS 10034 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems; 2022 (Reapproved 2025).
- B. NEMA ICS 61800-2 - Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements-Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems; 2005.
- C. NEMA IS 10033 - Adjustable Speed Drives; 2020 (Reapproved 2025).
- D. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- E. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
- C. Shop Drawings: Indicate front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.
- D. Test Reports: Indicate field test and inspection procedures and test results.
- E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Manufacturer's Field Reports: Indicate start-up inspection findings.
- G. Operation Data: NEMA IS 10034. Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.
- H. Maintenance Data: NEMA IS 10034. Include routine preventive maintenance schedule.
- I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Air Filters: Two of each type.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum years experience and with service facilities within of Project.
- C. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Variable-Frequency Motor Controllers:
 - 1. ABB; _____: www.abb.com/#sle.
 - 2. Eaton Corporation; _____: www.eaton.com/#sle.
 - 3. Schneider Electric; Square D Products; _____: www.se.com/#sle.
 - 4. Yaskawa.
- B. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Source Limitations: Furnish variable-frequency motor controllers and associated components produced by a single manufacturer and obtained from a single supplier.

2.02 DESCRIPTION

- A. Variable Frequency Controllers: Enclosed controllers suitable for operating the indicated loads, in conformance with requirements of NEMA IS 10033. Select unspecified features and options in accordance with NEMA ICS 3.1.
 - 1. Employ microprocessor-based inverter logic isolated from power circuits.
 - 2. Employ pulse-width-modulated inverter system.
 - 3. Design for ability to operate controller with motor disconnected from output.
 - 4. Design to attempt five automatic restarts following fault condition before locking out and requiring manual restart.
- B. Pulse width modulated (PWM) design converting the fixed utility voltage and frequency to variable voltage and frequency output. The VFD shall consist of an input section, intermediate section, and output section. NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of a NEMA MG 1, Design B, 3-phase, premium-efficiency induction motor by adjusting output voltage and frequency
- C. Enclosures: NEMA EN 10250, Type 1, suitable for equipment application in places accessible only to qualified personnel.
- D. Finish: Manufacturer's standard enamel.

2.03 OPERATING REQUIREMENTS

- A. Rated Input Voltage: 480 volts, three phase, 60 Hertz.
- B. VFD must meet the requirements for Radio Frequency Interference (RFI) above 7MHz as specified by FCC Regulations, part 15, subpart J, Class A devices
- C. VFD efficiency shall exceed 96% at 100% speed and load. Line side displacement power factor shall exceed (0.96) regardless of speed and load. The VFD shall be rated for 110% current for (1) minute for variable torque loads and 150% current for (1) minute for constant torque loads
- D. Total Harmonic Distortion (THD) Compliance: Give the information provided by the owner's electric power one-line diagram and distribution transformer data, the VFD manufacturer shall carry out an analysis of the system to review the potential for the proposed equipment, and any existing equipment to meet IEEE 519 recommendations at the Point of Common Coupling (PCC). The result of the analysis shall determine if additional power quality improvement measures should be included in the proposal to meet the THD

- recommendations of IEE 519. The PCC shall be at the primary side of the main distribution transformer
- E. Displacement Power Factor: Between 1.0 and 0.95, lagging, over entire range of operating speed and load.
 - F. VFD's must have a minimum short circuit rating of 65,000 Amps RMS without additional input fusing
 - G. VFD shall employ microprocessor based inverter logic, isolated from all power circuits
 - H. VFD must be selected for operation at carrier frequencies at or above 5kHz without de-rating to satisfy the conditions for current, voltage, and horsepower as indicated.
 - I. The VFD shall include (2) independent analog inputs. (1) analog input shall be 0-10VDC, and (1) analog input shall be programmable for either 0-10VDC or 4-20mA. Either input shall respond to a programmable bias and gain.
 - J. The VFD shall include (2) 0-10VDC analog outputs for monitoring, or "speed tracking" the VFD. The analog output signal will be proportional to output frequency, output current, output power, PID (Proportional, Integral, Derivative control) feedback or DC bus voltage.
 - K. The VFD shall provide terminals for remote input contact closure, to allow starting in the automatic mode
 - L. The VFD shall include multiple external fault inputs, which shall be programmable for normally open or normally closed contacts. These terminals can be used for connection to freeze stats, high pressure limits or safety devices
 - M. 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
 - N. Operating Ambient: 0 degrees C to 40 degrees C.
 - O. Volts Per Hertz Adjustment: Plus or minus 10 percent.
 - P. Current Limit Adjustment: 60 to 110 percent of rated.
 - Q. Acceleration Rate Adjustment: 0.5 to 30 seconds.
 - R. Deceleration Rate Adjustment: 1 to 30 seconds.
 - S. Input Signal: 4 to 20 mA DC.

