



TOWN OF BAILEY'S HARBOR GEOTHERMAL DESIGN

2392 County F, Bailey's Harbor, WI 54202

Construction Documents PROJECT MANUAL

August 7, 2025

HGA

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Project No. 5410-001-00

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**DOCUMENT 000105
CERTIFICATIONS PAGE**

ARCHITECTURAL

MECHANICAL

GEOHERMAL

ELECTRICAL

END OF DOCUMENT

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DOCUMENT 001100 ADVERTISEMENT FOR BIDS

1.1 PROJECT INFORMATION

- A. Notice to Bidders: Qualified bidders are invited to submit sealed stipulated sum bids for Work required to complete Project as described in the Contract Documents.

Project Owner: Town of Baileys Harbor
Project Title: Town of Baileys Harbor Geothermal Design
Project Location: Town Hall Building, 2392 County F, Baileys Harbor, WI 54202

Architect & Engineers: Hammel, Green and Abrahamson, Inc.

- B. Project Description: The project consists of the construction of a vertical-bore, closed-loop geothermal system connected to distributed zone heat pumps and an energy recovery ventilation unit for an existing two-story building, approximately 12,000 square foot in area located in Baileys Harbor, WI. The building type is an office building. Associated architectural, mechanical and electrical selective demolition and construction is included within the building as indicated within the scope of Construction Documents.
- C. Single-Prime Contract: Construction Contract Bids will be received for Work performed under a Single Contract, including General Construction, Mechanical Work and Electrical Work.

1.2 BID SUBMITTAL AND OPENING

- A. Owner will receive sealed stipulated sum bids until the bid time and date at the location given below. Bids will be thereafter publicly opened and read aloud. Owner will consider bids prepared in compliance with the Instructions to Bidders as issued by Owner, and delivered as follows:

Bid Date: Friday, 09/12/2025
Bid Time: 10:00 AM
Location: Baileys Harbor Town Hall, 2392 County F, Baileys Harbor, WI 54202

- B. Bids will be received in person or via mail only.
1. Oral or emailed bids will not be considered.
 2. Bids can be mailed to Baileys Harbor Town Hall, 2392 County F, Baileys Harbor, WI 54202 or PO Box 308 Baileys Harbor, WI 54202.
 3. All Bids shall be sealed and submitted with Bid Form 004100.
- C. Pre-Bid Meeting: A mandatory pre-bid meeting and tour for bidders to tour existing site and existing buildings will be at 10:00 am on Tuesday, 08/26/2025. Representatives of Architect and Owner will be present..
- D. Performance Bond: Upon Award of Contract, provide Performance and Payment Bond in amount of 10% of Contract Sum in accordance with General Conditions.

1.3 DOCUMENTS

- A. Complete digital Bidding Documents are available at <https://baileysharborwi.gov/>.
- B. Bidders may also inspect bidding documents at Baileys Harbor Town Hall, 2392 County F, Baileys Harbor, WI 54202.
- C. OWNER and ENGINEER in making copies of Bidding Documents available on the above terms do so only for the purpose of obtaining Bids for the Work and do not confer a license or grant for any other use.

END OF DOCUMENT

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DOCUMENT 002100 INSTRUCTIONS TO BIDDERS

1.1 NOTICE FOR BIDS

- A. Stipulated sum bids will be received for complete construction of Dodgeville Public Library Addition and Renovation as described within the scope of the Contract Documents.

1.2 BID DATE

- A. Bids will be received Friday, 09/12/2025 at 10:00 a.m. and will be opened immediately after bid closing hour and read publicly at Baileys Harbor Town Hall, 2392 County F, Baileys Harbor, WI 54202.

1.3 CONTRACTS

- A. Project will be constructed under a Single Prime Contract including General Construction, Mechanical Work and Electrical Work.

1.4 INQUIRIES REGARDING PROJECT

- A. All inquiries, requests for clarifications of Bidding Documents, requests for consideration of materials not specified and similar questions shall be submitted to the Architect, in writing. All inquiries, requests for clarification, requests for consideration of materials and products, must be received by Architect ten (10) days prior to bid date and bid hour. It is Bidder's responsibility to bring all discrepancies, ambiguities, omissions or matters in need of clarification to attention of Architect for interpretation and decision prior to the Bid Date.

1.5 ADDENDA

- A. Replies to inquiries, requests for interpretations or clarifications and requests for consideration of materials which involve or provide information that is not already a part of Bidding Documents will be contained in Addenda and shall become a part of Contract Documents and incorporated in all bids submitted.
- B. All bidders, including those submitting subcontract or supply bids, are responsible to ascertain what Addenda have been issued prior to bid date, examining Addenda and determining effect of Addenda provisions on their bid and their work.
- C. Interpretations, clarifications, modifications and supplemental instructions in form of written Addenda will be provided to all Bidders on record at Architect's office.
- D. Architect and Owner will not be responsible for or honor any claims resulting from, or alleged to be result of, misunderstanding by bidder (or Contractor) of verbal discussion of Project conditions prior to receiving bids. All verbal comments made during bidding period are subject to inclusion in addenda; otherwise they shall not be binding on Owner or Architect.
- E. During construction, discrepancies, ambiguities and intent not clarified by Addenda will be subject to interpretation of Architect only, and work shall be provided in accordance with Architect's interpretations.
- F. Bidders shall state on Bid Form the number of Addenda received.

1.6 OBLIGATION OF BIDDER - EXAMINATION OF DOCUMENTS AND SITE

- A. Each Bidder (including subcontract bidders where appropriate) is required to visit site and to become fully informed and record their own investigations as to extent of Work, conditions under which Work is to be performed, existing buildings and streets, conditions of area, existing utilities and other features, type of soil, available facilities and difficulties that may be encountered in connection therewith, and other relevant items which will affect the bidder's bid or Work.

- B. Prior to submitting a Bid, each Bidder is required to examine all of Bidding requirements, Contract Documents including drawings and specifications for Project, become thoroughly familiar with scope of Project and all factors and items of work which will affect the Contractor's Bid or Work, whether shown or specified in documents primarily for Work of others or Work of this Contract.
- C. No extras will be allowed to the Contractor as a result of misunderstanding of extent or scope of Work as a result of the Contractor's failure to study and record own findings. Submission of a bid shall be proof that such examinations have been made and that bidder has recorded own investigation and has become thoroughly familiar with all contract documents (including all Addenda). The failure or omissions of any Bidder to examine any form, instrument or bidding document shall in no way relieve any Bidder from any obligation in respect to the bidder's bid.

1.7 EXAMINATION OF SITE AND EXISTING FACILITIES

- A. A mandatory pre-bid meeting and tour for bidders to tour existing site and existing buildings will be at 10:00 am on Tuesday, 08/26/2025. Representatives of Architect and Owner will be present. Bidders shall assemble in the Auditorium at Baileys Harbor Town Hall, 2392 County F, Baileys Harbor, WI 54202.
- B. Should a bidder wish or need to further examine facilities contact the Architect to arrange a visit.

1.8 CONDITIONS OF WORK

- A. Each bidder must become fully informed of conditions relating to construction of Project and availability and employment of labor thereon. Failure to do so will not relieve a successful Bidder of an obligation to furnish all materials and labor necessary to carry out provisions of the Bidder's contract. Contractor, in carrying out the Contractor's work, must employ such methods or means as will not cause any interruption of or interference with Work of any other Contractor.

1.9 PREPARATION OF BID

- A. Submit bids to Owner in accordance with following requirements:
 - 1. Bids will be received physically only , in person or through mail for the Town of Baileys Harbor.
 - a. All Bids shall also be accompanied with Bid Form 004100.
 - 2. Completely fill in all blank spaces on Bid Form, in ink or typewriter, in both words and figures.
 - 3. Sign in longhand, executed by a principal duly authorized to enter into an agreement. If a bidder is a co-partnership, then signatures on bid shall be by an authorized member of firm, with names and addresses of each member of partnership.
 - 4. Base Bid and all Alternate bids shall be stated both in writing and in figures. In all cases, written and numerical figures must agree; otherwise at Owner's option, it shall be cause for rejection of bid. Complete form without interlineation, alteration, erasure.
 - 5. Submit Alternate bids amounts for each Alternate listed and indicate if Alternate is either increasing or decreasing cost.
 - 6. Submit Bids to designated place on or before time and date specified. Bids received after this time will not be opened or considered.
 - 7. Do not stipulate any other conditions, alternates or qualifications. Owner will not accept any condition not contained in Bidding Documents.

1.10 BID SECURITY

- A. Bid cannot be withdrawn for a period of 60 calendar days after opening of bids.

1.11 MODIFICATIONS OF BIDS

- A. Oral, telephone or telegraphic bids or modifications to bids will not be considered.

1.12 WITHDRAWAL OF BIDS

- A. The Bidder may withdraw bids at any time prior to date set for receiving of bids. Thereafter, bids may be withdrawn only after 30 days has elapsed after bid date, provided Owner has not acted thereon.

1.13 BIDDER'S QUALIFICATIONS

- A. Owner may make such investigations as deemed necessary to determine ability and responsibility of bidder to perform work, and any bidder shall furnish to Owner all such information and data for this purpose, as Owner may request.
- B. Owner reserves right to reject any bid if evidence submitted by, or investigation of, such bidder fails to satisfy Owner that such bidder is properly qualified to carry out obligations of Contract and to complete Work contemplated therein. The competence and responsibility of bidder will be considered in making an award, including, but not be limited to: (1) proof of financial responsibility, (2) quality of similar work, (3) amount of experience with similar projects, (4) facilities, personnel and equipment, (5) reputation for performance and, (6) ability to complete work within specified time. Owner reserves right to reject any Bid where there is reasonable doubt as to qualifications of bidder.

1.14 ACCEPTANCE OF BID - AWARD OF CONTRACT

- A. Owner reserves right to:
 - 1. Accept bidder's Base Bid only,
 - 2. Accept any one or more of bidder's Alternate Bids, in any order regardless of order in which they are listed,
 - 3. Reject any or all Bids,
 - 4. Award contract based on Owner's investigation of bidders, as well as acceptance of alternates, all of which Owner deems to be in the Owner's best interest,
 - 5. Waive informalities or minor irregularities in bids and waive minor irregularities or discrepancies in bidding procedure.
- B. Owner reserves the right to reject any and all bids, to accept bids it deems to be in its best interest, to waive any informalities or irregularities in bids submitted and to waive minor irregularities or discrepancies in bidding procedure.
- C. Performance Bond: Upon Award of Contract, provide Performance and Payment Bond in amount of 10% of Contract Sum in accordance with General Conditions.
- D. Completion Time: Commencement of Work and Time of Completion shall be essential condition of Contract. Work must be completed by date entered on Bid Form by Bidder, as agreed upon, and entered into Contract.

1.15 PROCEDURE FOR PROPOSED SUBSTITUTE MATERIALS AND EQUIPMENT

- A. The word "product" herein means any material, equipment, assembly, manufacturer, brand, trade name, element, item or similar description as applicable. Wherever a product is named on drawings or in specifications phrase "or acceptable substitute in opinion of Architect" shall be implied throughout, whether specifically noted or not.
- B. All requests for consideration of proposed substitute products for those specified shall be made in writing and must be received by Architect at least seven (7) days prior to bid date and bid hour. Acceptable substitute products will be included in addenda.
- C. Requests received after this time will not be considered or reviewed. Requests shall clearly define and describe product for which acceptance is requested, and shall be accompanied by manufacturer's literature, specifications, drawings, cuts, performance data, list of references, model numbers, or other information necessary to completely describe item.
- D. Acceptance of a product by Architect for bidding purposes will be in form of addenda to Contract Documents, issued as specified. No information or indication of acceptance will be provided in any other manner than addendum.
- E. The use of references to standards, manufacturers, brands and similar designations is intended to establish measure of quality as to minimum standards of design, function, appearance, type, strength, durability, construction, efficiency, sound level, finish, appearance, availability, service and similar characteristics, which have been determined as requisite for this Project.

- F. Proposed alternate products shall also be available in same range of colors, textures, dimensions, gauges, types, and finishes as material or article specified. Product must equal specified item in strength, durability, efficiency, serviceability, ease and cost of maintenance. Product must be compatible with building design and not necessitate design modifications; nor impose additional work or require changes in work of any Prime Contractor, or any other Subcontractor, vendor, or materials supplier, nor result in any additional cost to Owner.
- G. The supplier or manufacturer providing any acceptable product shall bear cost of any required modifications to spaces, services, utilities and other features as result of use of product, including, but not limited to: larger capacity mechanical or electrical service, devices or utilities resulting from acceptance of product for bidding purposes, as well as to pipes, conduits, ducts, and controls for conveying, distributing, and controlling those services or utilities; as well as insulation, wrappings, coatings, or other integral features of lines or items conveying those lines.
- H. Any product or manufacturer used as basis of specifications shall generally set criteria.
- I. It shall be expressly understood that any other product or manufacturer listed in specification or any addenda as acceptable will be acceptable provided they fully comply with requirements and match basic and essential criteria of product used for base specification, including level of workmanship quality, as determined by Architect.
- J. For final acceptance for use in work, Architect shall have right to accept or reject proposed deviations. Should a proposed product be unable to meet requirements, product shall not be used.
- K. Where two or more products are shown or specified, bidder and Contractor has an option of which to use, provided product proposed will meet all requirements of specifications and design criteria. The right is reserved by Architect to accept or reject proposed deviations in design, function, construction or similar differences that will affect design intent or quality.
- L. For any same or like product for this Project, only one brand, manufacturer, source or type shall be used, as approved by Architect.
- M. For products specified or shown by describing proprietary items, model numbers, catalog numbers, manufacturers, trade names or similar reference, each bidder obligates himself to submit bids and accept awards of a contract based upon use of such products. The reference is intended to establish measure for quality which has been determined as requisite and necessary for Project.

END OF DOCUMENT

DOCUMENT 003100

AVAILABLE PROJECT INFORMATION

PART 1 - GENERAL

1.1 GENERAL

- A. Documents referenced in this Section are part of the Procurement and Contracting Requirements for Project but are not part of the Contract Documents.
 - 1. Referenced documents provided by Owner for Bidders' convenience are intended to supplement rather than serve in lieu of Bidders' own investigations.
 - 2. Referenced documents are made available for Bidders' convenience and information but are not a warranty of existing conditions.
 - 3. Each Bidder shall be responsible for verifying the accuracy and reliability of such information by visiting the Site and through careful review of the documents.

1.2 FORMATION THERMAL CONDUCTIVITY DATA

- A. Data Use Limitations: Because the sub-surface conditions indicated by the borings and analysis are a sampling in relation to the entire construction area, and for other reasons, the Owner, Architect or firm reporting the sub-surface conditions based on borings, do not warrant the conditions below the depths of the borings or that the strata logged from the borings are necessarily typical of the entire site.
 - 1. Any party using information described in this Section shall accept full responsibility for its use and for obtaining additional soil information which may be required.
 - 2. Owner is not responsible for interpretations or conclusions drawn from the data.
- B. Formation Thermal Conductivity Report for G.O. Loop LLC: Formation Thermal Conductivity Test & Data Analysis prepared for the Baileys Harbor Town Hall location by GRTI, dated June 3-5, 2025, is available for viewing by the Owner and Architect.

END OF DOCUMENT

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**DOCUMENT 004100
BID FORM**

Project Name: Town of Baileys Harbor Geothermal Design
Project Location: Town Hall Building, 2392 County F, Baileys Harbor, WI 54202
Owner: Town of Baileys Harbor
Bid Closing: 10:00 a.m., Friday, 09,12,2025
Send To: Town Hall Building, 2392 County F, Baileys Harbor, WI 54202

Bidder: _____
COMPANY NAME

ADDRESS

CONTACT PERSON PHONE

We hereby submit our Bid for the Work indicated in the Bidding Documents. We agree to accomplish the Work in strict accordance with the requirements of the Construction Documents for the work as prepared by Hammel, Green and Abrahamson, Inc., Architects and Engineers, dated July 31, 2025, Commission Number 5410-001-00.

Having examined the Bidding Documents, visited the site and noted all conditions affecting the Work, undersigned proposes to furnish all labor, materials and equipment required to accomplish the Work called for by said documents in amounts as proposed herein.

BASE BID

For the completion of the of the Work as described within the scope of the Contract Documents as set forth in the Bidding Documents, for the sum of:

Dollars (\$ _____)

ALTERNATES

Alternate No. 1: Roof Truss Insulation

Provide mineral wool insulation at roof trusses with 10 mil polyethylene vapor retarder in lieu of spray foam insulation with intumescent fireproofing finish.

(Add/Deduct) Dollars (\$ _____)

ACCEPTANCE OF BIDS

In submitting this bid, it is understood that right is reserved by Owner to accept any bid in the owner's best interest, reject all bids, to accept any of Alternates in the owner's best interest, and to waive minor discrepancies in bidding procedure. The Undersigned will not withdraw this bid within 15 days after date of opening of bids.

CONTRACT AND BOND

If awarded Contract, Undersigned agrees to execute an Agreement within specified time in form of Standard Agreement of American Institute of Architects A-101, for above stated compensation and provide specified Performance and Labor/Material Payment bonds.

CHANGES IN WORK

In event changes in work necessitate a change in cost, percentage applied for supervision, profit and overhead will be in accordance with the General Conditions and Supplementary Conditions.

COMPLETION OF WORK

If Undersigned is notified of acceptance of this bid within 30 days after date of bid opening, the Bidder agrees hereby to commence the Work of the Contract Documents following a written Notice to Proceed no later than 10/01/2025, and shall achieve Substantial Completion no later than 180 days.

ACKNOWLEDGEMENT OF ADDENDA

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 _____.

ACKNOWLEDGEMENT

WITNESS Our Hands and seals this _____ day of _____, 20____.

Individual	)	_____
or	)	_____
Partner-	)	_____
ship	)	_____
Execution	)	Co-partners doing business under the name and style of:
	)	_____
	)	_____
	)	_____
	)	_____
	)	A Corporation of the State of _____
Corporate	)	_____
Execution	)	_____
	)	By _____
	)	_____
	)	Title _____
	)	_____
Corporate	)	By _____
Seal	)	_____
	)	Title _____
	)	_____

END OF DOCUMENT

SECTION 005000 CONTRACTING FORMS & SUPPLEMENTS

PART 1 - GENERAL

1.1 APPLICABLE FORMS

- A. The following is a list of forms and standards applicable to this Project.
 - 1. Bid Form: As bound in this Project Manual. Submit exact form in duplicate.
 - 2. Agreement: The Contract form will be AIA Document A-101, 2017 Edition.
 - 3. Payment and Performance Bond: AIA 312, (Performance Bond and Labor and Material Payment Bond) provided by Surety. Submit in two copies, with proper Power of Attorney and acknowledgements.
 - 4. FFP-03-01 Potential Conflict of Interest Disclosure
 - 5. FFP-03-04 Lobbying Certification Form
- B. Draft Forms are available as follows:
 - 1. Editable electronic versions will be available from the Architect by request by the successful Contractor.

END OF DOCUMENT

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**SECTION 007000
CONDITIONS OF THE CONTRACT**

1.1 GENERAL CONDITIONS

- A. The following forms of the General Conditions and Supplementary Conditions shall be used for Project:
 - 1. The General Conditions are the AIA A201 – 2017 General Conditions of the Contract for Construction and included in the Project Manual.

END OF SECTION

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SECTION 011100 SUMMARY OF WORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Description of construction delivered under a single contract.
 - 2. Restrictions that affect construction operations.
 - 3. Use of buildings, premises and site.

1.2 GENERAL SUMMARY OF WORK AND ADDITIONAL DEFINITIONS

- A. Owner: Town of Baileys Harbor
- B. Project Location:
 - Town Hall Building
 - 2392 County F
 - Baileys Harbor, WI 54202
- C. General Scope: The project consists of the construction of a vertical-bore, closed-loop geothermal system connected to distributed zone heat pumps and a DOAS energy recovery ventilation unit for an existing two-story building, approximately 12,000 square foot in area located in Baileys Harbor, WI. The building type is an office building. Associated architectural, mechanical and electrical selective demolition and construction is included within the building as indicated within the scope of Construction Documents.
 - 1. Work Included: Provide labor, materials, articles, equipment, incidentals, items, tools, services, supplies, methods, operations, skills in such quantities as may be necessary to complete Project within intent of Contract Documents.
 - 2. Singular notations shall be considered plural where plural application is reasonably inferable. Mention or indication of extent of work under work division or specification section is done only for convenience of Contractor and shall not be construed as describing all work required under that Division or Section.
- D. Construction Contract: Construction will be accomplished under a single Prime Contract including General Construction, Mechanical and Electrical work.
- E. Construction Limits: Except as specifically indicated or as may be necessary to complete the Work under the Contract, activities of the Contract shall be limited to within the limits designated on Drawings.