2.04 COMPONENTS

- A. Display: Provide integral digital display to indicate output voltage, output frequency, and output current.
- B. Status Indicators: Separate indicators for overcurrent, overvoltage, ground fault, overtemperature, and input power ON.
- C. Furnish HAND-OFF-AUTOMATIC selector switch and manual speed control.
- D. Include undervoltage release.
- E. Control Power Source: Integral control transformer.
- F. Safety Interlocks: Furnish terminals for remote contact to inhibit starting under both manual and automatic mode.
- G. Control Interlocks: Furnish terminals for remote contact to allow starting in automatic mode.
- H. Emergency Stop: Use dynamic brakes for emergency stop function.
- I. Disconnecting Means: Include integral fused disconnect switch on the line side of each controller.
- J. 5% line reactors shall be provided on each drive as a minimum.
- K. For loads further than 100 feet from VFD output, provide load reactors.
- L. Provide output filter.

- M. Automatic Temperature Controls System Interface: The VFD Manufacturer shall provide all software, hardware, interface card(s) and documentation required to effect a communications interface that can be used by the Controls Contractor to interface with the Facilities Management and Control System
- N. Communications: Provide an RS485 interface allowing VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.
- O. VFD shall be capable of allowing open and close operation of remote service disconnect switch between VFD and motor, while motor is running, without damage to VFD.
- P. Wiring Terminations: Match conductor materials and sizes indicated.

2.05 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Factory test controllers in accordance with NEMA ICS 61800-2.
- C. Shop inspect and perform standard productions tests for each controller.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surface is suitable for controller installation.
- B. Verify that conditions are satisfactory for installation prior to starting work.
- C. Do not install controller until building environment can be maintained within the service conditions required by the manufacturer.

3.02 INSTALLATION

- A. Do not exceed manufacturer's recommended maximum cable length between controller and motor.
- B. Provide required support and attachment in accordance with Section 26 05 29.
- C. Provide required seismic controls in accordance with Section 26 05 48.
- D. Provide fuses complying with Section 26 28 13 for fusible switches as indicated.
- E. Provide required support and attachment in accordance with Section 26 05 29.
- F. Tighten accessible connections and mechanical fasteners after placing controller.
- G. Provide fuses in fusible switches; refer to Section 26 28 13 for product requirements.
- H. Select and install overload heater elements in motor controllers to match installed motor characteristics.
- I. Provide engraved plastic nameplates; refer to Section 26 05 53 for product requirements and location.
- J. Neatly type label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place in clear plastic holder.

3.03 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 01 40 00.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.17. The insulation-resistance test on control wiring listed as optional is not required.
- D. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
- E. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers larger than _____ amperes. Tests listed as optional are not required.

- F. Test for proper interface with other systems.
- G. Correct deficiencies and replace damaged or defective controllers or associated components.

3.04 ADJUSTING

- A. Make final adjustments to installed controller to assure proper operation of load system.
Obtain performance requirements from installer of driven loads.

3.05 CLEANING

- A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

- A. Demonstrate operation of controllers in automatic and manual modes.

3.07 PROTECTION

- A. Protect installed controllers from subsequent construction operations.

3.08 MAINTENANCE

- A. See Section 01 70 00 - Execution Requirements, for additional requirements relating to maintenance service.
- B. Provide trouble call-back service upon notification by Owner:
 - 1. Provide on-site response within 4 hours of notification.
 - 2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
 - 3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.
- C. Provide service and maintenance of controllers for one year from Date of Substantial Completion.

END OF SECTION

SECTION 26 51 00
INTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Interior luminaires.
- B. Emergency lighting units.
- C. Exit signs.
- D. Drivers.
- E. Lamps.
- F. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- B. Section 26 05 33.16 - Boxes for Electrical Systems.
- C. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 09 23 - Lighting Control Devices.
- F. Section 26 27 26 - WIRING DEVICES: Manual wall switches and wall dimmers.

1.03 REFERENCE STANDARDS

- A. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code); 2013-08, with 2015 Corrigendum.
- B. Vermont State Commercial Building Energy Standards (VCBES), latest approved edition.
- C. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Cor 1, 2012).
- D. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; 2008.
- E. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules; Illuminating Engineering Society; 2015.
- F. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- G. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; 2006.
- H. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; 2012.
- I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. NFPA 101 - Life Safety Code; 2015.
- K. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.
- L. UL 1598 - Luminaires; Current Edition, Including All Revisions.
- M. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.

2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
3. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
4. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS

- A. Shop Drawings:
 1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
 2. Provide photometric calculations where luminaires are proposed for substitution upon request.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
 1. LED Luminaires:
 - a. Include estimated useful life, calculated based on IES LM-80 test data.
 - b. Include IES LM-79 test report upon request.
 2. Drivers: Include wiring diagrams and list of compatible lamp configurations.
 3. Lamps: Include rated life, color temperature, color rendering index (CRI), and initial and mean lumen output.
- C. Certificates for Dimming Ballasts: Manufacturer's documentation of compatibility with dimming controls to be installed.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. Extra Lenses and Louvers: Two percent of total quantity installed for each type, but not less than one of each type.
 2. Extra Lamps: Ten percent of total quantity installed for each type, but not less than two of each type.
 3. Extra Drivers: One of each type used.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND PROTECTION

- A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.08 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

- A. See Division 1 for additional warranty requirements.
- B. Provide five year pro-rata warranty for batteries for emergency lighting units.
- C. Provide ten year pro-rata warranty for batteries for self-powered exit signs.

PART 2 PRODUCTS

2.01 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.
- B. Substitutions: See Section 016000 - Product Requirements, except where individual luminaire types are designated with substitutions not permitted. Substitutions shall meet or exceed life cycle, lumens/watt and construction of specified fixtures.

2.02 LUMINAIRES

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products that meet energy efficiency requirements for full rebates of electric utility or state agency.
- C. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- D. Provide products listed, classified, and labeled as suitable for the purpose intended.
- E. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- F. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- G. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- H. Recessed Luminaires:
 - 1. Ceiling Compatibility: Comply with NEMA LE 4.
 - 2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
 - 3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.
- I. LED Luminaires:
 - 1. Components: UL 8750 recognized or listed as applicable.
 - 2. Tested in accordance with IES LM-79 and IES LM-80.
 - 3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.
- J. LED Tape Lighting Systems: Provide all power supplies, drivers, cables, connectors, channels, covers, mounting accessories, and interfaces as necessary to complete installation.
 - 1. LED Tape - General Requirements:
 - a. Listed.
 - b. Designed for field cutting in accordance with listing.
 - c. Wet Location Applications: IEC 60529, IP 68 (waterproof) rated.
- K. LED Luminaire Components: UL 8750 recognized or listed as applicable.
- L. Track Lighting Systems: Provide track compatible with specified track heads, with all connectors, power feed fittings, dead ends, hangers and canopies as necessary to complete installation.
- M. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

2.03 LED LIGHT FIXTURES

A. General:

1. LED light fixtures shall be in accordance with IES, NFPA, UL, as shown on the drawings, and as specified.
2. LED light fixtures shall be Reduction of Hazardous Substances (RoHS)-compliant.
3. LED drivers shall include the following features unless otherwise indicated:
 - a. Minimum efficiency: 85% at full load.
 - b. Minimum Operating Ambient Temperature: -20C. (-4F.)
 - c. Input Voltage: 120 - 277V ($\pm 10\%$) at 60 Hz.
 - d. Integral short circuit, open circuit, and overload protection.
 - e. Power Factor: > 0.95 .
 - f. Total Harmonic Distortion: $< 20\%$.
 - g. Comply with FCC 47 CFR Part 15.
4. LED modules shall include the following features unless otherwise indicated:
 - a. Comply with IES LM-79 and LM-80 requirements.
 - b. Minimum CRI 80 and color temperature 4000 K unless otherwise specified in LIGHTING FIXTURE SCHEDULE.
 - c. Minimum Rated Life: 50,000 hours per IES L70.
 - d. Light output lumens as indicated in the LIGHTING FIXTURE SCHEDULE.