1.3 PROJECT DELIVERY

- A. Bidding Method: Project will be competitively bid to invited prime contract bidders for a single stipulated sum contract.
- B. Construction Contract: Construction will be accomplished under a single Prime Contract.

1.4 SUBCONTRACTORS

- A. Do not award work to Subcontractor without prior approval of Owner and Architect. Approval will not be given until Contractor submits List of Subcontractors containing such information as Owner and Architect may require concerning the proposed Subcontractor and scope of subcontract.

1.5 USE BY OWNER

- A. Owner reserves the right to jointly occupy the premises with Contractor in performance of Owner's duties and functions. Owner also reserves the right to: enter into the Project and premises; make installations of materials and equipment at appropriate times as the Work progresses; install equipment, furniture and furnishings when spaces are at appropriate stages of completion. Coordinate work with Owner and cooperate with Owner to minimize undue interferences.
- B. If any part, unit, phase, or the entire Project is substantially complete or ready for occupancy, Owner may, upon notice to Contractor, and without prejudice to rights of Owner or Contractors, enter into and make use of work that is substantially complete.

1.6 MAINTAINING SERVICES AND FUNCTIONS

- A. General: It is essential that full Owner's services and functions are maintained throughout construction period, with minimum disturbance and disruption to Owner's operations. Contractor and Subcontractors shall be aware of these requirements and objectives. Contractor must conduct work and develop a detailed schedule to meet these requirements and objectives.
- B. Work at Occupied Facilities: After Owner's occupancy (full or partial) of Project or unit, stage, phase or area, work remaining to be accomplished in the occupied spaces shall be done in cooperation with, and approval by, Owner and scheduled in advance with Owner. In general, work in occupied spaces shall be done when the space is not in use, such as after hours in administrative areas or public spaces when public use hours are over for the day, unless specifically approved by Owner. Where necessary, overtime shall be used if work cannot reasonably be accomplished during normal work periods, at no extra cost to Owner. Perform work in occupied areas in a manner and at such time as will not significantly interfere with, hamper or inconvenience Owner's program or functions.

1.7 PERFORMANCE/PAYMENT BOND

- A. Owner reserves the right to require a bond in accordance with General Conditions and Supplementary Conditions. Provide on form specified.
 - 1. AIA A311 or equivalent.
 - 2. Provide and pay for bond.

1.8 OTHER BONDS, PERMITS, FEES

- A. Other Bonds, Permits, Fees: Provide and pay for bonds, fees and permits that may be required, including bonds, permits and fees required by local authorities to directly accomplish work under this project.
- B. Submit copies of required permits to Owner prior to the start of that work.

1.9 WARRANTIES

- A. In the event of conflict, inconsistency, or difference between a warranty issued by a supplier or contractor and terms of specifications, Owner, if it becomes necessary to enforce terms and provisions of warranty or specifications, may elect to enforce either submitted warranty or specifications.

1.10 ELECTRONIC FILES

- A. Upon request, one copy of electronic files in Architect's current file format, including applicable layers, for each issue (bid packages, construction packages, addenda, etc.) will be provided via e-mail, CD, or website posting at Architect's option to General Contractor at no charge for:
 - 1. Architectural floor plans

2. Reflected ceiling plans
 3. Structural framing plans
 4. HVAC plans
 5. Plumbing plans
 6. Lighting plans
 7. Signal/System plans
 8. Power plans.
- B. Additional documents not listed or additional copies of electronic files are available upon request with advance payment of applicable fee(s) and subject to conditions of use. Contact Architect for schedules of fees and additional details about conditions. Subcontractors and others can obtain copies of electronic files from General Contractor.
- C. Electronic files and information therein are instruments of service and works in progress created for this Project and not to be used for other projects, additions to this project or completion of this Project by others.
- D. Signed and sealed original hard copy Drawings, Specifications and other documents as defined by General Conditions are Contract Documents. Electronic files are not Contract Documents and may be subject to manipulation beyond Architect's control. Therefore, Architect cannot verify that electronic files accurately or completely reflect Contract Documents, actual construction or field conditions. Each user of electronic files must determine accuracy, completeness and suitability for its intended use.
- E. Electronic files are subject to discrepancies as a result of numerous factors including but not limited to transmission and translation errors resulting from differences in software, hardware and other equipment related problems, disc or server malfunctions, data corruption during transmission through website or email and user error. Neither Architect nor Owner shall be responsible for such discrepancies.
- F. Architect makes no representation regarding accuracy, completeness or permanence of electronic files. Changes to Contract Documents may not be incorporated into electronic files including without limitation, Addenda information or revisions made after date indicated on electronic files.
- G. By accepting electronic files, user covenants not to sue, and agrees to indemnify and hold harmless Architect and Owner from costs (including attorneys' fees), claims or causes of action be it tort, breach of contract or otherwise that result from the use of electronic files, and waives claims for consequential and/or liquidated damages against Architect and Owner.
- H. Architect and Owner provide no warranties, express or implied with respect to electronic files, including but not limited to, Spearin type warranties, warranties of merchantability and/or fitness for a particular purpose.
- I. Use of electronic files provided by Architect does not obviate Contractor, subcontractor/installer or supplier from responsibility for proper checking and coordination of dimensions, details, member sizes, quantities and other requirements to facilitate complete and accurate fabrication, installation and completion of Work.
- J. Providing electronic files by Architect is not to be construed to be in derogation of reserved or intellectual property rights.

1.11 CONSTRUCTION DOCUMENTS

- A. Specifications: 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. Singular notations shall be considered plural where plural application is reasonably inferable.
 3. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
 4. Indication of extent of work by division or specification section is done only for convenience of Contractor and shall not be construed as describing all work required under that Division or Section.
 5. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
 6. Basis of Design Product Specification: Where Specifications name a product, or refer to a product indicated on Drawings, provide the specified or indicated product or equivalent 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.
- B. Drawings: 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. Material Identification Codes and Abbreviations: Materials and products are identified by abbreviation codes referencing Specification Section numbers found in this Project Manual.
 2. Other Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections

1.12 COPIES OF DRAWINGS AND SPECIFICATIONS

- A. Drawings and Specifications will be made available to Contractor via an electronic distribution service. Subcontractors obtain documents from Contractor. Subcontractors are responsible for costs associated with hard copy printing drawings from this service. Provide one set for the on-site set to record changes as Record Set.

1.13 USE OF PREMISES - SPECIAL CONSIDERATIONS, REQUIREMENTS AND CONSTRAINTS

- A. Work Over Finished Floors: Where work is performed over finished floors (i.e. ceramic tile, concrete, VCT) or where area is used as a passage, provide hardboard or plywood cover to protect against damage or stains. Covering to be provided by General Contractor.
- B. Safety Program: Develop a safety program and provide first aid kits in several accessible locations on site for temporary on-site first aid. Contractor is responsible for safety of persons and property and compliance with applicable statutes, rules, regulations, and orders for work under this Contract.
- C. Temporary Plywood Enclosures, General: Supported, sound plywood of appearance acceptable to Architect. Insulate enclosures at building openings where temporary enclosure serves as building exterior wall.
- D. Accomplish work in streets in conformance with Municipality requirements and to a schedule as Municipality may require. Contractor must make arrangements with Municipality.
- E. Snow Removal: Remove snow from the building work areas, storage areas, and access routes after each period of snowfall to prevent the accumulation of snow and ice from impeding job progress or creating unsafe conditions.
1. Provide covered walkways at public sidewalks, fire exit as required to maintain public safety, and as may be required by the Municipality. Refer to Section 015000 for further requirements.

1.14 USE OF PREMISES - CLEAN CONDITIONS

- A. References: Refer to General Conditions for general cleaning requirements, Section 017700 for Project Closeout Clean-up and Section 015000 for additional temporary closure requirements.
- B. General: Contractor and subcontractors shall maintain clean conditions in areas of existing buildings and where new construction interfaces with existing buildings. Maintain areas free of accumulations of combustible materials. Provide good housekeeping and regular cleaning to maintain areas clean and free of debris. Provide proper closures between areas under construction including closures and measures to prevent spread of dust or other contamination.

1.15 HAZARDOUS SUBSTANCES AND HARMFUL PHYSICAL AGENTS

- A. Where work of this project involves possible hazardous substances or harmful physical agents, exercise extreme care to avoid damage and preserve safety of personnel.
- B. Regulations concerning availability of information and employee training in use and handling of "hazardous substances" and "harmful physical agents" are governed by Employee Right-to-Know Act of (1983 unless otherwise revised or updated; or amended by local jurisdictions).
- C. Regulations governing handling of asbestos-containing materials and disposal of asbestos-containing debris are:
 - 1. Code of Federal Regulations, Title 29, U.S. Department of Labor - Occupational Safety and Health Administration (OSHA), Section 1910.1001 - Asbestos.
 - 2. Local pollution control agency Rules for Emission Standards for Asbestos.

1.16 GENERAL PROTECTION AND SAFETY

- A. References: Refer to General Conditions of the Contract for general requirements.
- B. General: In accordance with best construction practices, Contractor is solely and completely responsible for conditions of job site, including safety of persons and property affected directly or indirectly by contractor's operations during performance of Work. This requirement shall apply continuously 24 hours per day until acceptance of Work by Owner and shall not be limited to normal working hours.

1.17 SAFETY DIRECTOR - FIRE AND ACCIDENT

- A. Safety Director: Appoint a responsible employee to act as Safety Director (fire and accident or separate individuals for each) whose duty it shall be to prevent accidents and minimize fire hazards and to enforce safety precautions. Safety Director shall develop procedures and regulations to guide Contractor, subcontractors and workers. With particular respect to existing buildings, facilities, and Owner's staff, Safety Director shall consult with and be guided by directions of Owner.
- B. Compliance: Contractor and Subcontractors shall conform to and abide by requirements of Safety Director.
- C. Inspection: Safety Director shall periodically inspect spaces of work under this Contract and operations of Contractor and list hazards to be removed or corrected. These shall be reported to Owner, Contractor and responsible subcontractors, who shall promptly remove or correct hazards.
- D. Site Meetings: Safety Director shall hold accident and fire prevention meetings at least once a month with representatives of various trades employed to insure employees understand and comply with programs.

1.18 FIRE SAFETY PRECAUTIONS

- A. Reference: Refer to General Conditions for general requirements.

- B. General: Contractor and Safety Director shall recognize the utmost importance of extraordinary precautions to prevent a fire in or adjacent to functioning and occupied building. Contractor, subcontractors and workers shall exercise extreme care to maintain and exercise fire safety precautions through work. This shall include providing sufficient fire fighting devices, watchmen, standby helpers or other precautions during construction, in use of temporary heat, welding, bracing, sweating, testing or other phases of work. Refer to Section 015000 for temporary fire fighting devices to be provided under Contract.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

END OF SECTION

SECTION 012600 CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for handling and processing Contract modifications.

1.2 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.

1.3 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 time specified in Proposal Request or 20 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.
- 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.

1.4 CHANGE ORDER PROCEDURES

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

1.5 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: Architect may issue a Construction Change Directive on AIA Document G714. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
 - 1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.
- B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
 - 1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 012900 PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.

1.2 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.

1.3 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 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 seven 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. Provide at least one line item for each Specification Section.
 - 1. Identification: Include the following Project identification on the schedule of values:
 - a. Project name and location.
 - b. Owner's name.
 - c. Owner's Project number.
 - d. Name of Architect.
 - e. Architect's Project number.
 - f. Contractor's name and address.
 - g. Date of submittal.
 - 2. Arrange the schedule of values in tabular form, with separate columns to indicate the following for each item listed (matching format of AIA Document G703):
 - 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. Round dollar amounts to whole dollars, with total equal to Contract Sum.
 - 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. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
 - 4. 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.

5. Allowances: Provide a separate line item in the schedule of values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
6. Overhead Costs, Proportional Distribution: Include total cost and proportionate share of general overhead and profit for each line item.
7. Temporary Facilities: Show cost of temporary facilities and other major cost items that are not direct cost of actual work-in-place as separate line items.
8. Schedule of Values Revisions: Revise the schedule of values when Change Orders or Construction Change Directives result in a change in the Contract Sum. Include at least one separate line item for each Change Order and Construction Change Directive.

1.4 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.
- B. Payment Application Times: Submit Application for Payment to Architect by the second Tuesday 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 seven 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.
 1. Other Application for Payment forms proposed by the Contractor may be acceptable to Architect and Owner. Submit forms for approval with initial submittal of schedule of values.
- 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.
 4. Indicate separate amounts for work being carried out under Owner-requested project acceleration.
- 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, evidence of transfer of title to Owner, and consent of surety to payment 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 pdfs of each Application for Payment to Architect by a email. 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 subcontractors, sub-subcontractors, and suppliers for construction period covered by the previous application.
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. Submit final Application for Payment with or preceded by conditional final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
 5. 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. Copies of building permits.
 6. Certificates of insurance and insurance policies.
 7. Performance and payment bonds.
 8. Data needed to acquire Owner's insurance.
- I. Application for Payment at Substantial Completion: After Architect issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
 - a. Complete administrative actions, submittals, and Work preceding this application, as described in Section 017700 "Closeout Procedures."
 2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
- 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. Certification of completion of final punch list items.
 3. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
 4. Updated final statement, accounting for final changes to the Contract Sum.
 5. AIA Document G706.
 6. AIA Document G706A.
 7. AIA Document G707.
 8. Evidence that claims have been settled.
 9. 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.
 10. Final liquidated damages settlement statement.
 11. Proof that taxes, fees, and similar obligations are paid.
 12. Waivers and releases.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 013100 PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project, including, but not limited to, the following:
 - 1. General coordination procedures.
 - 2. Coordination drawings.
 - 3. RFIs.
 - 4. Digital project management procedures.
 - 5. Web-based Project management software package.
 - 6. Project meetings.

1.2 DEFINITIONS

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

1.3 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, telephone number, and email address 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: Within 15 days of 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, 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. Post copies of list in Project meeting room, in temporary field office, and in prominent location in built facility. Keep list current at all times.

1.4 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
 - 1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
 - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
 - b. Coordinate the addition of trade-specific information to coordination drawings in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
 - c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.

- d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
- e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
- f. Indicate required installation sequences.
- g. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

1.5 REQUEST FOR INFORMATION (RFI)

- A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
 1. Architect will return without response those RFIs submitted to Architect by other entities controlled by Contractor.
 2. Coordinate and submit RFIs in a prompt manner 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. Owner name.
 3. Owner's Project number.
 4. Name of Architect.
 5. Architect's Project number.
 6. Date.
 7. Name of Contractor.
 8. RFI number, numbered sequentially.
 9. RFI subject.
 10. Specification Section number and title and related paragraphs, as appropriate.
 11. Drawing number and detail references, as appropriate.
 12. Field dimensions and conditions, as appropriate.
 13. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 14. Contractor's signature.
 15. 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: Software-generated form acceptable to Architect.
 1. Attachments shall be electronic files in PDF format.
- D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow three days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.
 1. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Architect's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.

2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt by Architect 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 5 days of receipt of the RFI response.
- E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number.
 1. Project name.
 2. Name and address of Contractor.
 3. Name and address of Architect.
 4. RFI number, including RFIs that were returned without action or withdrawn.
 5. RFI description.
 6. Date the RFI was submitted.
 7. Date Architect's response was received.
 8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
- 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 three days if Contractor disagrees with response.

1.6 DIGITAL PROJECT MANAGEMENT PROCEDURES

- A. Use of Architect's Digital Data Files: Digital data files of Architect's BIM model will be provided by Architect for Contractor's use during construction.
 1. Refer to "Electronic Files" Article in Section 011000 "Summary".
- B. Web-Based Project Management Software Package: Provide, administer, and use approved web-based Project management software package for purposes of hosting and managing Project communication and documentation until Final Completion.
 1. At completion of Project, provide digital archive in format that is readable by common desktop software applications in format acceptable to Architect. Provide data in locked format to prevent further changes.
- C. PDF Document Preparation: Where PDFs are required to be submitted to Architect, prepare 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. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

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 a minimum of seven days prior to meeting.
 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.

- B. Preconstruction Conference: Architect will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement.
1. Attendees: Authorized representatives of Owner Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Responsibilities and personnel assignments.
 - b. Tentative construction schedule.
 - c. Phasing.
 - d. Critical work sequencing and long lead items.
 - e. Designation of key personnel and their duties.
 - f. Lines of communications.
 - g. Use of web-based Project software.
 - h. Procedures for processing field decisions and Change Orders.
 - i. Procedures for RFIs.
 - j. Procedures for testing and inspecting.
 - k. Procedures for processing Applications for Payment.
 - l. Distribution of the Contract Documents.
 - m. Submittal procedures.
 - n. Preparation of Record Documents.
 - o. Use of the premises and existing building.
 - p. Work restrictions.
 - q. Working hours.
 - r. Owner's occupancy requirements.
 - s. Responsibility for temporary facilities and controls.
 - t. Procedures for moisture and mold control.
 - u. Procedures for disruptions and shutdowns.
 - v. Construction waste management and recycling.
 - w. Parking availability.
 - x. Office, work, and storage areas.
 - y. Equipment deliveries and priorities.
 - z. First aid.
 - aa. Security.
 - bb. Progress cleaning.
 3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other Sections and when required for coordination with other construction.
- D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Architect, but no later than 60 days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.
 2. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
 - a. Preparation of Record Documents.
 - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
 - c. Procedures for completing and archiving web-based Project software site data files.
 - d. Submittal of written warranties.
 - e. Requirements for preparing operations and maintenance data.

- f. Requirements for delivery of material samples, attic stock, and spare parts.
 - g. Requirements for demonstration and training.
 - h. Preparation of Contractor's punch list.
 - i. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
 - j. Submittal procedures.
 - k. Owner's partial occupancy requirements.
 - l. Installation of Owner's furniture, fixtures, and equipment.
 - m. Responsibility for removing temporary facilities and controls.
 - 4. Minutes: Entity conducting meeting will record and distribute meeting minutes.
- E. Progress Meetings: Conduct progress meetings at biweekly intervals.
 - 1. Coordinate dates of meetings with preparation of payment requests.
 - 2. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, 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.
 - 3. 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) Deliveries.
 - 5) Off-site fabrication.
 - 6) Access.
 - 7) Site use.
 - 8) Temporary facilities and controls.
 - 9) Progress cleaning.
 - 10) Quality and work standards.
 - 11) Status of correction of deficient items.
 - 12) Field observations.
 - 13) Status of RFIs.
 - 14) Status of Proposal Requests.
 - 15) Pending changes.
 - 16) Status of Change Orders.
 - 17) Pending claims and disputes.
 - 18) Documentation of information for payment requests.
 - 4. Minutes: Entity responsible for conducting the meeting 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)

END OF SECTION

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SECTION 013200 CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 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. Construction schedule updating reports.

1.2 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
 - 1. PDF file.

1.3 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.
 - 2. Coordinate each construction activity in the network with other activities, and schedule them in proper sequence.

1.4 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.
- B. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Final Completion.
 - 1. Contract completion date to not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- C. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion.
- D. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
 - 1. Unresolved issues.
 - 2. Unanswered Requests for Information.
 - 3. Rejected or unreturned submittals.
 - 4. Notations on returned submittals.
 - 5. Pending modifications affecting the Work and the Contract Time.
- E. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
 - 1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.

- F. 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, equipment required to achieve compliance, and date by which recovery will be accomplished.
- G. Distribution: Distribute copies of approved schedule to Architect, Owner, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
 - 1. Post copies in Project meeting rooms and temporary field offices.
 - 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

1.5 GANTT-CHART SCHEDULE REQUIREMENTS

- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's Construction Schedule within 20 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.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 013300 SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Submittal schedule requirements.
 - 2. Administrative and procedural requirements for submittals.

1.2 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. Closeout Submittals: Operation and maintenance manuals, warranties, and project record documents required at project closeout.

1.3 SUBMITTAL SCHEDULE

- A. Submittal Schedule: Submit, as an action submittal, a list 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. 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.

1.4 SUBMITTAL FORMATS

- A. Submittal Information: Include the following information in each submittal:
 - 1. Project name.
 - 2. Date.
 - 3. Name of Architect.
 - 4. Name of Contractor.
 - 5. Name of firm or entity that prepared submittal.
 - 6. Names of subcontractor, manufacturer, and supplier.
 - 7. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier and alphanumeric suffix for resubmittals.
 - 8. Category and type of submittal.
 - 9. Submittal purpose and description.

10. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
 11. Drawing number and detail references, as appropriate.
 12. Indication of full or partial submittal.
 13. Location(s) where product is to be installed, as appropriate.
 14. Other necessary identification.
 15. Remarks.
 16. Signature of transmitter.
- B. Options: Identify options requiring selection by Architect.
- C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.
- D. Electronic Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.

1.5 SUBMITTAL PROCEDURES

- A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
1. Email: Prepare submittals as PDF package and transmit to Architect by sending via email. Include PDF transmittal form. Include information in email subject line as requested by Architect.
 - a. Architect will return annotated file. Annotate and retain one copy of file as a digital Project Record Document file.
- B. Transmittal Form: Include completed transmittal form attached to the end of this Section. Submittals sent without completed Submittal Transmittal Form will be considered incomplete, marked NOT ACCEPTED, and returned without review.
- C. 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 submittals for related parts of the Work specified in different Sections, 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.
- D. 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 15 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 15 days for review of each resubmittal.
- E. 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.
- F. 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.
- G. 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.

1.6 SUBMITTAL REQUIREMENTS

- A. 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 unsuitable 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 that show 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 Shop Drawings, and before or concurrently with Samples.
- B. 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 unless submittal based on Architect's digital data drawing files is otherwise permitted.
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.
- C. Samples: Submit Samples for review of type, color, pattern, and texture for a check of these characteristics with other materials.
1. Transmit Samples that contain multiple, related components, such as accessories together in one submittal package.
 2. Identification: Permanently attach label on unexposed side of Samples that includes the following:
 - a. Project name and submittal number.
 - b. Generic description of Sample.
 - c. Product name and name of manufacturer.
 - d. Sample source.

- e. Number and title of applicable Specification Section.
 - f. Specification paragraph number and generic name of each item.
3. Email Transmittal: Provide PDF transmittal. Include 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 one full set(s) 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 three sets of Samples. Architect will retain two Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a project record Sample.
 - 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 three sets of paired units that show approximate limits of variations.
- D. 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.
- E. 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.
- F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.
- G. Certificates:
 1. Certificates and Certifications Submittals: Submit 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. Provide a notarized signature where indicated.
 2. 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.

3. **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.
 4. **Material Certificates:** Submit written statements on manufacturer's letterhead, certifying that material complies with requirements in the Contract Documents.
 5. **Product Certificates:** Submit written statements on manufacturer's letterhead, certifying that product complies with requirements in the Contract Documents.
 6. **Welding Certificates:** Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of AWS B2.1/B2.1M on AWS forms. Include names of firms and personnel certified.
- H. **Test and Research Reports:**
1. **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 substrate preparation and primers required.
 2. **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.
 3. **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.
 4. **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.
 5. **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.
 6. **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:
 - a. Name of evaluation organization.
 - b. Date of evaluation.
 - c. Time period when report is in effect.
 - d. Product and manufacturers' names.
 - e. Description of product.
 - f. Test procedures and results.
 - g. Limitations of use.

1.7 DELEGATED DESIGN SERVICES

- A. **Delegated Design Submittal and Shop Drawings:** Where professional design services or certifications by a qualified Professional Engineer are specifically required of the Contractor by the Contract Documents, prepare and incorporate the following delegated design requirements into the shop drawings submittal package.
1. Shop drawings shall be signed and sealed by a qualified Professional Engineer or contain an attached certificate, signed and sealed by a qualified Professional Engineer, indicating that the products and systems comply with performance and design criteria in the Contract Documents.
 2. Shop drawings or certificate shall clearly define the design criteria and applied loads for which the system components and connections have been designed. If design criteria indicated in the Contract Documents are not sufficient to perform services or certification required, submit a written request for additional information to Architect/Engineer.
 - a. Include list of design criteria, codes, standards, loads, and other factors used in performing these services.

3. Shop drawings shall clearly indicate magnitude and location of all forces transferred to the supporting building structure by the product or system in which it is connected to. Forces shall be provided as unfactored values determined in accordance with the applicable building codes.
- B. Calculations: Upon request from the Architect/Engineer only, Contractor shall submit signed and sealed engineering calculations prepared by a qualified Professional Engineer. Submitted calculations that have not been requested by the Architect/Engineer will be returned without review.
 1. Calculations shall indicate structural integrity of members, anchors, fasteners and connections to supporting building structure, in accordance with performance and design criteria in Contract Documents. Provide load calculations, summary of loads and any applicable load diagrams.
 2. Calculations will be reviewed by Architect/Engineer for stated design criteria, general compliance to specified requirements, and forces imposed on supporting structure only. The accuracy of the design calculations is the sole responsibility of the Contractor's Professional Engineer.

1.8 CONTRACTOR'S REVIEW

- A. Action Submittals 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. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp. Include 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.
 1. Architect will not review submittals received from Contractor that do not have Contractor's review and approval.

1.9 ARCHITECT'S REVIEW

- A. Action Submittals: Architect will review each submittal, indicate corrections or revisions required, and return.
 1. PDF Submittals: Architect will indicate, via markup on each submittal, the appropriate action.
- B. Architect's Action:
 1. APPROVED: Submittal has no exceptions noted.
 2. CONDITIONALLY APPROVED: Submittal has exceptions noted, but resubmission is not required.
 3. NOT APPROVED: Submittal is incomplete and/or need corrections. Complete and/or correct and resubmit until final acceptance is obtained.
 4. RECEIVED: Submittal is for information only.
 5. NOT REVIEWED: Submittal was not required and has not been reviewed.
- C. 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.
- D. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.
- E. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- F. Architect will return without review submittals received from sources other than Contractor.
- G. Submittals not required by the Contract Documents will be returned by Architect without action.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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DOCUMENT 013310
SUBMITTAL TRANSMITTAL FORM

To: Hammel Green and Abrahamson, Inc.
Attn: Submittals Coordinator
333 East Erie Street
Milwaukee, Wisconsin 53202
CA.MKE@hga.com
7475 Hubbard Avenue, Suite 201
Middleton, Wisconsin 53562

Owner: Town of Baileys Harbor
Project: Town Hall Building Geothermal Design

HGA No.: 5410-001-00

From: _____

Address: _____

Contact: _____

Email: _____

Phone: _____

Submittal Date: _____

Previous Date: _____

PRODUCT DATA

☐ Partial ☐ Complete ☐ Preliminary ☐ Final

Specification Section, Article, Paragraph: _____

Description: _____

Product/Model: _____

Manufacturer: _____

Supplier: _____

Subcontract: _____

SHOP DRAWINGS

☐ Partial ☐ Complete ☐ Preliminary ☐ Final

Specification Section, Article, Paragraph: _____

Description: _____

Product/Model: _____

Manufacturer: _____

Supplier: _____

Subcontract: _____

SAMPLES

☐ Partial ☐ Complete ☐ Preliminary ☐ Final

Specification Section, Article, Paragraph: _____

Description: _____

Product/Model: _____

Manufacturer: _____

Supplier: _____

Subcontract: _____

SUBMITTED BY

Name: _____ Company: _____

Signature: _____ Date: _____

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SECTION 014000 QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1.2 DEFINITIONS

- A. Experienced: When used with an entity or individual, "experienced," unless otherwise further described, means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- B. Field Quality-Control Tests and Inspections: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, subcontractor, or sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
 - 1. Use of trade-specific terminology in referring to a Work result does not require that certain construction activities specified apply exclusively to specific trade(s).
- D. Mockups: Physical assemblies of portions of the Work constructed to establish the standard by which the Work will be judged. Mockups are not Samples.
 - 1. Mockups are used for one or more of the following:
 - a. Verify selections made under Sample submittals.
 - b. Demonstrate aesthetic effects.
 - c. Demonstrate the qualities of products and workmanship.
 - d. Demonstrate successful installation of interfaces between components and systems.
 - e. Perform preconstruction testing to determine system performance.
 - 2. Product Mockups: Mockups that may include multiple products, materials, or systems specified in a single Section.
 - 3. In-Place Mockups: Mockups constructed on-site in their actual final location as part of permanent construction.
- E. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria. Unless otherwise indicated, copies of reports of tests or inspections performed for other than the Project do not meet this definition.
- F. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) in accordance with 29 CFR 1910.7, by a testing agency accredited in accordance with NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- G. Source Quality-Control Tests and Inspections: Tests and inspections that are performed at the source (e.g., plant, mill, factory, or shop).

- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. The term "testing laboratory" has the same meaning as the term "testing agency."
- I. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work, to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- J. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work, to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Architect.

1.3 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements is specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, inform the Architect regarding the conflict and obtain clarification prior to proceeding with the Work. Refer conflicting requirements that are different, but apparently equal, to Architect for clarification before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified is the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data : For Contractor's quality-control personnel.
- B. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- C. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
 - 1. Specification Section number and title.
 - 2. Entity responsible for performing tests and inspections.
 - 3. Description of test and inspection.
 - 4. Identification of applicable standards.
 - 5. Identification of test and inspection methods.
 - 6. Number of tests and inspections required.
 - 7. Time schedule or time span for tests and inspections.
 - 8. Requirements for obtaining samples.
 - 9. Unique characteristics of each quality-control service.

1.5 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
 - 1. Date of issue.
 - 2. Project title and number.
 - 3. Name, address, telephone number, and email address of testing agency.
 - 4. Dates and locations of samples and tests or inspections.
 - 5. Names of individuals making tests and inspections.
 - 6. Description of the Work and test and inspection method.
 - 7. Identification of product and Specification Section.
 - 8. Complete test or inspection data.
 - 9. Test and inspection results and an interpretation of test results.

10. Record of temperature and weather conditions at time of sample-taking and testing and inspection.
 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 12. Name and signature of laboratory inspector.
 13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, telephone number, and email address of technical representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at Project site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement of whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, telephone number, and email address of factory-authorized service representative making report.
 2. Statement that equipment complies with requirements.
 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 4. Statement of whether conditions, products, and installation will affect warranty.
 5. Other required items indicated in individual Specification Sections.

1.6 QUALITY ASSURANCE

- A. Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems 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. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.
- C. Fabricator Qualifications: A firm experienced in producing products 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.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that is similar in material, design, and extent to those indicated for this Project.

- F. Testing and Inspecting Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented in accordance with ASTM E329, and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
- G. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- H. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect, demonstrate, repair, and perform service on installations of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
 - 1. Contractor's Responsibilities:
 - a. Provide test specimens representative of proposed products and construction.
 - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
 - d. When testing is complete, remove test specimens and test assemblies; do not reuse products on Project.
 - 2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect, with copy to Contractor. Interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from the Contract Documents.

1.7 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
 - 1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
 - 2. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
 - 1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
 - 2. Engage a qualified testing agency to perform quality-control services.
 - 3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
 - 4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 - 5. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 - 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

- C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- D. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
 - 1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 - 2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
 - 3. Conduct and interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from requirements.
 - 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 - 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 - 6. Do not perform duties of Contractor.
- E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."
- F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- G. Contractor's Associated Requirements and Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
 - 1. Access to the Work.
 - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 - 3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
 - 4. Facilities for storage and field curing of test samples.
 - 5. Delivery of samples to testing agencies.
 - 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 - 7. Security and protection for samples and for testing and inspection equipment at Project site.
- H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.
 - 1. Schedule times for tests, inspections, obtaining samples, and similar activities.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
 - 1. Date test or inspection was conducted.
 - 2. Description of the Work tested or inspected.
 - 3. Date test or inspection results were transmitted to Architect.

4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's and authorities' having jurisdiction reference during normal working hours.
 1. Submit log at Project closeout as part of Project Record Documents.

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspection, sample-taking, and similar services, repair damaged construction and restore substrates and finishes.
 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION

SECTION 014200 REFERENCES

PART 1 - GENERAL

1.1 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Architect. Other terms, including "requested," "authorized," "selected," "required," and "permitted," have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms, including "shown," "noted," "scheduled," and "specified," have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.2 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
 - 1. For standards referenced by applicable building codes, comply with dates of standards as listed in building codes.
- C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1.3 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 015000 TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

1.2 USE CHARGES

- A. Installation, removal, and use charges for temporary facilities to be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Architect, testing agencies, and authorities having jurisdiction.
- B. Water and Sewer 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. Exercise measures to conserve water.
- C. 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. Exercise measures to use Owner's electricity conservatively.

1.3 INFORMATIONAL SUBMITTALS

- A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.
- B. Implementation and Termination Schedule: Within 15 days of date established for commencement of the Work, submit schedule indicating implementation and termination dates of each temporary utility.
- C. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.
- D. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.

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.
- C. Accessible Temporary Egress: Comply with applicable provisions in ICC A117.1.

1.5 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Chain-Link Fencing: Minimum 2-inch, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts .
- B. Portable Chain-Link Fencing: Minimum 2-inch, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts. Provide concrete or galvanized-steel bases for supporting posts.

2.2 TEMPORARY FACILITIES

- A. Field Offices:
 - 1. Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
- B. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
 - 1. Store combustible materials apart from building.

2.3 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
 - 1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
 - 2. Heating, Cooling, and Dehumidifying Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

PART 3 - EXECUTION

3.1 TEMPORARY FACILITIES, GENERAL

- A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

3.2 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 as specified in Section 011000 "Summary."
- 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.

3.3 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. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
 - 1. Connect temporary sewers to municipal system as directed by authorities having jurisdiction.
- C. Water Service:
 - 1. 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.
- D. Sanitary Facilities: Provide temporary toilets, wash facilities, safety shower and eyewash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
 - 1. Use of Permanent Toilets: Use of Owner's existing or new toilet facilities [is not permitted] [will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
- E. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
 - 1. Provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.
- F. Electric Power Service:
 - 1. Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.
- G. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
 - 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
- H. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install land-based telephone line(s) for each field office.
 - 1. At contractor's option, provide each superintendent and foreman with a cell phone with satisfactory service.
 - 2. At each telephone, ore other prominent location in field office, post a list of important telephone numbers.
 - a. Police and fire departments.
 - b. Ambulance service.
 - c. Contractor's home office.
 - d. Contractor's emergency after-hours telephone number.
 - e. Architect's office.
 - f. Owner's office.
 - g. Principal subcontractors' field and home offices.

3.4 SUPPORT FACILITIES INSTALLATION

- A. Comply with the following:
 - 1. One of the following at Contractor's option:
 - a. Provide construction for temporary field offices, shops, and sheds located within construction area or within 30 feet of building lines that is noncombustible in accordance with ASTM E136. Comply with NFPA 241.
 - b. Utilize designated area within existing building for temporary field offices.
 - 2. 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. Temporary Use of Planned Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
 - 1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
 - 2. Prepare subgrade and install subbase and base for temporary roads and paved areas in accordance with Section 312000 "Earth Moving."
 - 3. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course in accordance with Section 321216 "Asphalt Paving."
- C. Traffic Controls: Comply with requirements of authorities having jurisdiction.
 - 1. Protect existing site improvements to remain, including curbs, pavement, and utilities.
 - 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- D. Parking: Use designated areas of Owner's existing parking areas for construction personnel.
- E. Storage and Staging: Use designated areas of Project site for storage and staging needs.
- F. 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.
- G. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.
 - 1. Identification Signs: Provide Project identification signs as shown on the attached "FFP Project Site Sign Specifications."
 - 2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
 - a. Provide temporary, directional signs for construction personnel and visitors.
 - 3. Maintain and touch up signs, so they are legible at all times.
- H. Waste Disposal Facilities:
 - 1. Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017300 "Execution."

3.5 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.
 - 1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.
- 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:
 - 1. Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, in accordance with erosion- and sedimentation-control Drawings.
 - a. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant-protection zones.

- b. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
 - c. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
 - d. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.
- 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:
 - 1. Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
- F. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people from easily entering site except by entrance gates.
 - 1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
 - 2. Maintain security by limiting number of keys and restricting distribution to authorized personnel.
- 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: Provide temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction. Provide signage directing occupants to temporary egress.
- I. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
 - 1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.

3.6 MOISTURE AND MOLD CONTROL

- A. Exposed Construction Period: 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.
- B. Partially Enclosed Construction Period: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
 - 1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
 - 2. Keep interior spaces reasonably clean and protected from water damage.
 - 3. Periodically collect and remove waste containing cellulose or other organic matter.
 - 4. Discard or replace water-damaged material.
 - 5. Do not install material that is wet.
 - 6. Discard and replace stored or installed material that begins to grow mold.
 - 7. Perform work in a sequence that allows wet materials adequate time to dry before enclosing the material in gypsum board or other interior finishes.

- C. Controlled Construction Period: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
 2. Use temporary or permanent HVAC system to control humidity within ranges specified for installed and stored materials.
 3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.
 - a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective and require replacing.
 - b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
 - c. Remove and replace materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.7 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. Owner reserves right to take possession of Project identification signs.
 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

SECTION 016000 PRODUCT REQUIREMENTS & SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Procedures, requirements and limitations for considering substitutions.
 - 2. Criteria for selecting product options and substitutions.
 - 3. Administrative and procedural requirements for selection of products for use in Project;
 - 4. Product delivery, storage, and handling;
 - 5. Manufacturers' standard warranties special warranties;
 - 6. Equivalent products.
 - 7. Substitution requirements and procedures.
- B. Related Requirements:
 - 1. Section 012300 - Alternates: Products selected under an alternate.
 - 2. Section 013300 - Submittal Requirements
 - 3. Section 014200 - References: Applicable industry standards for products specified.
 - 4. Divisions 02 through 49 Sections for specific requirements for products in those Sections.

1.2 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. Equivalent 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," 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 equivalent products of additional manufacturers named in the specification.

1.3 SUBMITTALS

- A. Proposed Materials and Products List:
 - 1. Submit within 10 working days after award of Contract and prior to procurement.
 - 2. Do not order materials or equipment until proposed list of materials is accepted.
 - 3. Materials and equipment are subject to Architect's and Owner's acceptance.
 - 4. Arrange list in order of specification sections and in form indicated by Architect/Engineer.
 - a. Items listed shall fully conform to project requirements and specifications.

- b. Identify each material, product or equipment item by manufacturer and model and other identifying designations such as material identification abbreviations and equipment numbers, including those where only 1 material or product is specified.
 - c. Name products specified by reference standards, described by performance requirements and descriptive language.
 - d. Do not list "as specified."
- 5. Where 2 or more makes or kinds of items are named in specifications (or additional names are listed in an addendum), state which particular make or kind of each item is to be provided.
- 6. If list is not received within 10 working days, mechanical and electrical equipment under Divisions 23, and 26, will be as scheduled.

1.4 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.
 - 1. Comply with manufacturer's written instructions.
 - 2. Comply with requirements specified in individual Specification Sections.
- 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.

1.5 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. Warranty Submittals: Comply with requirements in Section 017700 - Closeout Procedures and Section 017800 - Closeout Submittals.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS

- 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. Comply with General Conditions of the Contract for Construction.
 2. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 3. 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.
 4. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
 5. Where products are accompanied by the term "as selected," Architect will make selection.
 6. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
 7. Provide pricing based on products listed in Contract Documents. Contract award is based on use of specified products or substitutions approved prior to bidding or pricing.
 - a. By execution of Contract, Contractor agrees and understands Work will be accomplished with products specified or accepted by substitution.
- B. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Equivalent products or substitutions for Contractor's convenience will not be considered.
1. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements.
 2. Nonrestricted 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 and is compatible with adjacent construction, as certified in writing by Manufacturers' of adjacent materials.
 3. Comply with requirements in "Equivalent Products" Article for consideration of an unnamed product.
- C. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Equivalent products or substitutions for Contractor's convenience will not be considered.
1. Restricted List: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
 2. Nonrestricted 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.
 3. Comply with requirements in "Equivalent Products" Article for consideration of an unnamed manufacturer's product.