B. LED Downlights:

1. Housing, LED driver, and LED module shall be products of the same manufacturer.

C. LED Troffers:

1. LED drivers, modules, and reflector shall be accessible, serviceable, and replaceable from below the ceiling.
2. Housing, LED driver, and LED module shall be products of the same manufacturer.

2.04 EMERGENCY LIGHTING UNITS

- A. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
- B. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
- C. Battery:
 1. Sealed maintenance-free nickel cadmium unless otherwise indicated.
 2. Size battery to supply all connected lamps, including emergency remote heads where indicated.
- D. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
- E. Provide low-voltage disconnect to prevent battery damage from deep discharge.
- F. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101; provide indicator light(s) to report test and diagnostic status.
- G. Accessories:
 1. Provide compatible accessory mounting brackets where indicated or required to complete installation.

2.05 EXIT SIGNS

- A. Description: Exit signs and similar signs for special purpose applications such as area of refuge/rescue assistance.

- B. Description: Internally illuminated exit signs with LEDs unless otherwise indicated; complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
 - 1. Number of Faces: Single or double as indicated or as required for the installed location.
 - 2. Directional Arrows: As indicated or as required for the installed location.
- C. Self-Powered Exit Signs:
 - 1. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
 - 2. Battery: Sealed maintenance-free nickel cadmium unless otherwise indicated.
 - 3. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
 - 4. Provide low-voltage disconnect to prevent battery damage from deep discharge.
 - 5. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.
- D. Accessories:
 - 1. Provide compatible accessory high impact polycarbonate vandal shields where indicated.
 - 2. Provide compatible accessory wire guards where indicated.

2.06 DRIVERS

- A. Dimmable LED Drivers:
 - 1. Dimming Range: Continuous dimming from 100 percent to one percent relative light output unless dimming capability to lower level is indicated, without flicker.
 - 2. Control Compatibility: Fully compatible with the dimming controls to be installed.
 - 3. Drivers shall be fully isolated.

2.07 ACCESSORIES

- A. Stems for Suspended Luminaires: Steel tubing, minimum 1/2" size, factory finished to match luminaire or field-painted as directed.
- B. Threaded Rods for Suspended Luminaires: Zinc-plated steel, minimum 1/4" size, field-painted as directed.
- C. Provide accessory plaster frames for luminaires recessed in plaster ceilings.
- D. Fire-Rated Luminaire Enclosures:
 - 1. Provide as required to preserve fire resistance rating of building elements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of luminaires provided under this section.
- B. Install products in accordance with manufacturer's instructions.
- C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting) and NECA 502 (industrial lighting).
- D. Provide required support and attachment in accordance with Section 26 05 29.
- E. Provide required seismic controls in accordance with Section 26 05 48.
- F. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- G. Suspended Ceiling Mounted Luminaires:
 - 1. Do not use ceiling tiles to bear weight of luminaires.
 - 2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
 - 3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members or to building structure.
 - 4. Secure pendant-mounted luminaires to building structure.
 - 5. In addition to ceiling support wires or chain, provide two galvanized steel safety wire(s), minimum 12 gage, or chain connected from opposing corners of each recessed luminaire to building structure.
 - 6. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.
- H. Recessed Luminaires:
 - 1. Install trims tight to mounting surface with no visible light leakage.
 - 2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
 - 3. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.
- I. Suspended Luminaires:
 - 1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
 - 2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
 - 3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet nominal length, with no more than 4 feet between supports.
 - 4. Install canopies tight to mounting surface.
 - 5. Unless otherwise indicated, support pendants from swivel hangers.
- J. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
- K. Install accessories furnished with each luminaire.
- L. Bond products and metal accessories to branch circuit equipment grounding conductor.
- M. Emergency Lighting Units:
 - 1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.

N. Exit Signs:

1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.

3.04 FIELD QUALITY CONTROL

- A. Inspect each product for damage and defects.
- B. Operate each luminaire after installation and connection to verify proper operation.
- C. Test emergency lighting units to verify proper operation upon loss of normal power supply.
- D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.05 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.
- B. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by Architect or authority having jurisdiction.
- C. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Architect or authority having jurisdiction.

3.06 CLEANING

- A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.07 CLOSEOUT ACTIVITIES

- A. See Division 1 for closeout submittals.
- B. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.

3.08 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

SECTION 27 10 00
STRUCTURED CABLING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Communications pathways.
- B. Copper cable and terminations.
- C. Fiber optic cable and interconnecting devices.
- D. Communications equipment room fittings.
- E. Communications outlets.
- F. Communications grounding and bonding.
- G. Communications identification.

1.02 RELATED REQUIREMENTS

- A. Division 7-Firestopping.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 33.13 - Conduit for Electrical Systems.
- D. Section 26 05 33.16 - Boxes for Electrical Systems.
- E. Section 26 05 53 - Identification for Electrical Systems: Identification products.
- F. Section 26 27 26 - WIRING DEVICES.

1.03 REFERENCE STANDARDS

- A. BICSI N1 - Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure, 1st Edition; 2019.
- B. EIA/ECA-310 - Cabinets, Racks, Panels, and Associated Equipment; Electronic Industries Alliance/Electrical Components Association; Revision E, 2005.
- C. NECA/BICSI 568 - Standard for Installing Building Telecommunications Cabling; National Electrical Contractors Association; 2006.
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set; 2016.
- F. TIA-568.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards; 2009c, with Addendum (2016).
- G. TIA-569 - Telecommunications Pathways and Spaces; 2015d, with Addendum (2016).
- H. TIA-606 - Administration Standard for Telecommunications Infrastructure; 2017c.
- I. TIA-607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; 2015c, with Addendum (2017).
- J. UL 444 - Communications Cables; Current Edition, Including All Revisions.
- K. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; Current Edition, Including All Revisions.
- L. UL 1863 - Communications-Circuit Accessories; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for communications equipment.
 - 2. Coordinate arrangement of communications equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

- B. Preinstallation Meeting: Convene one week prior to commencing work of this section to review service requirements and details with Communications Service Provider representative.

1.05 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- B. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
- C. Evidence of qualifications for installer.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
- E. Field Test Reports.
- F. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
 - 1. Record actual locations of outlet boxes and distribution frames.
 - 2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
 - 3. Identify distribution frames and equipment rooms by room number on drawings.

1.06 QUALITY ASSURANCE

- A. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- B. Installer Qualifications: A company having at least 3 years experience in the installation and testing of the type of system specified, and:
 - 1. Employing a BICSI Registered Communications Distribution Designer (RCDD).
 - 2. Supervisors and installers factory certified by manufacturers of products to be installed.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Keep stored products clean and dry.

1.08 WARRANTY

- A. Correct defective Work within a 2 year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 SYSTEM DESIGN

- A. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
 - 1. Provide fixed cables and pathways that comply with NFPA 70 and TIA-607 and are UL listed or third party independent testing laboratory certified.
 - 2. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
 - 3. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.

- B. Cabling to Outlets: Specified horizontal cabling, wired in star topology to distribution frame located at center hub of star; also referred to as "links".

2.02 PATHWAYS

- A. Conduit: As specified in Section 26 05 33.13; provide pull cords in all conduit.
- B. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

2.03 COPPER CABLE AND TERMINATIONS

- A. Provide cables with lead content less than 300 parts per million.
- B. Copper Horizontal Cable:
 - 1. Description: 100 ohm, balanced twisted pair cable complying with TIA-568.2 and listed and labeled as complying with UL 444.
 - 2. Cable Type - Voice and Data: TIA-568.2 Category 6A ScTP (screened twisted pair) or F/UTP (foiled unshielded twisted pair); 23 AWG.
 - 3. Cable Capacity: 4-pair.
 - 4. Cable Applications:
 - a. Plenum Applications: Use listed NFPA 70 Type CMP plenum cable.
 - b. Riser Applications: Use listed NFPA 70 Type CMR riser cable or Type CMP plenum cable.
 - c. General Purpose Applications: Use listed NFPA 70 Type CM/CMG general purpose cable, Type CMR riser cable, or Type CMP plenum cable.
 - d. Outdoor Applications: Use cable rated for exterior use.
 - 5. Cable Jacket Color -Data Cable: Blue.
- C. Copper Cable Terminations: Insulation displacement connection (IDC) type using appropriate tool; use screw connections only where specifically indicated.
- D. Jacks and Connectors: Modular RJ-45, non-keyed, terminated with 110-style insulation displacement connectors (IDC); high impact thermoplastic housing; suitable for and complying with same standard as specified horizontal cable; UL 1863 listed.
 - 1. Performance: 500 mating cycles.
 - 2. Voice and Data Jacks: 8-position modular jack, color-coded for both T568A and T568B wiring configurations.