- D. 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 equivalent 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 "Equivalent Products" Article for consideration of an unnamed product by one of the other named manufacturers.
1. Reference to "Basis of Design" and a named specific product or manufacturer is intended to establish criteria for use of that product and manufacturer based on that products published information whether or not those criteria are explicitly stated in Specifications.
 2. Criteria may establish higher performance requirement than specified reference or performance standards. Such reference is intended to establish minimum level of quality, standard of design, function, appearance, type, strength, durability, construction, efficiency, sound level, finish, appearance, availability, service and similar characteristics determined necessary for Project.
 3. Specification criteria including basis of design products are considered as a whole.
 4. Other products or manufacturers listed meet features, performance, appearance and other criteria established by that product or manufacturer even if product must be customized to meet those criteria.
 5. When other products are listed in a Section those products may be used if they meet entire specification criteria including criteria implied by product listed as basis of design. Meeting some requirements but not meeting criteria established by basis of design product does not qualify as meeting specified requirements.
 6. Products or manufacturers accepted for substitution will be acceptable provided they fully comply with requirements and match basic and essential criteria of product used for basis of specification or design, including level of fabrication quality, as determined by Architect.
 7. Some specification Sections refer to the Material Identification List on the Drawings where Basis of Design products, and sometimes equivalent products, are scheduled.
- E. Equivalent Products: Architect will consider Contractor's request for equivalent 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.
 6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," or "or equivalent product," comply with requirements in "Equivalent Products" Article to obtain approval for use of an unnamed product.
- F. Equivalent Product Requests: Submit request for consideration of each equivalent 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 "Equivalent Products" Article.
 2. Architect and Owner reserve right to accept or reject proposed product. Should a proposed product be unable to meet requirements to satisfaction of Architect, product shall not be used. No additional compensation will be allowed for required Work resulting from use of product accepted by Addendum.

- G. 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 this Section for proposal of product.
- H. 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.
- I. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.
- J. Labels, Nameplates and Trademarks: Do not permanently attach or imprint labels or trademarks on surfaces exposed to view when installed, except as follows:
 - 1. Service-Connected or Power-Operated Equipment: Provide permanent nameplate indicating manufacturer, model number, serial number, capacity, speed, electrical characteristics and similar essential operating data.
 - a. Locate nameplate on easily accessible surface.
 - 2. UL Fire Rating Labels and Other Required Labels: Install on accessible inconspicuous surfaces. Do not paint, deface or conceal required nameplates or labels.

2.2 PRODUCT SUBSTITUTIONS

- A. Intent is to limit unnecessary substitutions after bids. Changes will not be allowed to accepted list of products, except when specified or accepted product subsequently is determined as not meeting requirements of Contract Documents or product becomes unavailable, and then only under following conditions:
 - 1. Orders were placed in timely manner as required after list of materials is accepted. No excuse or proposed substitution will be considered for products due to unavailability unless proof is submitted that firm orders were placed in a timely manner.
 - 2. Reason for unavailability is beyond control of Contractor: prolonged strikes or lockouts which will delay Project to an extent unacceptable to Owner, bankruptcy, discontinuance of a product, delays or Acts of God or other similar reasons.
 - 3. Request for substitution is submitted in writing within 10 days after date Contractor becomes aware product does not comply with specifications or has become unavailable, accompanied by supporting evidence.
 - 4. No extra cost to Owner.
 - 5. Substitution does not compromise design intent or quality required.
 - 6. Substitute product is acceptable to Owner and Architect.
 - 7. 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.
 - 8. Requested substitution does not require revisions to Contract Documents.
 - 9. Requested substitution is consistent with the Contract Documents and will produce intended and indicated results.
 - 10. Substitution request is fully documented and properly submitted.
 - 11. Requested substitution will not adversely affect Contractor's Construction Schedule.
 - 12. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - 13. Requested substitution is compatible with other portions of Work.
 - 14. Requested substitution has been coordinated with other portions of Work.

15. Requested substitution provides specified warranty.
 16. If requested substitution involves more than one trade, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to installers involved.
- B. Substitution Request Submittals: Submit requests for substitution in writing to Architect at least 10 calendar days prior to bid date and hour. Requests received after this time will not be considered. Clearly define and describe proposed substitute product including following items:
1. Fully completed Section 016211 - Substitution Request Form.
 2. Manufacturer's printed information supporting claim that proposed product meets specified requirements. Provide following as applicable:
 - a. Literature Specifications Drawings Cut Sheets Performance data List of reference projects of similar size, value and complexity Model numbers Other information necessary to completely describe item.
 3. Provide a point by point comparison between key features of specified Basis of Design item and proposed substitution.
 4. Provide submitted materials marked with Article and Paragraph references from Specification using highlighter, marker and flags on pages to facilitate review and show that substitution meets specified requirements.
 5. Provide a letter indicating requestor has reviewed Contract Documents and examined site (if needed) and that proposed substitution meets specified requirements.
- C. Accepted substitutions will be published in writing. No information or indication of acceptance will be provided by means other than written Addendum during bidding or Architect's written construction administration document following bidding. Refer to "Limitations on Substitutions after Bids or During Construction" in this Section.
- D. Bid and construct according to Contract Documents unless approval of substitution is provided in writing.
- E. Architect is not obligated to state reasons for rejecting substitution.
- F. Substitute products shall:
1. Be available in same range of colors, textures, dimensions, gauges, types, and finishes as specified product.
 2. Be equal to specified item in strength, durability, efficiency, serviceability, ease and cost of maintenance.
 3. Be compatible with building design.
 4. Not necessitate design modifications.
 5. Not impose additional work or require changes in work of Prime Contractor, or other Subcontractor, vendor, or materials supplier.
 6. Not add cost to Owner.
 7. Be similar in essential fabrication features.
- G. Reference Standards for Products:
1. When references to Federal Specification, ASTM Standard, American National Standards Institute (ANSI) or similar association standards are listed for product quality, provide an acceptable affidavit certifying that proposed substitution for this Project meets with same standard.
 2. Submit supporting test data to substantiate compliance.
- H. Contractor, supplier or manufacturer providing accepted substitute product shall bear cost of required modifications to spaces, services, utilities and other features as result of accepting substitute products, including but not limited to:
1. Larger capacity mechanical or electrical service, devices or utilities resulting from acceptance of product for bidding purposes.

2. Modification to pipes, conduits, ducts, and controls for conveying, distributing, and controlling those services or utilities.
3. Modification to insulation, wrappings, coatings, or other integral features of lines or items conveying those lines.
- I. 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.

PART 3 - EXECUTION

Not Used.

END OF SECTION

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To: Hammel Green and Abrahamson, Inc.
Attn: Submittals Coordinator
7475 Hubbard Avenue, Suite 201
Middleton, Wisconsin 53562

Owner: Town of Baileys Harbor
Project: Town Hall Building Geothermal Design

HGA No.: 5410-001-00
From: _____

Address: _____

Contact: _____

Email: _____

Phone: _____

Submittal Date: _____

Previous Date: _____

PROPOSED SUBSTITUTION

Specification Section, Article, Paragraph: _____

Applicable Drawing & Details: _____

In Lieu Of: _____

Product/Model: _____

Manufacturer: _____

REASON FOR SUBSTITUTION REQUEST

☐ Pre-Bid Substitution (Prior Approval) Date: _____

☐ Specified product is not available. Explain: _____

☐ Cost savings to Owner. Provide comparative cost analysis.

☐ Other: _____

EFFECTS OF PROPOSED SUBSTITUTION

Does substitution affect dimensions indicated on Drawings?

☐ NO ☐ YES Explain: _____

Does substitution affect Work of other Sections?

☐ NO ☐ YES Explain: _____

Does substitution require modifications to design, changes to Drawings, or revisions to specifications to be incorporated into the Project?

☐ NO ☐ YES Explain: _____

CONTRACTOR'S / BIDDER'S REPRESENTATION

Undersigned accepts responsibility for coordination of proposed substitution and accepts all additional costs resulting from the incorporation of proposed substitution into the Project per Section 016210.

Subcontractor: _____

Signature: _____

Date: _____

Contractor: _____

Signature: _____

Date: _____

ARCHITECT'S REVIEW

Review Date: _____

Reviewer Name: _____

☐ Accepted

☐ Not Accepted

☐ No Action Required

☐ Incomplete Submission

☐ Late Submission

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SECTION 017300 EXECUTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work, including, but not limited to, the following:
 - 1. Construction layout.
 - 2. Field engineering.
 - 3. Installation.
 - 4. Cutting and patching.
 - 5. Progress cleaning.
 - 6. Starting and adjusting.
 - 7. Protection of installed construction.
 - 8. Correction of the Work.

1.2 DEFINITIONS

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

1.3 QUALITY ASSURANCE

- A. Professional Engineer Qualifications: Refer to Section 014000 "Quality Requirements."
- B. 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, or when encountering the need for cutting and patching of elements whose structural function is not known, notify Architect of locations and details of cutting and await directions from Architect before proceeding. 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. Operational Elements: Do not cut and patch operating elements and related components in a manner 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.
- C. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of specified products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. 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. Use materials that are not considered hazardous.
- C. 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.

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 sitework, investigate and verify the existence and location of underground utilities and other construction affecting the Work.
 - 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, gas service piping, 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. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Existing Utility Information: Furnish information to local utility that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. 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.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect in accordance with requirements in Section 013100 "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks and existing conditions. If discrepancies are discovered, notify Architect promptly.
- B. Engage a land surveyor experienced in laying out the Work, using the following accepted surveying practices:
 - 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
 - 2. Establish limits on use of Project site.
 - 3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 - 4. Inform installers of lines and levels to which they must comply.
 - 5. Check the location, level and plumb, of every major element as the Work progresses.
 - 6. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
 - 7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.4 FIELD ENGINEERING

- A. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
 - 1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
 - 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- B. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
 - 1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
 - 2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
 - 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

3.5 INSTALLATION

- A. 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, unless otherwise indicated on Drawings.
- 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 satisfactory results as judged by Architect. 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 of type expected for Project.
- 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: Select tools or equipment that minimize production of excessive 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 portions of the 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 with manufacturer.
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, as judged by Architect. Fit exposed connections together to form hairline joints.

3.6 CUTTING AND PATCHING

- A. 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. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 - 4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
 - 5. 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.
 - 6. 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, as judged by Architect. 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 eliminate evidence of patching and refinishing.
 - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 - 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, corner to corner of wall and edge to edge of ceiling. Provide additional coats until patch blends with adjacent surfaces.
 - 4. 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.

3.7 PROGRESS CLEANING

- A. 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.
 - 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, in accordance with 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 in accordance with 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: 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."
- 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 ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.8 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements."

3.9 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. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.
- C. Comply with manufacturer's written instructions for temperature and relative humidity.

3.10 CORRECTION OF THE WORK

- A. Repair or remove and replace damaged, defective, or nonconforming Work. Restore damaged substrates and finishes.
 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.

- a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
- B. Repair Work previously completed and subsequently damaged during construction period. Repair to like-new condition.
- C. Restore permanent facilities used during construction to their specified condition.
- D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- E. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- F. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION

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SECTION 017420 CONSTRUCTION WASTE MANAGEMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Administrative and procedural requirements for the following:
 - 1. Salvaging nonhazardous waste.
 - 2. Recycling nonhazardous waste.
 - 3. Disposing of nonhazardous waste.
- B. Related Sections:
 - 1. Section 018113 - Sustainable Design Requirements.
 - 2. Section 024110 - Structure Demolition.
 - 3. Section 024113 - Selective Site Demolition: For disposition of waste resulting from demolition and removal of existing sitework.
 - 4. Section 024120 - Selective Demolition: For disposition of waste resulting from demolition and removal of existing construction and equipment.
 - 5. Section 024130 - Selective Interior Demolition: For disposition of waste resulting from demolition and removal of existing construction and equipment.

1.2 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.

1.3 ACTION SUBMITTALS

- A. Waste Management Plan: Prior to start of construction, submit a construction waste management plan indicating how Contractor proposes to collect, segregate, recycle, and recover at least **75%** of construction wastes and debris generated by the Work.
 - 1. Submit documentation indicating compliance with regulations specified in this Section.
 - 2. Include a list of recycling facilities to which indicated recyclable materials will be sent for recycling.
 - 3. Identify materials that are not recyclable or otherwise recoverable that must be disposed of in a landfill or other means acceptable under governing State where project is located and local regulations.
 - 4. List permitted landfills and/or other disposal means to be employed.

1.4 QUALITY ASSURANCE

- A. Waste Management Coordinator Qualifications: Experienced firm, or individual employed and assigned by General Contractor, with a record of successful waste management coordination of projects with similar requirements. Superintendent [may] [may not] serve as Waste Management Coordinator.
- B. Regulatory Requirements: Comply with applicable requirements of the State in which Project is located and applicable local ordinances and regulations concerning management of construction, demolition, land clearing, inert, and site trash debris and subsequent modifications and amendments to same.
- C. Disposal Sites, Recyclers, and Waste Materials Processors: Use only facilities properly permitted by the State of Wisconsin, and by local authorities where applicable.
- D. Waste Management Preconstruction Conference: Prior to beginning work at the site, schedule and conduct a conference to review the Construction Waste Management Plan and discuss procedures, schedules and specific requirements for waste materials recycling and disposal. Discuss coordination and interface between Contractor and other construction activities. Identify and resolve problems of compliance with requirements. Record minutes of the meeting, identifying conclusions reached and matters requiring further resolution. Maintain waste management as an agenda item at future construction meetings.
 - 1. Attendees: Construction Manager, Prime Contractors, Waste Management Coordinator, and related Contractor personnel associated with work of this section, including personnel in charge of the waste management program; Architect; material suppliers where appropriate; and such additional Owner personnel as Owner deems appropriate.
 - 2. Plan Revision: Make revisions to Construction Waste Management Plan agreed upon during the meeting and incorporate resolutions agreed to be made subsequent to the meeting. Submit revised plan to Architect for approval.

1.5 STORAGE AND HANDLING

- A. Site Storage: Remove materials for recycling and recovery from the work location to approved containers or storage area as required. Failure to remove waste materials will be considered cause for withholding payment and termination of Contract.
- B. Position containers for recyclable and recoverable waste materials at a designated location on the Project Site. If materials are sorted on site, provide separate collection containers or storage areas for not less than the following materials:
 - 1. Concrete and masonry.
 - 2. Metals.
 - 3. Untreated lumber.
 - 4. Gypsum wallboard scrap.
 - 5. Paper and cardboard.
- C. Handling: Deposit indicated recyclable, and recoverable materials in storage areas or containers in a clean (no mud, adhesives, solvents, petroleum contamination), debris-free condition. Do not deposit contaminated materials into the containers until such time as such materials have been cleaned.
- D. If the contamination chemically combines with the material so that it cannot be cleaned, do not deposit into the recycle containers. In such case, request resolution by the Construction Quality Manager for disposal of the contaminated material. Directions from the Construction Quality Manager do not relieve the Contractor of responsibility for compliance with all legal and regulatory requirements for disposal, nor shall such directions cause a request for modification of the Contract.

1.6 PROJECT CONDITIONS

- A. Environmental Requirements: Transport recyclable and recoverable waste materials from the Work Area to containers and carefully deposit in the containers without excess noise and interference with other activities, to minimize noise and dust.
 - 1. Do not place recyclable waste materials on the ground adjacent to a container.

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.
 - 1. Comply with Section 015000 - Temporary Facilities and Controls for operation, termination, and removal requirements.
- B. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.
 - 1. Distribute waste management plan to everyone concerned within three days of submittal return.
 - 2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
- 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.
 - 2. Comply with Division 01 Section "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 WASTE MANAGEMENT

- A. General: Implement waste management procedures in accordance with approved Construction Waste Management Plan. Maintain procedure throughout the life of this Contract.
- B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan.
- 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 they are 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 off Owner's property and transport to recycling receiver or processor.
- D. Source Separation On- or Off-Site: Either separate, store, protect, and handle at the project site all identified recyclable and recoverable waste products to prevent contamination of materials and maximize recycleability and recoverability of materials. Or mix all identified recyclable and recoverable waste products for separation off-site.
- E. Arrange for the regular collection, transport from the site, and delivery to respective approved recycling centers of indicated recyclable waste materials. Maintain records accessible to the Architect for verification of construction waste materials recycling and recovery.
- F. Delivery Receipts: Arrange for timely pickups from the site or deliveries to approved recycling facilities of designated waste materials to keep construction site clear and prevent contamination of materials. Keep and maintain records of deliveries to recycling facilities and pickups of waste materials at the site by others as specified above.

3.3 RECYCLING CONSTRUCTION WASTE

- A. General: the following paragraphs supplement handling requirements for various materials identified for classification and recycling listed in Part 1 "Summary" article above.
- 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. Packaging and Paper:
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. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
 4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.
 5. Bond Paper: General office quality paper used for specifications, correspondence, copiers, PC laser printers, and FAX machines. Collect in separate container at each workstation and deposit loose in appropriate recycle container as required.
 6. Newsprint: Newspapers and tabloid style advertising (slick finish magazines and advertising materials are not typically recyclable). Collect in single location and deposit as required in appropriate recycle container.
 7. Construction Office Waste: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following construction office waste materials:
 - a. Paper.
 - b. Aluminum cans.
 - c. Glass containers.
 - d. Plastic bottles and containers.
 8. Other: Recycle paper and beverage containers used by on-site workers.
- D. Concrete and Masonry: Clean concrete, brick, rock, and masonry free of metals, woods and other contaminants.
1. If possible during demolition, crush existing concrete and concrete masonry units on-site into aggregate size.

2. Store crushed material on-site in clean area to avoid contamination from other materials or building processes.
 3. Reuse on-site crushed material for fill, for stabilizing soils, or as base and subbase materials.
 4. If crushing on site is impractical, store material during demolition processes on site in clean, uncontaminated area.
- E. Metals: Metal scrap including iron, steel, copper, brass, and aluminum including piping, fasteners, wiring, ductwork and sheet metal goods.
1. Cut items to lengths and sizes to fit within the container provided when necessary.
 2. Where there is sufficient quantity of a specific recyclable waste item, make special arrangements for items to be bundled, banded or tied, and stack in a designated location for a special pick-up. Coordinate special arrangements with Contractor.
- F. Untreated Wood: Unpainted, untreated dimensional lumber, timber beams, engineered wood products, plywood, oriented strand board, Masonite, particleboard, wood shipping pallets, and crates.
1. Salvaged wood materials to be free of metals, concrete, gypsum wallboard, insulation, and other contaminating materials.
 2. Stack dimensional wood into like piles. For example, store 2 x 4s with other 2 x 4s, and 2 x 6s with other 2 x 6s. Also, if quantity is sufficient, separate piles into lengths of 4-foot increments.
 3. Reuse lumber on site as studs, backing, blocking or other uses where appropriate.
 4. Stack non-dimensional wood in piles for possible reuse on-site or transport off-site.
- G. Gypsum Wallboard Scrap: Excess drywall construction materials including cuttings, other scrap, and excess materials.
1. Separate gypsum wallboard from other wastes. Dispose of waste gypsum wallboard off-site at a gypsum reclamation or recycling facility.

3.4 DISPOSAL OF NON-RECYCLABLE 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. Collect and segregate non-recyclable waste for delivery to a permitted landfill site.
 3. 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: Transport waste materials off Owner's property and legally dispose of them.

END OF SECTION

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SECTION 017700 CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 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. List of incomplete items.
 - 4. Submittal of Project warranties.
 - 5. Final cleaning.

1.2 DEFINITIONS

- A. List of Incomplete Items: Contractor-prepared list of items to be completed or corrected, prepared for the Architect's use prior to Architect's inspection, to determine if the Work is substantially complete.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of cleaning agent.
- B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.
- C. Certified List of Incomplete Items: Final submittal at Final Completion.

1.4 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.
- C. Field Report: For pest-control inspection.
- D. Operation and Maintenance Manual: As specified in Section 017823.

1.5 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 10 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, damage or settlement surveys, property surveys, and similar final record information.
 - 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, 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 Architect. Label with manufacturer's name and model number.
 5. Submit testing, adjusting, and balancing 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 10 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 utility services.
 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.
 10. Touch up paint 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 10 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. 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.

1.6 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 in accordance with 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 will 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 10 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. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.7 LIST OF INCOMPLETE ITEMS

- 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, starting with exterior areas first, listed by room or space number.
 - 2. Organize items applying to each space by major element, including categories for ceilings, 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.
 - 4. Submit list of incomplete items in one of the following formats:
 - a. MS Excel Electronic File: Architect will return annotated file.
 - b. PDF Electronic File: Architect will return annotated file.
 - c. Web-Based Project Software Upload: Utilize software feature for creating and updating list of incomplete items (punch list).

1.8 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, 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.
- C. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
 - 1. Submit on digital media acceptable to Architect.
- D. Warranties in Paper Form:
 - 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 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.
- E. Provide additional copies of each warranty to include in operation and maintenance manuals.

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.