2.04 COMMUNICATIONS EQUIPMENT ROOM FITTINGS

- A. Design intent is to use existing equipment. Below is if additional is required.
- B. Copper Cross-Connection Equipment:
 - 1. Connector Blocks for Category 5e and Up Cabling: Type 110 insulation displacement connectors; capacity sufficient for cables to be terminated plus 25 percent spare.
 - 2. Patch Panels for Copper Cabling: Sized to fit EIA/ECA-310 standard 19 inch wide equipment racks; 0.09 inch thick aluminum; cabling terminated on Type 110 insulation displacement connectors; printed circuit board interface.
 - a. Jacks: Non-keyed RJ-45, suitable for and complying with same standard as cable to be terminated; maximum 48 ports per standard width panel.
 - b. Capacity: Provide ports sufficient for cables to be terminated plus 25 percent spare.
 - c. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA-606.
 - d. Provide incoming cable strain relief and routing guides on back of panel.

2.05 COMMUNICATIONS OUTLETS

- A. Outlet Boxes: Comply with Section 26 05 33.16.

1. Provide depth as required to accommodate cable manufacturer's recommended minimum conductor bend radius.
- B. Wall Plates:
 1. Comply with system design standards and UL 514C.
 2. Accepts modular jacks/inserts.
 3. Capacity:
 - a. Data or Combination Voice/Data Outlets: 2 ports unless noted otherwise.
 4. Wall Plate Material/Finish - Flush-Mounted Outlets: Match wiring device and wall plate finishes specified in Section 26 27 26.

2.06 GROUNDING AND BONDING COMPONENTS

- A. Comply with TIA-607.

2.07 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606.
- B. Comply with Section 26 05 53.

2.08 SOURCE QUALITY CONTROL

- A. Factory test cables according to TIA-568 (SET).

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Comply with latest editions and addenda of TIA-568 (SET) (cabling), TIA-569 (pathways), TIA-607 (grounding and bonding), BICSI N1, NFPA 70, and SYSTEM DESIGN as specified in PART 2.
- B. Comply with Communication Service Provider requirements.
- C. Grounding and Bonding: Perform in accordance with TIA-607 and NFPA 70.
- D. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Division 7.

3.02 INSTALLATION OF PATHWAYS

- A. Install pathways with the following minimum clearances:
 1. 48 inches from motors, generators, frequency converters, transformers, x-ray equipment, and uninterruptible power systems.
 2. 12 inches from power conduits and cables and panelboards.
 3. 5 inches from fluorescent and high frequency lighting fixtures.
 4. 6 inches from flues, hot water pipes, and steam pipes.
- B. Conduit, in Addition to Requirements of Section 26 05 33.13:
 1. Arrange conduit to provide no more than the equivalent of two 90 degree bend(s) between pull points.
 2. Do not use conduit bodies.
- C. Outlet Boxes:
 1. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of telecommunications outlets provided under this section.

3.03 INSTALLATION OF EQUIPMENT AND CABLING

- A. Cabling:
 1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
 2. Do not over-cinch or crush cables.
 3. Do not exceed manufacturer's recommended cable pull tension.
 4. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.