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 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 not planted, mulched, or paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Remove snow and ice to provide safe access to building.
 - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - g. Remove debris and surface dust from limited-access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - h. Clean flooring, removing debris, dirt, and staining; clean in accordance with manufacturer's instructions.
 - i. Vacuum and mop concrete.
 - j. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean in accordance with manufacturer's instructions if visible soil or stains remain.
 - k. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscurating materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - l. Remove labels that are not permanent.
 - m. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - n. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - p. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.
 - q. Clean strainers.
 - r. Leave Project clean and ready for occupancy.
- C. Construction Waste Disposal: Comply with waste-disposal requirements in Section 015000 "Temporary Facilities and Controls."

3.2 CORRECTION OF THE WORK

- A. Complete repair and restoration operations required by "Correction of the Work" Article in Section 017300 "Execution" before requesting inspection for determination of Substantial Completion.

END OF SECTION

SECTION 017823 OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Systems and equipment operation manuals.
 - 2. Systems and equipment maintenance manuals.
 - 3. Product maintenance manuals.

1.2 CLOSEOUT SUBMITTALS

- A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved 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 operation and maintenance submittals is acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operation and maintenance manuals in the following format:
 - 1. Submit on digital media acceptable to Architect. Enable reviewer comments on draft submittals.
 - 2. Submit one paper copy.
- C. Initial Manual Submittal: Submit draft copy in electronic format of each manual at least 30 days before commencing demonstration and training. Architect will comment on whether general scope and content of manual are acceptable.
- D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 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 copies of each corrected manual within 15 days of receipt of Architect's comments and prior to commencing demonstration and training.
- E. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.3 FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. 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: Bookmark 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.
- B. 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 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. Enclose title pages and directories in clear plastic sleeves.
4. Supplementary Text: Prepared on 8-1/2-by-11-inch 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.

1.4 REQUIREMENTS FOR OPERATION AND MAINTENANCE MANUALS

- A. Organization of Manuals: 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 Construction Manager.
 7. Name and contact information for Architect.
 8. Name and contact information for Commissioning Authority.
 9. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
 10. 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. 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."

1.5 SYSTEMS AND EQUIPMENT OPERATION MANUALS

- A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
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.
- B. 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.
- C. 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.
- D. 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.
- E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

- F. Piped Systems: Diagram piping as installed and identify color coding where required for identification.

1.6 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.
 - 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.
- B. 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 warranties and bonds as described below.
- C. 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.
- D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:
 - 1. Standard maintenance instructions and bulletins; 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.
 - a. 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.
 - 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.
- E. 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.
- F. 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.
- G. 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.

- H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- I. 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.
- J. 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.

1.7 PRODUCT MAINTENANCE MANUALS

- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- B. 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.
- C. 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.
- D. 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.
- E. 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.
- F. Repair Materials and Sources: Include lists of materials and local sources of 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 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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SECTION 017839 PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for Project Record Documents, including the following:
 - 1. Record Drawings.

1.2 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit copies of Record Drawings as follows:
 - a. Initial Submittal:
 - 1) Submit PDF electronic files of scanned record prints and one set(s) of file prints.
 - 2) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
 - b. Final Submittal:
 - 1) Submit one paper-copy set(s) of marked-up record prints.
 - 2) Submit PDF electronic files of scanned Record Prints and three set(s) of file prints.
 - 3) Print each drawing, whether or not changes and additional information were recorded.

1.3 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.
 - e. Cross-reference record prints to corresponding photographic documentation.
 - 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. Depths of foundations.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Construction Change Directive.
 - k. Changes made following Architect's written orders.
 - l. Details not on the original Contract Drawings.
 - m. Field records for variable and concealed conditions.
 - n. 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 prints 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. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 2. Format: Annotated PDF electronic file.
 3. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Architect.
 - e. Name of Contractor.

1.4 MAINTENANCE OF RECORD DOCUMENTS

- A. Maintenance of Record Documents: Store Record Documents 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.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 017900 DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Instruction in operation and maintenance of systems, subsystems, and equipment.
 - 2. Demonstration and training video recordings.

1.2 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and 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. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.

1.3 CLOSEOUT SUBMITTALS

- A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.
 - 1. Identification: On each copy, provide an applied label with the following information:
 - a. Name of Project.
 - b. Name and address of videographer.
 - c. Name of Architect.
 - d. Name of Construction Manager.
 - e. Name of Contractor.
 - f. Date of video recording.
- B. Manuals: At completion of training, submit complete training manual(s) for Owner's use prepared in same paper and PDF file format required for operation and maintenance manuals specified in Section 017823 "Operation and Maintenance Data."

1.4 QUALITY ASSURANCE

- A. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.
- B. Videographer Qualifications: A professional videographer who is experienced photographing demonstration and training events similar to those required.
- C. Preinstruction Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:
 - 1. Inspect and discuss locations and other facilities required for instruction.
 - 2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
 - 3. Review required content of instruction.
 - 4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.5 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.
- 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 have been reviewed and approved by Architect.

1.6 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- 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 as applicable to the system, equipment, or component:
 - 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. Systems and equipment operation manuals.
 - b. Systems and equipment maintenance manuals.
 - c. Product 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.

1.7 INSTRUCTION

- A. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
- B. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 - 1. Schedule training with Owner with at least seven days' advance notice.
- C. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

1.8 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

- A. General: Engage a qualified commercial videographer to record demonstration and training video recordings. Record each training module separately.
- B. Scope of Video Recordings: Video recordings are required for the following scopes:
 - 1. HVAC controls.
 - 2. Lighting controls.
 - 3. Audio visual system.
 - 4. Video surveillance system.
 - 5. Access control system.
- C. Digital Video Recordings: Provide high-resolution, digital video in MPEG format.
 - 1. Submit video recordings on CD-ROM or thumb drive.
 - 2. File Hierarchy: Organize folder structure and file locations in accordance with Project Manual table of contents. Provide complete screen-based menu.
 - 3. File Names: Utilize file names based on name of equipment generally described in video segment, as identified in Project specifications.

4. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the equipment demonstration and training recording that describes the following for each Contractor involved on the Project, arranged in accordance with Project Manual table of contents:
 - a. Name of Contractor/Installer.
 - b. Business address.
 - c. Business phone number.
 - d. Point of contact.
 - e. Email address.
- D. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.
 1. Film training session(s) in segments not to exceed 15 minutes.
 - a. Produce segments to present a single significant piece of equipment per segment.
 - b. Organize segments with multiple pieces of equipment to follow order of Project Manual table of contents.
- E. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.
 1. Furnish additional portable lighting as required.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 024120 SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Demolition and removal of selected portions of building or structure.
 - 2. Demolition and removal of selected site elements.
 - 3. Salvage of existing items to be reused or recycled.

1.2 DEFINITIONS

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

1.3 MATERIALS OWNERSHIP

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

1.4 PREINSTALLATION MEETINGS

- A. Predemolition Conference: Conduct conference at Project site.
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review structural load limitations of existing structure.
 - 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
 - 5. Review areas where existing construction is to remain and requires protection.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For refrigerant recovery technician.
- B. Engineering Survey: Submit engineering survey of condition of building.

- C. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection , for dust control and , for noise control. Indicate proposed locations and construction of barriers.
- D. Schedule of Selective Demolition Activities: Indicate the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's building manager's on-site operations are uninterrupted.
 - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Use of elevator and stairs.
 - 5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- E. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Comply with Section 013230 "Photographic Documentation." Submit before Work begins.
- F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.
- G. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.6 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

1.7 QUALITY ASSURANCE

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

1.8 FIELD CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
 - 1. Before selective demolition, Owner will remove the following items:
 - a. <Insert items to be removed by Owner>.
- 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. Hazardous materials will be removed by Owner before start of the Work.
 - 2. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
- E. Historic Areas: Demolition and hauling equipment and other materials shall be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, including temporary protection, by 12 inches or more.
- F. Storage or sale of removed items or materials on-site is not permitted.
- G. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1.9 COORDINATION

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- B. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
 - 1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.
- C. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.
- D. Survey of Existing Conditions: Record existing conditions by use of measured drawings.
 - 1. Comply with requirements specified in Section 013230 "Photographic Documentation."
 - 2. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.
 - 3. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.2 PREPARATION

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

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Arrange to shut off utilities with utility companies.
 - 2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.

- a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
- b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
- c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
- d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
- e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
- g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.4 PROTECTION

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 4. Cover and protect furniture, furnishings, and equipment that have not been removed.
 5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."
- B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
 1. Strengthen or add new supports when required during progress of selective demolition.
- C. Remove temporary barricades and protections where hazards no longer exist.

3.5 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
 5. Maintain fire watch during and for at least <Insert number> hours after flame-cutting operations.

6. Maintain adequate ventilation when using cutting torches.
 7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 10. Dispose of demolished items and materials promptly. Comply with requirements in Section 017420 "Construction Waste Management and Disposal."
- B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- C. Removed and Salvaged Items:
1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers.
 3. Store items in a secure area until delivery to Owner.
 4. Transport items to Owner's storage area designated by Owner.
 5. Protect items from damage during transport and storage.
- D. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse.
 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
 3. Protect items from damage during transport and storage.
 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and reinstalled in their original locations after selective demolition operations are complete.

3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.
- B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.
- C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.
- D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.
- E. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings."

3.7 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
1. Do not allow demolished materials to accumulate on-site.

2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn demolished materials.

3.8 CLEANING

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

3.9 SELECTIVE DEMOLITION SCHEDULE

- A. Remove: Items as shown on drawings.
- B. Remove and Reinstall: Existing water heater in Mechanical Room 014.
- C. Existing to Remain: Items as not included in demolition drawings.
- D. Dismantle: Fuel oil storage and boiler infrastructure.

END OF SECTION

SECTION 061000 ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Concealed carpentry work not specified in other Sections and not used as exposed work, including:
 - 1. Miscellaneous wood framing and concealed wood blocking and nailers.
 - 2. Wood sheathing.
 - 3. Anchors nails, bolts, and screws.

1.2 COORDINATION

- A. Coordination: Fit carpentry work to other work; scribe and cope as required for accurate fit, show location of furring, nailers, blocking, grounds and similar supports to allow attachment of other work.
 - 1. Coordinate work directly with other subcontractors as necessary to insure proper fitting, joining or to clearances of other work. Obtain templates as required to insure proper fitting.

1.3 INFORMATIONAL SUBMITTALS

- A. Certificates: Submit letter certifying that lumber is kiln-dried to 15 - 19 percent moisture content, well-seasoned, grade marked, trademarked and free from warp.
 - 1. Pressure Treated Wood: Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 - 2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
 - 3. Submit letter from treatment plant certifying that chemicals and process used and net amount of salts retained are in conformance with specified standards
- B. Fire-Treated Wood: Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
 - 1. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
 - 2. Submit letter certifying that fire-retardant treatment materials comply with requirements herein stated and local authorities having jurisdiction and that treatment will not bleed through finished surfaces.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Inspect wood materials for conformance to specified grades, species, and treatment at time of delivery to Project site.
 - 1. Reject and return unsatisfactory wood materials.
- B. Provide facilities for handling and storage of materials to prevent damage to edges, ends and surfaces.
- C. Keep carpentry materials dry.
 - 1. Store lumber and plywood in stacks with provision for air circulation within stacks.

2. Protect bottom of stacks against contact with damp surfaces. Protect exposed materials against weather.
 3. Stack materials minimum 12 inches off ground, or if on concrete slab-on-grade, minimum 1-1/2 inches, fully protected from weather.
 4. Provide for air circulation within and around stacks and under temporary coverings.
- D. Place spacers between each bundle of pressure treated materials treated with waterborne chemicals to provide air circulation.

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.
 4. Species and allowable stresses to meet the requirements on drawing S001.
- B. Maximum Moisture Content of Lumber: 15 percent maximum, unless otherwise indicated.
- C. Plywood Standard: Comply with U. S. Product Standard PS 1-74/ANSI A199.1; and Grades and Specifications, Performance-Rated Panels and Specifications by APA – The Engineered Wood Association local code standard. Each construction and industrial panel shall bear APA trademark and appropriate identification.
- D. Mat-Formed Particleboard: Comply with ANSI A208.1. Provide particleboard bearing NPA grade marking.
- E. Not Allowed: Products containing following materials will not be permitted:
1. Urea Formaldehyde.
 2. Chromium in wood pressure treatment products.
 3. Arsenic.

2.2 LUMBER

- A. Dimension Lumber: Finished 4 sides, 15 percent maximum moisture content. Mark lumber "S-DRY".
1. Light Framing: Construction grade Douglas Fir or Southern Pine, appearance grades where exposed.
 2. Boards: Construction grade.
- B. Wood Blocking Miscellaneous Lumber: Lumber for support or attachment of other construction, including rooftop equipment curbs and support bases, cant strips, bucks, nailers, blocking, furring, grounds, stripping and similar members.
1. Grade: No. 3 or standard grade.
 2. Moisture content of 19 percent maximum for lumber items not specified to have wood preservative treatment.

2.3 WOOD FRAMING

- A. Dimension Lumber Framing: PS 20; graded in accordance with NFPA Grading Rules; maximum moisture content of 19 percent; of following species and grades:
 - 1. Maximum Moisture Content of Lumber: 15 percent.
 - 2. Provide dressed lumber, S4S, unless otherwise indicated.
 - 3. Structural light framing: Stress group A; grade.
 - a. Douglas Fir Stud Grade for wood studs, and Douglas Fir Standard Grade for other work.
 - b. Framing lumber 2 inches to 4 inches thick,
 - 4. Non-structural light framing: Stress group A; grade.
 - a. Wall framing members shall be Hem Fir No. 2.
 - b. Hem Fir Stud Grade: Interior and exterior wood blocking and nailers, 2 inches to 4 inches thick (2" x 6") and up to 4 inches wide.
 - c. Wall framing, nailing strips, blocking, furring: 2 inches to 4 inches thick, 6 inches and wider.
 - 5. Studding: Stress group A; stud grade.
 - 6. Structural joists and planks: Stress group A; No. 2 grade.
 - 7. Beams and stringers: Stress group A; No. 1 grade.

2.4 WOOD SHEATHING

- A. Specified sheathing thicknesses are minimums. Provide sheathing in other thicknesses as shown on Drawings.
- B. Concealed Sheathing: APA, C-D touch-sanded plugged, Exposure 1, square edge, fire-resistive treated, Douglas Fir.
 - 1. Thickness: 3/4-inch.

2.5 FIRE-RETARDANT TREATMENT AND TREATED MATERIALS

- A. (FRT-1) Fire-Retardant Treatment and Treated Materials: Provide materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
 - 1. Extent of Treatment: Treat all rough carpentry, unless otherwise indicated.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
 - 1. Complete fabrication prior to treatment to minimize cutting and jointing after treatment.
 - 2. Coat surfaces cut after treatment with heavy brush coat of same fire-retardant chemical.
 - 3. After treatment: Material shall be dried to an average moisture content of 15 percent or less for plywood and 19 percent or less for other lumber.
 - 4. Do not use twisted, warped, bowed or otherwise damaged or defective pieces.
- C. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency. Each piece to bear:
 - 1. UL FR-S rating (flame spread and smoke developed less than 25),
 - 2. Complying with extended 30-minute tunnel test, ASTM E84 or UL 723
 - 3. Meet interior Type A requirements in AWWA Standard C-20 for lumber and C-27 for plywood.
 - 4. And shall be registered for use as a wood preservative by the U.S. Environmental Protection Agency.

2.6 ROUGH HARDWARE, FASTENERS AND ANCHORAGE DEVICES

- A. General: Provide rough hardware required, including nails, screws, bolts, lag screws, cinch anchors, toggle bolts, shot anchors and similar items . Provide proper size and type for use intended and for materials to be fastened.
 - 1. Install adequate hardware to insure substantial and positive anchorage.
 - 2. Use galvanized for exterior locations and high humidity locations and treated wood, plain finish for other interior locations.
 - 3. Fasteners, hangers and bearing plates used on or in connection with treated wood shall comply with IBC 2304.9.
- B. Nails: Conform to materials standards established under FS FF-N-105.
 - 1. At exterior work, use galvanized steel nails.
 - 2. Use galvanized nails for attachment to treated sill plates.
 - 3. Refer to IBC Nailing Schedule for quality and size.
- C. Mechanical Fasteners for Wood Decking: Swaneze stainless steel decking screws.
- D. Metal Anchors for Wood Framing: Allowable design loads, as published by manufacturer, shall meet or exceed those of products of manufacturers listed on drawings. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency. Framing anchors shall be punched for fasteners adequate to withstand same loads as framing anchors.
 - 1. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653, G60 coating designation.
 - a. Use for interior locations unless otherwise indicated.
 - 2. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A 653; structural steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 coating designation; and not less than 0.036 inch thick.
 - a. Use for wood-preserved-treated lumber and where indicated.

2.7 INSTALLATION ACCESSORIES

- A. Adhesive: As recommended by manufacturer of product to be applied for surface material to give permanent adhesion, with material remaining flat to back surface. Comply with local code standards.
 - 1. Comply with APA AFG-01 for adhesive for use with type of construction panel indicated.
 - 2. Exterior: Phenolic resin waterproof glue.
 - 3. Interior: Water-resistant casein and other adhesives suited for particular use.
 - 4. Adhesive and Sealant VOC Limits: In accordance with South Coast Air Quality Management District Rule 1168 and GS-36 for aerosols. VOC Limits: As tested using U.S. EPA Reference Test Method 24 and as defined by South Coast Air Quality Management District Rules SCAQMD Rule 1168, Adhesive and Sealant Applications.
- B. Sill Sealer Gaskets:
 - 1. Glass-fiber resilient insulation, fabricated in strip form for use as a sill sealer.
 - 2. Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to suit width of sill members indicated.

PART 3 - EXECUTION

3.1 FRAMING, NAILERS, BUCKS, CANT STRIPS

- A. Install plumb, level, true and square to dimensions shown and required. Allow for finishes and proper clearances where necessary.
- B. Provide sound bearing, square cuts, and full bearing surfaces. Set crown up for horizontal members. Shim and block where required.
- C. Eliminate crooked, twisted, cupped or bowed framing where required.
- D. Anchorage: Adequately anchor, fasten and support members to form secure, substantial and accurate anchorage and to hold required dimensions and prevent twist.
 - 1. Use bolts and screws to eliminate loosening up of joints, sagging or similar movement.
 - 2. Use nailers for securing gravel stops, cornices, and where otherwise shown or required.

3.2 FURRING, STRIPPING, GROUNDS AND BACKING

- A. Install plumb, level, true and square. Anchor substantially for permanent installation. Set and shim to straight edge so finish wall is true and straight.
- B. Provide grounds and backing as shown or required. Blocking as required or shown on drawings for plumbing fixtures, brackets, drapery rods, window and door frames, built-in furniture and other woodwork, both interior and exterior.
- C. Allow for finishes and shim out to form level surfaces. Verify ground sizes and locations before installation.

3.3 INSTALLATION OF SHEATHING

- A. Install plywood in accordance with Plywood Construction Guide by APA – The Engineered Wood Association.
 - 1. Roofing: Comply with drawing requirements and roofing manufacturer's requirements for sheathing attachments.
 - 2. Place roof and wall sheathing with end joints staggered. Secure sheets over firm bearing.
 - 3. Maintain minimum 1/16 inch and maximum 1/8 inch spacing between joints on walls. Place perpendicular to framing members.
- B. Subflooring: Place subflooring with end joints staggered. Secure sheets over firm bearing. Maintain surface flatness of maximum 1/8 inch in 10 feet or more.

3.4 FACTORY WOOD TREATMENT

- A. Shop pressure treat and deliver to site ready for installation, wood materials requiring UL fire rating or pressure impregnated preservatives.
- B. Provide UL approved identification on fire resistant treated materials.
 - 1. Deliver fire retardant treated materials cut to required sizes so as to eliminate necessity of field cutting.
- C. Ensure exposed materials requiring stain or paint finish do not exceed 15 percent moisture content before applying wood preservative treatment.

END OF SECTION

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SECTION 064000

ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Custom-fabricated architectural woodwork.
 - 2. Woodwork for Transparent Finish:
 - a. Prefinished Hardwood Veneer and Solid Hardwood for Transparent Finish.
 - b. Custom Fabrications (WD FAB-1) and (WD FAB-2).
 - 3. Woodwork for Opaque Finish:
 - a. Painted Wood Crown Mold (WD FAB-3)).

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate work directly with Work of other Sections as necessary to ensure proper fitting, joining or required clearances of other work.
 - 1. Exchange and coordinate shop drawings and templates.
 - 2. Coordinate fabrication schedule.
 - 3. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that cabinets can be supported and installed as indicated.

1.3 ACTION SUBMITTALS

- A. Product Data: For each material and product to complete Work, including; solid hardwood, panel and veneer wood products, core materials, high-pressure decorative laminate, solid-surfacing, fire-retardant-treated materials, components for wood fabrications, accessories and finishing materials.
- B. Shop Drawings: Indicate dimensions, descriptions of materials and finishes, general construction, specific modifications, component connections, anchorage methods and installation procedures, including specific requirements where indicated.
 - 1. Indicate materials and wood species, component profiles, fastening, jointing, details, finishes and accessories.
 - 2. For Work to receive matched wood veneers, show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.
 - 3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 - 4. Indicate special requirements for field assembly and installation, including field connection locations, required clearances and tolerances.
 - 5. Indicate provisions for attachment of architectural woodwork and other components performed by others in the field.
- C. Samples: Submit full-size units or Samples of sizes indicated, prepared from same material to be used for the Work, with shop-applied transparent finish, that show full range of color and texture variations expected.
 - 1. Hardwood with Transparent Finish (WD FAB-1) and (WD FAB-2):
 - a. For approval as match to existing: Submit set of at least three units exhibiting approximate limits of variations in color, pattern, texture, or other characteristics inherent in material or product. Apply finish to all faces and edges.

- b. Solid Hardwood with: 12" long in profile to match existing,

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Fabricator and Installer.
- B. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.
- C. Site Conditions Reports: Relative humidity and temperature readings taken before, during and after installation. Include readings taken in areas where woodwork is stored on site prior to installation.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: A well-established and experienced fabricator, acceptable to Owner and Architect, employing skilled workers to custom-fabricate millwork, casework and other architectural woodwork similar to that required for this Project, whose Work meets or exceeds quality requirements of specified NAAWS Grade, and whose completed Work has a record of successful in-service performance.

1.6 SITE CONDITIONS

- A. Delivery, Handling and Storage: Protect woodwork items from damage, dust and dirt. Do not deliver, receive, store or install woodwork materials until storage and installation areas are conditioned in accordance with requirements and recommendations of NAAWS.
- B. 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.

PART 2 - PRODUCTS

2.1 ARCHITECTURAL WOODWORK, GENERAL

- A. Quality Standards: Provide custom-fabricated architectural woodwork, casework, millwork and other assemblies that are fabricated and installed in accordance with the *North American Architectural Woodwork Standards, Adopted and Published jointly by Architectural Woodwork Institute, Architectural Woodwork Manufacturer's Association of Canada and Woodwork Institute - Current Edition* (NAAWS).
 - 1. Comply with requirements of specified NAAWS Grade except where more stringent requirements are indicated in the Contract Documents.

2.2 WOOD MATERIALS, GENERAL

- A. General: Provide specified wood materials and other materials recommended by woodwork fabricator, and in compliance with specified NAAWS Grade.
 - 1. Wood Moisture Content: 5 to 10 percent.
 - 2. Provide wood products made with binder containing no urea formaldehyde,
 - 3. Dimensions: As indicated on Drawings.

4. Sheathing Thickness: As needed to comply with requirements specified, but not less than thickness indicated.
 5. Fire-Retardant-Treated Materials: Where fire-retardant-treated materials are indicated, use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
- B. Miscellaneous Lumber: DOC PS 20 and applicable grading rules of inspection agencies certified by ALSC's Board of Review.
- C. Dimension Lumber Items: Standard, Stud, or No. 3 grade lumber .
- D. Veneer-Faced Plywood: HPVA HP-1, made with adhesive containing no urea formaldehyde.
- E. Medium-Density Fiberboard: ANSI A208.2, Grade 130, made with binder containing no urea formaldehyde.
- F. Hardboard: AHA A135.4.
- G. Particleboard: ANSI A208.1, Grade M-2-Exterior Glue.
- H. Softwood Plywood: DOC PS 1, exterior.
- I. Thermoset Decorative Panels: Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for test methods 3.3, 3.4, 3.6, 3.8, and 3.10.
- J. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.

2.3 WOODWORK FOR TRANSPARENT FINISH

- A. Source Limitations for Wood Materials with Transparent Finish: The intent of this requirement is to ensure matching of wood species and finishes by providing solid wood and wood veneers of like species from a single source with resources to provide materials of consistent quality in appearance and physical properties, and by shop-finishing woodwork in single shop using one process for each finish type.
1. Engage a qualified woodworking firm to assume undivided responsibility for production of wood-veneer-faced cabinets / doors faced with veneers.
 2. Engage a qualified woodworking firm to assume undivided responsibility for finishing all (WD) woodwork.
- B. Minimum Quality Standard: Comply with *Architectural Woodwork Standards* (NAAWS) Premium Grade for architectural woodwork with transparent finish.
- C. (WD FAB -1) Wood Base: Hardwood Type for Transparent Finish:
1. Species and grain: Supply solid hardwood to match existing.
 2. Profile: Match to existing
 3. Finish/Stain: Match to existing
- D. (WD FAB -2) Chair Rail: Hardwood Type for Transparent Finish:
1. Species and grain: Supply solid hardwood to match existing.
 2. Profile: Match to existing
 3. Finish/Stain: Match to existing

- E. Transparent Finish: Shop-applied, NAAWS Premium Grade, System 5 Conversion Varnish system as recommended by Fabricator, and as approved by Architect. Provide system in compliance with Project's low-VOC requirements. Defer only final touchup, cleaning, and polishing until after installation. Finish all surfaces, faces and edges of architectural woodwork.
 - 1. Sheen: Matching Architect's sample.
 - 2. Backpriming: Apply two coats of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork.

2.4 WOODWORK FOR OPAQUE FINISH

- A. (WD FAB -3) Wood Crown Mold for Opaque Painted Finish: Natural Birch or Poplar, finished in shop or in field.
 - 1. Profile: Match to existing
 - 2. Field-Finishing: Shop-apply primer compatible with finishing system in accordance with Section 099000 - Painting.
 - 3. Prefinished: Spray-apply primer and finish coats in shop, defer only final touchup, cleaning, and polishing until after installation.
 - a. Minimum Quality Standard: NAAWS Premium Grade.
 - b. Sheen: Matching Architect's sample.
 - 4. Finish all exposed surfaces, faces and edges of woodwork. Back-prime concealed surfaces with two coats of sealer or primer.

2.5 INSTALLATION ACCESSORIES

- A. Installation Accessories: Provide assembly hardware as shown on Drawings, or as recommended by Fabricator and approved by Architect.
- B. Mechanical Fasteners and Anchors: Use material, type, size and finish required for each substrate for secure anchorage and as recommended by architectural woodwork fabricator and installer.
 - 1. Provide concealed anchors unless otherwise indicated.
 - 2. Provide metal expansion sleeves or expansion bolts for post-installed anchors.
 - 3. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls.
 - 4. Stainless steel eye-bolt anchors, washers and other fabrication and installation accessories as shown; or other types as required by design engineer and approved by Architect.
 - 5. Flathead Hex Wood Screw, black.
 - 6. Stainless steel fasteners with resilient neoprene washer.
 - 7. VOC Content, Adhesives: Provide meeting applicable VOC limits of South Coast Air Quality Management District (SCAQMD) Rule 1168, July 1, 2005, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168.

2.6 FABRICATION

- A. General: Fabricate Work of this Section using materials, methods and quality control procedures in accordance with NAAWS, and in accordance with reviewed Shop Drawings.
 - 1. Complete fabrication in shop, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site.
 - 2. Join and assemble work to provide durable, strong, rigid units that will not warp or rack, including during shipping and installation.
 - 3. Disassemble components only as necessary for shipment and installation. Allow for easy handling and passage through building openings.
 - 4. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 - 5. Woodwork in Spaces without Humidification Control: Fabricate Work as necessary to protect installed Work from moisture and damage due to movement and dimensional changes associated with fluctuating temperature and relative humidity levels during construction and after Substantial Completion.

- B. Shop Finishing: Pre-finish architectural woodwork at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.
 - 1. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural wood cabinets, as applicable to each unit of work.
 - 2. Backpriming: Apply two coats of sealer or primer, compatible with finish coats, to concealed surfaces. Concealed surfaces of plastic-laminate-clad paneling do not require backpriming when surfaced with plastic laminate.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. Examination and Acceptance of Conditions: Before proceeding with installation, take field measurements, examine substrates and verify temperature and relative humidity and other conditions.
 - 1. Verify that mechanical and electrical items affecting this section are properly placed, complete, and have been inspected by Architect prior to commencement of installation.
 - 2. Proceed with installation only after unsatisfactory conditions have been corrected and after building temperature and relative humidity are within specified range. Proceeding with the Work indicates acceptance of surfaces and site conditions.
- B. Material Moisture Content and Environmental Requirements: Install products at the time and under conditions that will ensure the best possible results and maintain conditions until Substantial Completion.
 - 1. Comply with recommendations of Architectural Woodwork Standards.
 - 2. Conditioning: Before installation, condition wood materials and cabinets in accordance with specified site condition requirements.
 - a. Do not install unconditioned woodwork.
 - b. Reject materials that are wet, moisture damaged or mold damaged.
- C. Substrate: Before proceeding with installation, examine substrate to receive work for compliance with requirements for installation tolerances and other conditions affecting performance. Installer must approve substrate prior to installation.
- D. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product.
 - 1. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication.
 - 2. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 3. Verify space requirements and dimensions of items shown diagrammatically on Drawings.

3.2 INSTALLATION

- A. General: Install architectural woodwork in accordance with *North American Architectural Woodwork Standards* (NAAWS) and in accordance with reviewed shop drawings and manufacturer instructions.
 - 1. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
 - 2. Install free from hammer or tool marks, open joints or slivers or other defects detrimental to appearance or performance.
 - 3. Set plumb, level, square and true to dimensions shown and required. Allow for finishes and proper clearances where necessary. Use concealed shims where required for alignment.
 - 4. Tolerances: Install to tolerance of 1/8 inch in 96 inches for level and plumb. Install adjoining work with 1/32-inch maximum offset for flush installation and 1/16-inch maximum offset for reveal installation.

5. Scribe and cut to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
 6. Coordinate with materials and systems in or adjacent to woodwork and provide cutouts for mechanical and electrical items that penetrate exposed surfaces of trim and rails.
 7. Shop-Fabricated Work: Before installing, examine shop-fabricated work for completion. Assemble shop fabricated work and complete fabrication at Project site to the extent that it was not completed in the shop. Backprime unfinished surfaces that are concealed when installed.
 8. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, or too small to fabricate with proper jointing arrangements.
- B. Anchorage: Adequately anchor, fasten and support members to form secure, substantial and accurate work and to hold required dimensions and prevent twist.
1. 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.
 2. Provide blocking, attachment plates, 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.
 3. Provide anchorage type required to allow movement of wood due to changes in relative humidity without permanent damage to the wood and other components.
- C. Joints: Fit exposed connections together to form hairline joints. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect as determined by Architect.
1. Provide joints to accommodate expansion of woodwork due to changes in relative humidity.
- D. Finish Carpentry:
1. Anchor to blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing.
 2. Install with minimum number of joints possible, using full-length pieces to greatest extent possible.
 3. Miter corners, countersink nails, drill holes for nails in hardwood.
- E. Wood Fabrications: Install woodwork assemblies in accordance with approved shop drawings.
- F. Finishes: Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.
1. Apply specified finish coats including, back-priming, opaque paint, stains and paste fillers if any, to exposed surfaces where only sealer/prime coats are applied in shop.
 2. Refer to Section 099000 - Painting for final finishing of installed architectural woodwork not indicated to be shop finished, and for related brackets and other Work exposed to view.

3.3 INSTALLED WORK

- A. Damaged or Non-Compliant Woodwork: Remove and replace materials that are damaged or do not comply with requirements.
1. Damaged woodwork may be repaired or refinished if resulting repair work complies with requirements and shows no evidence of repair or refinishing.
 2. Remove and replace woodwork materials that are wet, moisture damaged, or mold damaged.
 3. Replace, at no additional cost to Owner, materials that are damaged or that cannot be cleaned to satisfaction of Owner.
- B. Protection: Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
1. Comply with specified requirements for temperature and relative humidity.
 2. Protect installed products from damage from weather, moisture, dust, dirt and other causes during construction.

END OF SECTION

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SECTION 072100

THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Spray polyurethane foam insulation with intumescent coating finish (SPF-1).

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: Each 6 inches square.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect plastic insulation as follows:
 - 1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
 - 2. Protect 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
 - 1. Surface-Burning Characteristics: ASTM E84.
 - 2. Fire-Resistance Ratings: ASTM E119.
 - 3. Combustion Characteristics: ASTM E136.

2.2 PRODUCTS AND MANUFACTURERS

- A. Other Products and Manufacturers: Subject to specified requirements, provide equivalent product as approved by Architect prior to Bid.
- B. Products and Manufacturers: Subject to compliance with specified requirements, provide Basis of Design or equivalent product, approved by Architect.

2.3 SPRAY POLYURETHANE FOAM INSULATION

- A. Manufacturers:
 - 1. BASF Corporation.
 - 2. Dupont .
 - 3. Henry Company.
 - 4. SWD Urethane.
- B. (SPF-1) Basis of Design Closed-Cell Polyurethane Foam Insulation: ASTM C 1029, Type II.
 - 1. Basis of Design:
 - a. Quik-Shield 118 by SWD Urethanes.
 - 2. Minimum density of 1.5 lb/cu. ft.,
 - 3. thermal resistivity of 6.2 deg F x h x sq. ft./Btu x in. at 75 deg F.
 - 4. Fire Characteristics per ASTM E84:
 - a. Maximum flame-spread of 75
 - b. Maximum smoke-developed indices of 450
- C. Intumescent Fire-Resistive Coating System Finish over Spray Polyurethane Foam Insulation: Manufacturer's standard, water-based, factory-mixed formulation, and complying with indicated fire-resistance design.
 - 1. Application: Designated for interior use by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Thickness: As required for fire-resistance design indicated, measured according to requirements of fire-resistance design.
 - 3. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.
 - 4. VOC Content: 18 g/L
 - 5. 15 minute thermal barrier
 - 6. Finish: Rolled, spray-textured finish.
 - 7. Basis of Design Products and Manufacturers:
 - a. ThB Intumescent Coating by No-Burn, Inc.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.
- C. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths.
- D. Cut and trim insulation neatly to fit spaces. Butt edges and ends tight. Fit insulation tight against mechanical, electrical and other items which protrude through plane of insulation.
- E. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

3.2 INSTALLATION QUALITY

- A. Cut and trim insulation neatly to fit spaces. Butt edges and ends tight. Fit insulation tight against mechanical, electrical and other items which protrude through plane of insulation.

3.3 SPRAY-APPLIED INSULATION INSTALLATION

- A. Spray-Applied Insulation (SPF-1): Apply spray-applied insulation according to manufacturer's written instructions. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked. After insulation is applied, make flush with face of studs by using method recommended by insulation manufacturer.

3.4 INSTALLED WORK

- A. Protection: Protect installed insulation and intumescent finish from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

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SECTION 081400 WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Interior solid core flush wood doors:
 - a. Non-rated flush wood doors.
 - 2. Factory finishing.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of door. Include details of core and edge construction and trim for openings. 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; and the following:
 - 1. Dimensions and locations of blocking.
 - 2. Dimensions and locations of mortises and holes for hardware.
 - 3. Dimensions and locations of cutouts.
- C. Samples:
 - 1. Wood Veneer with Transparent Finish: Manufacturer's standard-sized veneer sample for approval as match to existing.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Protect wood doors from damage, dust and dirt. Do not deliver, receive, store or install wood doors until storage and installation areas are conditioned in accordance with requirements and recommendations of NAAWS.
- B. Comply with requirements of referenced standards and with manufacturer's written instructions.
- C. Package doors individually in cardboard cartons and wrap bundles of doors in plastic sheeting
 - 1. Use opaque plastic sheeting for natural finished doors.
 - 2. Mark each door on top and bottom edges with opening number used on Shop Drawings

1.4 WARRANTY

- A. Special Warranty: Signed by Manufacturer, Installer, and Contractor, 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 in a 42-by-84-inch section.
 - b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
 - 2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
 - 3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 WOOD DOORS, GENERAL

- A. Quality Standards: Provide wood doors fabricated and installed in accordance with specified Grade classification of the *North American Architectural Woodwork Standards, Adopted and Published jointly by Architectural Woodwork Institute, Architectural Woodwork Manufacturer's Association of Canada and Woodwork Institute - Current Edition (NAAWS)*
 - 1. Comply with NAAWS Premium Grade, except where more stringent requirements are indicated in the Contract Documents.
- B. Source Limitations: Obtain flush wood doors from single manufacturer.
- C. Manufacturers:
 - 1. Eggers Industries
 - 2. Marshfield Door Systems
 - 3. Algoma Group
- D. WDMA Performance Grade: Match to existing.
- E. Structural-Composite-Lumber-Core for Non-Fire-Rated Doors: WDMA I.S.10.
 - 1. Screw Withdrawal: 700 lbf at faces, 400 lbf at edges.
- F. Construction: Five plies. Stiles and rails are bonded to core, then entire unit is abrasive planed before veneering. Faces are bonded to core using a hot press.
- G. Adhesives: Type I per WDMA TM-6, waterproof.
- H. Low-Emitting Materials: Provide doors made with adhesives and composite wood products that do not contain urea formaldehyde.
 - 1. Facing and Crossband Adhesive: Type 1 waterproof.
 - 2. Door Construction: Type 2.
- I. Lite Kit: Provide frames that are flush to face of door, in species of wood to match face of door.

2.2 FABRICATION

- A. Fabricate wood doors in accordance with requirements of specified NAAWS Grade.
- B. Fabricate Work of this Section using materials, methods and quality control procedures necessary for installed units to withstand dimensional changes that can be expected resulting from temperature and humidity variations at project location when interior spaces do not have humidity control. Seal each surface to help mitigate dimensional change resulting from temperature and humidity variations.
- C. Fabricate doors with hardware blocking as follows:
 - 1. Provide head and sill rails on all doors.
 - 2. Provide adequate blocking for doors specified with surface mounted closers.
- D. Provide doors with minimum 1-1/4 inch thick edge strips, of wood species to match face veneers except as required for UL rating.
- E. Make cut-outs and provide stops for glass and louvers. Seal cut-outs prior to installation of moldings.
 - 1. For full light doors: Provide cut out from flush wood door, with vertical grain direction.
- F. Bevel strike edge of single acting doors 1/8 inch in 2 inches. Radius strike edge of double-acting swing doors 2-1/8 inches.
- G. Prepare doors to receive hardware: Re-use existing hardware

1. Prefit and bevel to net opening size less approximately 3/16 inch in width and provide 1/4 inch clearance above finished floor, unless otherwise indicated on drawings.
2. Slightly ease vertical edges.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examination and Acceptance of Conditions: Before proceeding with installation, examine openings to receive wood doors and other conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
 1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
 2. Material Moisture Content and Environmental Requirements: Comply with recommendations of NAAWS.
 - a. Do not install woodwork that has not been conditioned to average prevailing humidity conditions in installation areas.
 3. Reject doors with defects.
 4. Proceed with installation only after unsatisfactory conditions have been corrected.

Proceeding with the Work indicates acceptance of surfaces and conditions. Architectural woodwork Installer shall approve substrate prior to installation.

3.2 INSTALLATION

- A. Hardware: Prepare doors to receive existing hardware.
- B. Install doors to comply with manufacturer's written instructions, referenced quality standard, and as indicated.
- C. Job-Fitted 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 or permitted for fire-rated doors. Machine doors for hardware. Seal cut surfaces after fitting and machining.
 1. Clearances: Provide 1/8 inch at heads, jambs, and between pairs of doors. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering. Where threshold is shown or scheduled, provide 1/4 inch from bottom of door to top of threshold.
 2. Factory-Finished, Job-Fitted Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 INSTALLED WORK

- A. Damaged or Non-Compliant Work: Remove and replace materials that are damaged or do not comply with requirements.
 1. Damaged finish may be repaired or refinished if resulting repair work complies with requirements and shows no evidence of repair or refinishing.
- B. Adjusting: Adjust movable components to operate safely, smoothly, easily, and quietly, free from binding, warp, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range, and without binding or damaging assembly components.
 1. Lubricate hardware and moving parts in accordance with Manufacturer's written instructions.
 2. Operation: Rehang or replace doors that do not swing or operate freely.
- C. Cleaning: Clean and maintain installed work as frequently as necessary through the remainder of the construction period.
- D. Protection: Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

1. At clear finished doors, do not partially cover door surfaces with paper, cardboard, or other opaque covering that will create uneven aging of wood veneer.
- E. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION

SECTION 092900

GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Interior gypsum board (GYP BD).