- B. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:
 - 1. At Distribution Frames: 120 inches.
 - 2. At Outlets - Copper: 12 inches.
- C. Copper Cabling:
 - 1. Category 5e and Above: Maintain cable geometry; do not untwist more than 1/2 inch from point of termination.
 - 2. For 4-pair cables in conduit, do not exceed 25 pounds pull tension.
 - 3. Use T568B wiring configuration.
- D. Wall-Mounted Racks and Enclosures:
 - 1. Install to plywood backboards only, unless otherwise indicated.
 - 2. Mount so height of topmost panel does not exceed 78 inches above floor.
- E. Floor-Mounted Racks and Enclosures: Permanently anchor to floor in accordance with manufacturer's recommendations.
- F. Identification:
 - 1. Use wire and cable markers to identify cables at each end.
 - 2. Use manufacturer-furnished label inserts, identification labels, or engraved wallplate to identify each jack at communications outlets with unique identifier.
 - 3. Use identification nameplate to identify cross-connection equipment, equipment racks, and cabinets.

3.04 FIELD QUALITY CONTROL

- A. Comply with inspection and testing requirements of specified installation standards.
- B. Visual Inspection:
 - 1. Inspect cable jackets for certification markings.
 - 2. Inspect cable terminations for color coded labels of proper type.
 - 3. Inspect outlet plates and patch panels for complete labels.
- C. Testing - Copper Cabling and Associated Equipment:
 - 1. Test operation of shorting bars in connection blocks.
 - 2. Category 5e and Above Links: Perform tests for wire map, length, attenuation, NEXT, and propagation delay.
- D. Final Testing: After all work is complete, including installation of telecommunications outlets, and telephone dial tone service is active, test each voice jack for dial tone.

END OF SECTION

SECTION 28 46 00
FIRE DETECTION AND ALARM

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Replacement and removal of existing fire alarm system components, wiring, and conduit indicated.

1.02 RELATED REQUIREMENTS

- A. Division 7- Firestopping: Materials and methods for work to be performed by this installer.
- B. Section 21 22 00 - Clean-Agent Fire-Extinguishing System: Supervisory, alarm, and releasing devices installed in extinguishing system.
- C. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems: Requirements for the seismic qualification of equipment specified in this section.

1.03 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.
- B. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. NFPA 72 - National Fire Alarm and Signaling Code; 2016.
- E. NFPA 101 - Life Safety Code; 2015.

1.04 SUBMITTALS

- A. Proposal Documents: Submit the following with cost/time proposal:
 - 1. NFPA 72 "Record of Completion", filled out to the extent known at the time.
 - 2. Manufacturer's detailed data sheet for each control unit, initiating device, and notification appliance.
 - 3. Certification by Contractor that the system design will comply with Contract Documents.
 - 4. Proposed maintenance contract.
- B. Drawings must be prepared using AutoCAD Release 2020 or later.
 - 1. Owner will provide floor plan drawings for Contractor's use; verify all dimensions on Owner-provided drawings.
 - 2. Provide reproducible or electronic as-built drawings showing each device, with its unique identifier prior to project completion.
- C. Evidence of designer qualifications.
- D. Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:
 - 1. Copy (if any) of list of data required by authority having jurisdiction.
 - 2. NFPA 72 "Record of Completion", filled out to the extent known at the time.
 - 3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
 - 4. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
 - 5. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
 - 6. List of all devices on each signaling line circuit, with spare capacity indicated.

7. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
8. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
9. Certification by the manufacturer of the control unit that the system design complies with Contract Documents.
10. Certification by Contractor that the system design complies with Contract Documents.
11. Do not show existing components to be removed.
- E. Manufacturer's equipment seismic qualification certification.
- F. Inspection and Test Reports:
 1. Submit inspection and test plan prior to closeout demonstration.
 2. Submit documentation of satisfactory inspections and tests.
 3. Submit NFPA 72 "Inspection and Test Form," filled out.
- G. Project Record Documents: Have one set available during closeout demonstration:
 1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
 2. "As installed" wiring and schematic diagrams, with final terminal identifications.
 3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.
- H. Closeout Documents:
 1. Certification by manufacturer that the system has been installed in compliance with manufacturer's installation requirements, is complete, and is in satisfactory operating condition.
 2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.
 3. Certificate of Occupancy.
- I. Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.
 1. Furnish spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data and place in spare parts cabinet.