1.2 DEFINITIONS

- A. Gypsum Board Terminology: Refer to ASTM C11 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

1.3 ACTION SUBMITTALS

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

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage.
 - 1. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements and recommendations of gypsum board manufacturer, for environmental conditions before, during and after application of gypsum board.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
 - 1. Ventilation: Ventilate building spaces as required to remove water in excess of that required for drying of joint treatment material immediately after its application. Avoid drafts during dry, hot weather to prevent too rapid drying.
- C. Damaged Materials: Do not install panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For gypsum board assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. Fire-Resistance-Rated Assemblies: Indicated by design designations from UL's "Fire Resistance Directory." GA-600, "Fire Resistance Design Manual."

2.2 GYPSUM PANEL PRODUCTS

- A. Manufacturers:
 - 1. United States Gypsum.
 - 2. National Gypsum Company.
 - 3. Georgia-Pacific.
 - 4. CertainTeed Corporation.
 - 5. Temple-Inland.
- B. Gypsum Board Products, General: In accordance with ASTM C 1396, and other specified requirements, and as follows:
 - 1. Provide products that do not contain asbestos.
 - 2. Provide products in accordance with recommendations of GA 216 - Application and Finishing of Gypsum Panel Products.
 - 3. Provide products in maximum lengths and widths available to minimize joints and to correspond with support system indicated.
- C. (GYP BD-1) Fire-Rated Board: Type X, 5/8 inch thick.

2.3 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475.
- B. Corner Trim, Edge Trim, Inside Corner Trim for Abuse Resistant Gypsum Board:
 - 1. Provide fully bonded paper faced and joint tape backed copolymer tapered plastic trim at abuse resistant gypsum board.
 - 2. Provide corner trim as recommended by manufacturer for each condition.
 - 3. Manufacturer: Drywall Systems International No-Coat.
- C. Joint Tape:
 - 1. Interior Gypsum Wallboard: Paper.
 - 2. Tile Backing Panels: As recommended by panel manufacturer.
- D. 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. MNB3 Provide materials that comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 - 2. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
 - 3. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 - 4. Fill Coat: For second coat, use drying-type, all-purpose compound.
 - 5. Finish Coat: For third coat, use drying-type, all-purpose compound.
 - 6. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound, or high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat compound to produce Level 5 finish.

2.4 ACCESSORIES

- A. General: Provide auxiliary materials and accessories that comply with referenced installation standards and manufacturer's written instructions.

- B. Trim Accessories: ASTM C 1047; galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet; in the following shapes as required:
 - 1. Cornerbead.
 - 2. Bullnose bead.
 - 3. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - 4. L-Bead: L-shaped; exposed long flange receives joint compound.
 - 5. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - 6. Expansion (control) joint.
 - 7. Curved-Edge Cornerbead: With notched or flexible flanges.
- C. Fasteners and Anchorages: GA 216, type and size as recommended by board manufacturer.
- D. Fasteners: Use self-tapping or appropriate threaded fastener, compatible with all materials fasteners will contact with and not causing galvanic corrosion.
- E. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
 - 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
 - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- F. Joint Sealant (Non-Acoustic): As specified in Section 079200 - Joint Sealants.

2.5 ACOUSTIC SEALANT

- A. Acoustical Sealant for Exposed and Concealed Joints: Nonsag, paintable, nonstaining, latex sealant complying with ASTM C 834 and ASTM C 919 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.
 - 1. Pecora AC-20 FTR Acoustical and Insulation Sealant.
 - 2. United States Gypsum Co. SHEETROCK Acoustical Sealant.
 - 3. Hilti Incorporated CP 506 Acoustical Sealant
 - 4. DAP Dynaflex 230
 - 5. GE SCS7000
 - 6. Sikaflex 1a
- B. For fire-rated locations, acoustical sealants shall be one of the following approved products. Substitutions are unacceptable unless otherwise approved by the Architect and project Acoustics Consultant.
 - 1. HILTI CP 601S
 - 2. STI Spec Seal PEN300
 - 3. Tremco Fyre-Sil
 - 4. Johns Manville Firetemp CI
- C. Back-Box Putty: Moldable putty and accessories as recommended by Manufacturer.
 - 1. SpecSeal SSP Intumescent Putty, Specified Technologies, Inc., Somerville, NJ
 - 2. IsoBacker, Kinetics Noise Products
 - 3. Firestop Putty Pads, Acoustical Solutions
- D. Putty Pads: Polybutene-butyl with inert fillers or other approved permanently resilient self-adhering material; minimum thickness of 1/8-inch.
 - 1. For non-rated locations, putty pads shall be the following approved product. Substitutions are unacceptable unless otherwise approved by the Architect and project Acoustics Consultant.
 - a. Harry A. Lowry & Associates Outlet Box Pads

2. For fire-rated locations, putty pads shall be one of the following approved products. Substitutions are unacceptable unless otherwise approved by the Architect and project Acoustics Consultant.
 - a. Hevi-Duty Nelson FSP Putty Pads
 - b. STI Spec Seal SSP Putty Pads
 - c. 3M Fire Barrier Putty Pads
- E. Foam Backer Rod: Closed cell polyethylene, ASTM C962; size 30 percent greater than the joint width, unless otherwise indicated on details.
 1. Manufacturers:
 - a. ITP.
 - b. Nomeco.

PART 3 - EXECUTION

3.1 PREPARATION

3.2 GYPSUM BOARD INSTALLATION

- A. Install and finish gypsum board and accessories in accordance with manufacturer's printed instructions and comply with recommendations of GA 216 and ASTM C840, including appendixes. Verify control joint locations at walls and ceilings with Architect.
- B. Minimize butt joints by using gypsum board of maximum length possible. If cut butt joints are unavoidable, locate end butt joints as far from center of walls or ceilings as possible and stagger not less than 12 inches in alternate courses of board.
- C. Do not install imperfect, damaged, damp or wet gypsum board.
- D. Abut boards together for light contact at edges or ends with not more than 1/16 inch open space between boards. Do not force into place.
- E. Locate edges and joints over supports or back-blocking except in horizontal applications. Position gypsum board so that both tapered edge joints and cut edges abut. Do not place tapered edges against cut edges or ends. Stagger vertical joints over different studs on opposite sides of partition/walls.
 1. Form curved surfaces by carefully bending and fastening board to smooth even curve, free of flat or distorted areas and other imperfections. Comply with manufacturer's instructions for dampening of sheets or scoring of back face, if required to form to radius shown.
 2. Hold gypsum board 1/4 inch above floor at each type of partition.
- F. Install solid and semisolid drywall partitions made-up of coreboard or gypsum board studs with face courses of exposed gypsum board, laminated with both adhesive and screws.
- G. Isolate gypsum surfaces with control joints or other stress relief where:
 1. Partition or furring abuts structural element (except floor) or dissimilar wall or ceiling.
 2. Ceiling abuts structural element, dissimilar wall or partition or other vertical penetration.
 3. Construction changes within plane of partition or ceiling.
 4. Partition or furring run exceeds 30 feet.
 5. Ceiling dimensions exceed 30 feet in either direction.
 6. Wings of "L", "U" and "T" shaped ceiling areas are joined.
 7. Expansion joints occur in exterior wall if expansion joints are not used.
 8. Where control joint is near a door opening, locate and align control joint with edge of door frame.
 - a. Ceiling height door frames may be used as control joints.

- b. Where door frames are less than ceiling height, extend control joints to ceiling from both corners
 - 9. Review location of joints with Architect.
 - H. Cover both faces of stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft.in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - I. Provide perimeter isolation where non-load-bearing partitions abut structural decks or ceilings, or vertical structural elements. Allow not less than 1/4 inch, or more than 1/2 inch gap between gypsum and structure. Finish edges of face layer with casing bead. Seal space between casing bead and structure with continuous acoustical sealant bead. Do not attach board directly to tracks.
 - J. Cutting, Fitting and Trimming: Accurately measure and precut gypsum drywall units prior to installation. Make cuts from face side by scoring and snapping away from face side or by sawing. Completely cut paper on back face; do not break paper by tearing. Maintain close tolerances for accurate fit at joints between sheets and at framed openings, and allow for covering of edges of cut-outs with plates and escutcheons. Cut edges smooth as required for neat and accurate fit.
 - K. Begin fastening from center portion of sheet and work toward edges and ends. Ensure contact of drywall with supports by applying pressure on surface adjacent to fastener being driven. Do not locate fasteners closer than 3/8 inch from edges or ends of sheets. Drive with shank approximately perpendicular to drywall surface.
 - L. Drive screws with power screwdriver recommended by drywall manufacturer. Do not hammer drive screws. Set screw heads slightly below surface of drywall, but do not break or strip paper face around screw. Stagger screws on edges and ends of adjacent sheets.
- 3.3 ACCESSORIES INSTALLATION
- A. Drywall Sealant: Seal perimeter of sound-rated partitions by filling open space between drywall and floor or ceiling construction with continuous bead of sealant. Fill open spaces between drywall and fixtures, cabinets and other flush or penetrating items with continuous bead of sealant. Seal sides and back of electrical boxes to completely close up openings and joints. Seal perimeter of wallboard shaft wall where it abuts other work.
 - 1. Apply joint sealant in accordance with Section 079200 - Joint Sealants.
 - B. Reinforce external corners of drywall with metal corner bead. Securely fasten metal corner beads, edge trim casing beads and control joints.
- 3.4 FINISHING
- A. Finish exposed drywall surfaces with joints, corners and exposed edges reinforced or trimmed and with joints, fastener heads, trim accessory flanges and surface defects filled with joint compound in accordance with drywall manufacturer's recommendations for smooth, flush surface. Form true, level or plumb lines, without joints, fastener heads, flanges of trim accessories or defects visible after application of field-applied decoration. Exposed metal trim (not filled) will not be acceptable.
 - B. Use joint tape to reinforce joints formed by tapered edges or butt ends of drywall units and at interior corners and angles. Set tape in joint compound and apply skim coat over tape in one application. Do not use topping or finishing compounds for setting of tapes.

- C. Apply joint compound to joint. Apply joint compound to fill holes left from removal of screws at intermediate studs. Finish gypsum drywall thereafter, including sanding of final coat, in accordance with ASTM C840.
- D. Where open spaces of more than 1/16 inch width occur between abutting drywall units, except at control joints, prefill joints with joint compound and allow prefill to dry before application of joint tape.
- E. Finish Levels of Joints in Interior Gypsum Board Work:
 - 1. Level 0: No taping, finishing, or accessories required.
 - a. Use above suspended ceilings and within other concealed spaces, unless assembly is fire rated, sound rated, sound or smoke controlled, or unless space serves as air plenum.
 - 2. Level 1: At joints and interior angles embed tape in joint compound. Leave surface free of excess joint compound. Tool marks and ridges are acceptable.
 - 3. Level 2: At joints and interior angles embed tape in joint compound with one separate coat of joint compound applied over joints, angles, fastener heads, and accessories.
 - a. Use for mold and water resistant gypsum board indicated for use as a substrate for ceramic tile.
 - b. Use for gypsum board indicated for use as a substrate for wood paneling or acoustical panels.
 - c. Use above suspended ceilings and within other concealed spaces if gypsum board assembly is fire rated, sound rated, sound or smoke controlled, or space serves as air plenum.
 - 4. Level 3: At joints and interior angles embed tape in joint compound with 2 separate coats of joint compound applied over joints, angles, fastener heads, and accessories. Apply joint compound smooth and free of tool marks and ridges.
 - a. Use where heavy grade wall covering is final decoration.
 - b. Use where gypsum board is base for acoustical ceiling tile.
 - 5. Level 4: At joints and interior angles embed tape in joint compound with 3 separate coats of joint compound applied over joints, angles, fastener heads, and accessories. Apply joint compound smooth and free of tool marks and ridges.
 - a. Use for all locations, except those indicated for other finish levels.
 - 6. Level 5: At joints and interior angles embed tape in joint compound with 3 separate coats of joint compound applied over joints, angles, fastener heads, and accessories. Apply thin skim coat, as specified in Joint Treatment Materials Article above, to entire surface. Leave surface smooth and free of tool marks and ridges.
 - a. Use where semi-gloss or gloss finish coatings are final decoration.
 - b. Use for 2 story walls with direct natural day lighting (Lobbies, Entries, Rooms with large day lighting and long walls perpendicular to windows).
 - c. Use at ceilings in Lobbies, assembly areas with direct natural day lighting.
 - d. Use where skim coat finish is indicated.
 - e. On surfaces scheduled to receive wall coverings.
- F. Cementitious Backer Units: Finish according to manufacturer's written instructions.
- G. Glass-Mat, Water-Resistant Backing Panels: Finish according to manufacturer's written instructions.

3.5 FIELD QUALITY CONTROL

- A. Above-Ceiling Observation: Before Contractor installs gypsum board ceilings, Architect will conduct an above-ceiling observation and report deficiencies in the Work observed. Do not proceed with installation of gypsum board to ceiling support framing until deficiencies have been corrected.
 - 1. Notify Architect seven days in advance of date and time when Project, or part of Project, will be ready for above-ceiling observation.
 - 2. Before notifying Architect, verify installation of mechanical, electrical and other facility services work and Installation of ceiling support framing in areas to receive gypsum board ceilings.

3.6 INSTALLED WORK

- 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

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SECTION 095100
ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Acoustical panel ceilings and exposed suspension system (ACT).

1.2 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.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:
 - 1. Ceiling suspension members.
 - 2. Method of attaching hangers to building structure.
 - 3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 4. Minimum Drawing Scale: 1/8 inch equals 1 foot.
- C. Samples: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
 - 1. Acoustical Panel: Set of manufacturers standard size samples of each type, color, pattern, and texture.
 - 2. Suspension System Members, Moldings, and Trim: Set of 12 inch-long samples of each type, finish, and color.

1.4 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports per ICC-ES: For each seismically qualified acoustical tile ceiling suspensions system used in lieu of the industry standard design.

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. Acoustical Ceiling Units: Full-size panels equal to 2 percent of quantity installed.
 - 2. Suspension-System Components: Quantity of each exposed component equal to [2] percent of quantity installed.
 - 3. Hold-Down Clips: Equal to 2 percent of quantity installed.
 - 4. Impact Clips: Equal to 2 percent of quantity installed.

1.6 QUALITY ASSURANCE

- A. Installer's Qualifications: Firm experienced in application or installation of systems similar in complexity to those required for this Project, including specific requirements indicated; acceptable to or certified by manufacturer

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.8 SITE CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
 - 1. Install ceiling tile after carpeting and other interior materials that off-gas has been installed and odors and VOC fumes have dissipated.
 - 2. Permit wet work to dry prior to commencement of installation.
- B. Maintain uniform temperatures of minimum 60 degrees F and humidity as recommended by acoustical ceiling manufacturer prior to, during and after installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Class A according to ASTM E 1264.
 - 2. Smoke-Developed Index: 50 or less.

2.2 PRODUCTS AND MANUFACTURERS

- A. Source Limitations for Ceiling Units and Suspension Systems: Obtain each acoustical ceiling panel and suspension system from one source with resources to provide products of consistent quality in appearance and physical properties without delaying Work.
- B. Products and Manufacturers: Provide specified Basis of Design or approved equivalent product by one of the following:
 - 1. Armstrong World Industries, Inc.;
 - 2. USG Interiors, Inc.;
 - 3. Ecophon CertainTeed, Inc.;
 - 4. Chicago Metallic Corporation;
- C. (ACT) Panel and Grid Configurations and Basis-of-Design: As indicated on the Material Identification List.

2.3 ACOUSTICAL CEILING PANELS

- A. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectance, unless otherwise indicated.
 - 1. Recycled Content: Provide acoustical panels with recycled content such that postconsumer recycled content plus one-half of pre-consumer recycled content constitutes a minimum of 40 percent by weight.
 - 2. Surface-Burning Characteristics: Provide acoustical panels with surface-burning characteristics complying with ASTM E 1264 for Class A materials with flame spread of 0-25, as determined by testing identical products per ASTM E 84.
- B. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.
- C. Metal Suspension System: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.
 - 1. Double-Web, Exposed Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653, not less than G30coating designation, with prefinished metal caps on flanges.
 - a. Structural Classification: Heavy-duty system.
 - b. Face Design: Flat, flush.
 - c. Cap Material: Steel cold-rolled sheet.
 - d. Face Width: As indicated on Material Identification list.
 - 2. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft temper, pre-stretched, with a yield stress load of at least time three design load, but not less than 12 gauge.
- D. Accessories: Provide stabilizer bars, furring clips, splices, edge moldings and hold down clips as required to complete and complement suspended ceiling grid system.
 - 1. Attachment Devices: Size for five times design load indicated in ASTM C 635, Table 1, Direct Hung unless otherwise indicated.
 - 2. Edge Moldings and Trim: Provide Roll-formed sheet metal type in profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations, [formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners, and complying with seismic design requirements.
 - 3. Touch-up Paint: Manufacturer's touch-up paint for field cut tegular or other reveal edge tiles.
- E. Carrying Channels and Hangers: Primed steel, size and type to suit application and to rigidly secure complete acoustic unit ceiling system, with maximum deflection of 1/360.
- F. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.

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. 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 SUSPENSION GRID INSTALLATION

- A. General: Install acoustical panel ceilings to comply with ASTM C636, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
- B. Suspend ceiling hangers from building's 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 structure or of ceiling suspension system.
 - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
 - 4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - 5. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, post-installed mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 - 6. Do not attach hangers to steel deck tabs.
 - 7. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 - a. Provide alternate framing method if structural members are spaced too far apart.
 - 8. Space hangers not more than 48 inches o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
- C. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
 - 1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 - 2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
 - 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- D. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- E. Tolerances: Erect ceiling system level within 1/8 inch in 12'-0" in any direction.

3.4 ACOUSTICAL PANEL INSTALLATION

- A. Fit acoustic lay-in panels in place, free from damaged edges or other defects detrimental to appearance and function. Lay directional patterned tile one way with pattern parallel to shortest room axis.
 - 1. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

2. Field recess units with tegular or reveal edge at border or ceiling edge.
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.

- B. Install lay-in panels level, in uniform plane and free from twist, warp and dents with straight joints, edges in alignment, and edges and corners flush.

3.5 INSTALLED WORK

- A. Adjusting: Adjust sags or twists that develop in ceiling systems and replace part which is damaged or faulty.
- B. Cleaning: 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.
- C. Replace: Remove and replace work that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION

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SECTION 099000

PAINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Painting and finishing of new and existing materials (PT)
 - 2. Preparation of surfaces for painting and finishing.
 - 3. Repainting and refinishing of existing surfaces as indicated and as specified in Section 017329 - Cutting and Patching. Preparation of existing surfaces for repainting and refinishing.
 - 4. Wall-identification signs for fire and smoke assemblies.

1.2 ACTION SUBMITTALS

- A. Product Data: For each paint system specified, all coats, including block fillers and primers.
 - 1. Submit Manufacturer's certifications that products comply with specified requirements and with local regulations for VOC content.
- B. Samples: Submit three 4 inch by 6 inch samples of each specified finish to be reviewed for color and sheen. Architect reserves right to select color or finish from any manufacturer, herein specified, as necessary to achieve desired color or finish.
- C. Product Schedule: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations and cross-reference each material by manufacturer's catalog number and general classification.

1.3 SUSTAINABLE DESIGN SUBMITTALS

- A. Submit required product data and documentation in accordance with Section 018113 - Sustainable Design Requirements and Section 013300 - Submittal Procedures.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Materials (Attic Stock): Furnish extra paint materials from the same production run as the materials applied and in the quantities described below. Package with protective covering for storage and identify with labels describing contents. Deliver extra materials to Owner.
 - 1. Quantity: Furnish Owner with extra paint materials in quantities indicated below:
 - a. Interior, Paint: **3 gal.** of each color applied.

1.5 QUALITY ASSURANCE

- A. Coordination of Work: Review other sections in which primers are provided to ensure compatibility of total systems for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
- B. Applicator Qualifications: Engage experienced applicator who has completed painting system applications similar in material and extent to that indicated for this Project with record of successful in-service performance.