1.05 QUALITY ASSURANCE

- A. Copies of Design Criteria Documents: Maintain at the project site for the duration of the project, bound together, an original copy of NFPA 72, the relevant portions of applicable codes, and instructions and guidelines of authorities having jurisdiction; deliver to Owner upon completion.
- B. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer, with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.
- C. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
 1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
 2. Installer Personnel: At least 2 years of experience installing fire alarm systems.

3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.
 4. Certified in the State in which the Project is located as fire alarm installer.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 WARRANTY

- A. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

PART 2 PRODUCTS

2.01 FIRE ALARM SYSTEM

- A. Fire Alarm System: Provide modifications and extensions to the existing, addressable, automatic fire detection and alarm system.
1. Provide all components necessary, regardless of whether shown in the contract documents or not.
 2. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
 - a. ADA Standards.
 - b. The requirements of NFPA and the state Fire Code, latest adopted editions.
 - c. The requirements of the local authority having jurisdiction .
 - d. Applicable local codes.
 - e. Contract Documents (drawings and specifications).
 - f. NFPA 101.
 - g. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
- B. Circuits:
1. Match existing.
- C. Seismic Qualification: Provide fire alarm system and associated components suitable for application under the seismic design criteria specified in Section 26 05 48 where required. Include certification of compliance with submittals.

2.02 EXISTING COMPONENTS

- A. Existing Fire Alarm System: Remove existing components indicated and incorporate remaining components into new system, under warranty as if they were new; do not take existing portions of system out of service until new portions are fully operational, tested, and connected to existing system.
- B. Remove unused existing components and materials from site and dispose of properly.

2.03 COMPONENTS

- A. General:
1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
 2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.
- B. Fire Alarm Control Units: Analog, addressable type; listed, classified, and labeled as suitable for the purpose intended.
- C. Initiating Devices:

1. Addressable Systems:
 - a. Addressable Devices: Individually identifiable by addressable fire alarm control unit.
 - b. Provide suitable addressable interface modules as indicated or as required for connection to conventional (non-addressable) devices and other components that provide a dry closure output.
2. Manual Pull Stations:
 - a. Provide 1 extra.
 - b. Provide each station with clear polycarbonate protective cover to prevent inadvertant operation.
3. Smoke Detectors:
 - a. Provide 1 extra.
4. Duct Smoke Detectors:
 - a. Provide 1 extra.
5. Heat Detectors:
 - a. Provide 1 extra.
6. Addressable Interface Devices:
 - a. Provide 1 extra.
- D. Notification Appliances:
 1. Horns:
 - a. Provide 1 extra.
 2. Speakers:
 - a. Provide 1 extra.
 3. Strobes:
 - a. Provide 1 extra.
- E. Circuit Conductors: Copper; provide 200 feet extra; color code and label. Match pathway type of existing fire alarm system.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and Contract Documents.
- B. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.
- C. Obtain Owner's approval of locations of devices, before installation.
- D. Install instruction cards and labels.

3.02 INSPECTION AND TESTING FOR COMPLETION

- A. Notify Owner 7 days prior to beginning completion inspections and tests.
- B. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- C. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
- D. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
- E. Provide all tools, software, and supplies required to accomplish inspection and testing.
- F. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
- G. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

- H. Diagnostic Period: After successful completion of inspections and tests, Operate system in normal mode for at least 14 days without any system or equipment malfunctions.
 - 1. Record all system operations and malfunctions.
 - 2. If a malfunction occurs, start diagnostic period over after correction of malfunction.
 - 3. Owner will provide attendant operator personnel during diagnostic period; schedule training to allow Owner personnel to perform normal duties.
 - 4. At end of successful diagnostic period, fill out and submit NFPA 72 "Inspection and Testing Form."

3.03 CLOSEOUT

- A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
 - 1. Be prepared to conduct any of the required tests.
 - 2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
 - 3. Have authorized technical representative of control unit manufacturer present during demonstration.
 - 4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
 - 5. Repeat demonstration until successful.
- B. Occupancy of the project will not occur prior to Substantial Completion.
- C. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:
 - 1. Specified diagnostic period without malfunction has been completed.
 - 2. Approved operating and maintenance data has been delivered.
 - 3. Spare parts, extra materials, and tools have been delivered.
 - 4. All aspects of operation have been demonstrated to Owner.
 - 5. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
 - 6. Occupancy permit has been granted.

END OF SECTION