- C. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each paint system.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
 - b. Other Items: Architect will designate items or areas required.
 - 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver paint materials in sealed original labeled containers, bearing manufacturer's name, type of paint, brand name, color designation and instructions for mixing or reducing.
- B. Provide adequate storage facilities. Store paint materials at minimum ambient temperature of 45 degrees F in well ventilated area. Restrict storage to paint materials and related equipment.
- C. Take precautionary measures to prevent fire hazards and spontaneous combustion. Comply with health and fire regulations.

1.7 PROJECT CONDITIONS

- A. Environmental Requirements: Comply with manufacturer's recommendations as to environmental conditions under which painting and finishing can be applied. Do not apply finish in areas where dust is being generated.
- B. Measure moisture content of surfaces using electronic moisture meter. Do not apply finishes unless moisture contents of surfaces are below following maximums:
 - 1. Gypsum Wallboard: 12 percent.
 - 2. Masonry, Concrete and Concrete Block: 12 percent.
 - 3. Interior Wood: 15 percent.
- C. Ensure surface temperature and surrounding air temperature is above 40 degrees F before applying finishes. Minimum application temperature for latex paints for interior work shall be 45 degrees F and 50 degrees F for exterior work. Minimum application temperature for transparent finish shall be 65 degrees F, or surface and air temperature shall be 5 degrees above dew point.
- D. Provide adequate continuous ventilation and sufficient heating facilities to maintain temperatures above 45 degrees F for 24 hours before, during and 48 hours after application of finishes.
- E. Provide minimum 25 foot candles of lighting on surfaces to be finished.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS

- A. Manufacturers:

1. Sherwin-Williams Company
 2. Benjamin Moore & Co.
 3. PPG Industries
 4. Diamond Vogel Paints.
- B. Compatibility: Provide block fillers, 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.
- C. Single-Source Responsibility: Provide primers and undercoat coating produced by same manufacturer as finish coats. No Exceptions.
- D. 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.
- E. VOC Content of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24); these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
1. Flat Paints and Coatings: 50 g/L.
 2. Nonflat Paints and Coatings: 150 g/L.
 3. Dry-Fog Coatings: 400 g/L.
 4. Primers, Sealers, and Undercoaters: 200 g/L.
 5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
 6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
 7. Pretreatment Wash Primers: 420 g/L.
 8. Floor Coatings: 100 g/L.
 9. Shellacs, Clear: 730 g/L.
 10. Shellacs, Pigmented: 550 g/L.
- F. Painting and Finishing Schedules: Refer to Painting and Finishing Schedules in Part 3 of this Section.
1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.
 2. Sheen: When one of following terms is used to denote specific sheen for coating listed, following index shall apply:
 - a. Flat: Less than 15 units based on 85 degrees of sheen.
 - b. Eggshell: 5 to 20 units based on 60 degrees of sheen.
 - c. Satin/Low Lustre: 15 to 35 units based on 60 degrees of sheen.
 - d. Semi-gloss: 30 to 65 units based on 60 degrees of sheen.
 - e. Gloss: Above 65 units based on 60 degrees of sheen.
- G. (PT) Paint Colors: Provide specified color in paint type as scheduled in this Section
1. Refer to Material Identification List for color selections.
 2. Mixing and Tinting: Deliver paints ready-mixed to job site. Job mixing and job tinting is not acceptable.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces to receive paint and transparent finishes for conditions that would adversely affect execution, permanence or quality of work and which cannot be put into acceptable condition through preparatory work. Do not proceed with surface preparation or coating application until conditions are suitable.

3.2 PREPARATION OF SURFACES

- A. Perform preparation and cleaning procedures in accordance with paint manufacturer's instructions and as specified, for each particular substrate condition.
 - 1. Remove mildew, by scrubbing with solution of detergent, bleach and warm water. Rinse with clean water and allow surface to dry completely.
 - 2. Provide barrier coats over incompatible primers or remove and reprime as required. Notify Architect in writing of anticipated problems in using specified coating systems with substrate primed by others.
- B. Remove hardware, hardware accessories, plates, lighting fixtures, and similar items in-place and not to be finish painted, or provide surface-applied protection prior to surface preparation and painting operations. Remove, if necessary, for complete painting of items and adjacent surfaces. Following completion of painting of each space or area, reinstall removed items by workmen skilled in trades involved.
- C. Clean surfaces to be painted before applying paint or surface treatment. Remove oil and grease with clean cloths and cleaning solvents prior to mechanical cleaning. Program cleaning and painting so that dust and other contaminants from cleaning process will not fall in wet, newly painted surfaces.
 - 1. Remove dirt, grease and oil from canvas and cotton insulated coverings.
- D. Gypsum Wallboard: Remove contamination from gypsum wallboard surfaces and prime to show defects, if any. Paint after defects have been remedied.
- E. Plaster Surfaces: Fill hairline cracks, small holes and imperfections on plaster surfaces with patching plaster. Smooth off to match adjacent surfaces. Wash and neutralize high alkali surfaces where they occur.
- F. Galvanized Surfaces: Clean free of oil and surface contaminates with acceptable non-petroleum based solvent.
- G. Ferrous Metals: Clean non-galvanized, ferrous surfaces that have not been shop-coated of oil, grease, dirt, loose mill scale and other foreign substances by solvent or mechanical cleaning, complying with Steel Structures Painting Council (SSPC)-SP3.
 - 1. Touch-up shop-applied prime coats which have damaged or bare areas. Wire-brush, solvent-clean, and touch-up with same primer as shop coat.
 - 2. Clean unprimed steel surfaces by washing with solvent. Apply treatment of phosphoric acid solution, ensuring weld joints, bolts and nuts are similarly cleaned. Prime surfaces to indicate defects, if any. Paint after defects have been remedied.
 - 3. Sand and scrape shop primed steel surfaces to remove loose primer and rust. Feather out edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Prime steel including shop primed steels.
- H. Wood: Clean wood surfaces to be painted of dirt, oil, or other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sandpaper smooth those finished surfaces exposed to view, and dust off.

1. Prime or seal wood required to be job painted immediately upon delivery to job. Prime edges, ends, faces, undersides, and backsides of such wood.
 2. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood-filler. Sandpaper smooth when dried.
- I. Existing Surfaces to be Repainted or Refinished: Wash surfaces to remove grease, oil, soil or other matter which will interfere with proper bond of new materials. Scrape and wire brush loose or flaking paint. Fill cracks, voids or other defects.

3.3 MATERIALS PREPARATION

- A. Mix and prepare painting materials and transparent finish materials in accordance with manufacturer's directions.
- B. Store materials not in actual use in tightly covered containers. Maintain containers used in storage, mixing, and application of paint in clean condition, free of foreign materials and residue.
- C. Stir materials before application to produce mixture of uniform density, and as required during application of materials. Do not stir any film that may form on surface into material. Remove film and, if necessary, strain material before using.

3.4 APPLICATION

- A. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.
1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
 2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
 3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.
 4. Apply each coat at proper consistency.
 5. Each coat of paint shall be slightly darker than preceding coat unless otherwise approved by Architect.
 6. Provide finish coats which are compatible with prime paints used.
- B. Do not apply succeeding coats until previous coat has completely dried. Sand between each enamel or varnish coat application with fine sandpaper, or rub surfaces with pumice stone where required to produce even, smooth surface in accordance with coating manufacturer's directions.
1. Allow each coat of finish to dry before following coat is applied, unless directed otherwise by manufacturer.
- C. 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 insure that surfaces, including edges, corners, crevices, welds, and exposed fasteners receive film thickness equivalent to that of flat surfaces.
- D. Finish doors on tops, bottoms, and side edges same as exterior faces, unless otherwise indicated.
- E. Film Thickness: Apply materials in accordance to paint manufacturer's recommendations and spreading rates to provide total dry film thickness as recommended.
1. Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated
 2. Use precision instruments designed for measuring and evaluation wet and dry films of paints and coatings.

3. Results measuring less than recommended thickness will require additional material application.
 4. Use of poor hiding colors may require application of additional coats in order to achieve proper coverage and hiding.
- F. Apply first-coat material to surfaces that have been cleaned, pre-treated or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
- G. Allow sufficient time between successive coatings to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat of paint does not cause lifting or loss of adhesion of undercoat.
- H. Prime Coats: Recoat primed and sealed walls and ceilings where there is evidence of suction spots or unsealed areas in first coat, to assure finish coat with no burn-through or other defects due to insufficient sealing.
- I. Transparent Finish: On exposed portions, use multiple coats to produce glass-smooth surface film continuity of even luster. Provide finish free of laps, cloudiness, color irregularity, runs, brush marks, orange peel, nail holes, or other surface imperfections. Provide satin finish for final coats, unless otherwise indicated.
- J. Painting and Repainting of Existing Surfaces: Where repainting of existing surfaces is required, repaint wall and ceiling surfaces in their entirety, patch or spot painting is not acceptable.
- K. Paint surfaces behind movable equipment or furniture same as similar exposed surfaces. Paint surfaces behind permanently-fixed equipment or furniture with prime coat only.
- L. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.5 MECHANICAL AND ELECTRICAL EQUIPMENT

- A. Refer to mechanical and electrical documents with respect to field painting and finishing requirements. Painting of mechanical and electrical work is not required in pipe chases, tunnels, and mechanical rooms with unpainted walls.
- B. Remove grilles, covers and access panels for mechanical and electrical systems from location and paint separately.
- C. Finish paint primed equipment to color selected.
- D. Prime and paint insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars and supports, except where items are plated or covered with prefinished coating, or where they are not in finished space or room.
- E. Paint interior surfaces of air ducts, convector and baseboard heating cabinets that are visible through grilles and louvers before installation of equipment with 1 coat of flat black paint, to limit of sight line. Paint dampers exposed immediately behind louvers, grilles, convector and baseboard cabinets to match face panels.
- F. Paint exposed piping, insulated piping and conduit occurring in finished areas. Color and texture to match adjacent surfaces.
- G. Paint both sides and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them.

3.6 CLEANING

- A. As work proceeds and upon completion, promptly remove paint where spilled, splashed or spattered. Touch up and restore damaged or defaced painted areas.
- B. During progress of work keep premises free from unnecessary accumulation of tools, equipment, surplus materials and debris. Remove at end of each workday.
- C. Upon completion of work clean window glass and other paint-spattered surfaces and leave premises neat and clean, to satisfaction of Architect.

3.7 PROTECTION

- A. Adequately cover or otherwise protect finished work of other trades and other surfaces from paint and damage. Repair damage as result of inadequate or unsuitable protection as acceptable to Architect.
 - 1. Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being painted and in particular, surfaces within storage and preparation area.
- B. Place cotton waste, cloths and material which may constitute fire hazard in closed metal containers and remove daily from site.
- C. Remove electrical plates, surface hardware, fittings and fastenings, prior to painting operations. These items shall be carefully stored, cleaned and replaced on completion of work in each area. Do not use solvent to clean hardware that may remove permanent lacquer finish.
- D. Provide "Wet Paint" signs as required to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their work after completion of painting operations.

3.8 INTERIOR PAINTING AND FINISHING SCHEDULE

- A. Interior Ferrous and Non-Ferrous Metal Enamel:
 - 1. Surfaces Include:
 - a. Metal handrails, guardrails, ladders, stairs.
 - b. Hollow metal doors and frames.
 - 2. Water-Based Alkyd Urethane Enamel System:
 - a. VOC Content:<50g/L
 - b. Primer: Acrylic metal primer.
 - 1) 1 coat S-W Pro Industrial Pro-Cryl Universal Acrylic Metal Primer, B66-1300 Series.
 - c. Finish: Acrylic gloss enamel.
 - 1) 2 coats S-W Pro Industrial Waterbased Alkyd Urethane Enamel Low Sheen (Eg-Shel), B53-2250 Series .
 - 2) 2 coats S-W Pro Industrial Waterbased Alkyd Urethane Enamel Semi-Gloss, B53-1150/2150 Series
 - 3) 2 coats S-W Pro Industrial Waterbased Alkyd Urethane Enamel Gloss, B53-2050 Series
- B. Interior Galvanized Metal Enamel:
 - 1. Surfaces Include:
 - a. Galvanized.
 - b. Hollow metal doors and frames.
 - 2. Water-Based Alkyd Urethane Enamel System:
 - a. VOC Content:<50g/L
 - b. Primer: .
 - 1) 1 coat S-W Pro Industrial Pro-Cryl Universal Acrylic Metal Primer, B66-1300 Series.

- c. Finish: Acrylic gloss enamel.
 - 1) 2 coats S-W Pro Industrial Waterbased Alkyd Urethane Enamel Low Sheen (Eg-Shel), B53-2250 Series .
 - 2) 2 coats S-W Pro Industrial Waterbased Alkyd Urethane Enamel Semi-Gloss, B53-1150/2150 Series
 - 3) 2 coats S-W Pro Industrial Waterbased Alkyd Urethane Enamel Gloss, B53-2050 Series
- C. Gypsum Wallboard Surfaces:
 - 1. Surfaces Included:
 - a. Gypsum wallboard, including over skim coat of joint compound.
 - b. Apply additional coat of primer under deep tone finish paint.
 - 2. Sheens, General: Unless noted otherwise on Room Finish Schedule.
 - a. Walls: Eggshell
 - b. Ceilings and Soffits: Flat
 - c. Walls where indicated on Room Finish Schedule: Semi-gloss.
 - 3. Waterborne Zero-VOC, Low-Odor System: Zero-VOC, Low-Odor Acrylic Finish over Zero-VOC, Low-Odor Acrylic Primer - not more than 50 grams VOCs per liter, not less than 35 percent solids, ammonia free coating.
 - 4. Acrylic with Air Purify or Sanitizing Technology System:
 - a. VOC Content: <50g/L
 - b. Primer:
 - 1) S-W ProMar 200 Zero VOC Interior Latex Primer, B28W2600
 - c. Finish: Water-based, premium quality acrylic latex with Air Purifying Technology,
 - 1) 2 coats S-W SuperPaint Air Purify Interior Latex Flat, A86-60 Series.
 - 2) 2 coats S-W SuperPaint Air Purify Interior Latex Satin, A87-60 Series.
 - 3) 2 coats S-W SuperPaint Air Purify Interior Latex Semi-Gloss, A88-60 Series.
 - 4) 2 coats S-W SuperPaint Interior Latex Satin with Sanitizing Technology
 - 5. Zero VOC Vinyl Acrylic System:
 - a. VOC Content: 0g/L
 - b. Primer: Water-based vinyl acrylic primer and sealer.
 - 1) S-W ProMar 200 Zero VOC Interior Latex Primer, B28W2600
 - c. Finish: Water-based acrylic, not less than 35 percent solids, ammonia free.
 - 1) 2 coats S-W ProMar 200 Zero VOC Interior Latex Flat, B30-2600 Series.
 - 2) 2 coats S-W ProMar 200 Zero VOC Interior Latex Eg-Shel, B20-2600 Series.
 - 3) 2 coats S-W ProMar 200 Zero VOC Interior Latex Semi-Gloss, B31-2600 Series.
 - 6. Water Based Polyamine Epoxy System:
 - a. VOC Content: <50g/L
 - b. Primer:
 - 1) 1 coat S-W ProMar 200 Zero VOC Interior Latex Primer, B28W2600
 - 2) 2 coats S-W Pro Industrial Water Based Epoxy Eg-Shel, B73-300 Series.
 - 3) 2 coats S-W Pro Industrial Water Based Epoxy Gloss, B73-300 Series.
- D. Wood Surfaces for Painted Finish:
 - 1. Surfaces Included:
 - a. Wood doors and frames, except where pre-finish is indicated.
 - b. Other wood for paint finish.
 - c. Concealed surfaces of wood items to be back-primed.
 - 2. Water-Based Alkyd Urethane Enamel System:
 - a. VOC Content: <50g/L
 - b. Primer: Acrylic Latex Primer.
 - 1) 1 coat S-W Premium Wall & Wood Primer, B28W8111.
 - c. Finish: Water-Based Alkyd Urethane Enamel.
 - 1) 2 coats S-W Pro Industrial Waterbased Alkyd Urethane Enamel Low Sheen (Eg-Shel), B53-2250 Series .
 - 2) 2 coats S-W Pro Industrial Waterbased Alkyd Urethane Enamel Semi-Gloss, B53-1150/2150 Series

- 3) 2 coats S-W Pro Industrial Waterbased Alkyd Urethane Enamel Gloss, B53-2050 Series
- 3. Waterborne Zero-VOC, Low-Odor System: Zero-VOC, Low-Odor Acrylic Finish over Acrylic Latex Wood Primer - not more than 50 grams VOC's per liter, not less than 35 percent solids, ammonia free coating.
 - a. Primer: Acrylic Latex
 - 1) 1 coat S-W Premium Wall & Wood Latex Primer, B28W8111.
 - b. Finish:
 - 1) 2 coats S-W ProClassic Interior Latex Satin, B20-1150 Series.
 - 2) 2 coats S-W ProClassic Interior Latex Semi-Gloss, B31-2150 Series.
 - 3) 2 coats S-W ProClassic Interior Latex Gloss, B21-2150 Series.
- E. Non-Metal Ceilings and Soffits:
 - 1. Surfaces Included:
 - a. Gypsum board assemblies.
 - b. Plaster assemblies.
 - c. Spray fireproofing (SFRM)
 - d. Acoustical tile ceilings.
 - 2. Dry Fall Spray-Applied Waterborne System: Waterborne Multi-Surface Acrylic with Dryfall attributes over Waterborne Bonding Primer.
 - a. Primer (touch up if pre-primed): 1 coat S-W Extreme Bond Primer B51W01150 or S-W Multi-Purpose Interior-Exterior Latex Primer-Sealer, B51-450 Series.
 - b. Finish:
 - 1) 1-2 coats S-W Pro Industrial Multi-Surface Acrylic Matte, B66W01570 Series
 - 2) 1-2 coats S-W Pro Industrial Multi-Surface Acrylic Eg-Shel, B66W01560 Series
 - 3) 1-2 coats S-W Pro Industrial Multi-Surface Acrylic Semi-Gloss, B66W01550 Series
 - 4) 1-2 coats S-W Pro Industrial Multi-Surface Acrylic Gloss, B66W01500 Series

3.9 SPECIAL SURFACES

- A. Insulation-Wrapped Piping and Equipment:
 - 1. Surfaces Included: Piping, ducts, tanks, and equipment.
 - 2. Waterborne System: Premium Quality Acrylic Latex finish over -Acrylic Primer.
 - a. Primer: 1 coat S-W Moisture Vapor Barrier Primer, B72W1.
 - b. Finish: 2 coats S-W ProMar 200 Zero-VOC Interior Latex Eg-Shel, B20-2600 Series.
- B. Black Enamel Finish:
 - 1. Surfaces Included: Duct throats for visible distance but not less than approximately 24 inches behind supply or return air grilles, registers, louvers.
 - a. Wood blocking exposed at reveals.
 - 2. Water-Based Systems, Low-VOC: Acrylic Latex Finish.
 - a. Finish: 1 coat S-W ProMar 400 Latex Flat Black, B30W400 Series.
- C. Plastic and Fiberglass Fabrication Substrates: Insulation-wrapped piping, and miscellaneous plastics.
 - 1. (PT) Latex System:
 - a. Prime Coat: Primer, bonding, water-based.
 - 1) Valspar, Interior/Exterior Bonding Primer, 11289 Series.
 - b. Intermediate Coat: Latex, exterior, matching topcoat.
 - c. Topcoat: Latex, exterior, flat.
 - 1) Valspar, Perennial 100% Acrylic Latex House Paint.
 - 2) Valspar, Emblem Exterior Flat.
 - 3) Valspar, Professional Exterior Latex Flat House Paint.

3.10 REPAINTING OF EXISTING SURFACES

- A. Concrete, Precast:
 - 1. Surfaces Included: Existing precast concrete panels where indicated.
 - 2. High Build Elastomeric Acrylic Waterproofing System:
 - a. VOC Content:<50g/L
 - b. Primer: Self-Priming *On New or Bare Concrete use 2 coats
 - c. Finish: Waterproofing acrylic elastomeric waterproofing.
 - 1) 1-2 coats S-W Loxon XP Waterproofing Masonry Coating Flat, LX11-50 Series
 - 2) 1-2 coats S-W Loxon XP Waterproofing Masonry Coating Satin, LX21-50 Series
- B. Miscellaneous Existing Surfaces:
 - 1. Surfaces Included:
 - a. Existing surfaces where indicated to be repainted.
 - 2. Low-VOC Latex System:
 - a. Primer/Finish: 2 coats paint similar to type listed above.

END OF SECTION

SECTION 230500 COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Grout.
 - 5. HVAC demolition.
 - 6. Equipment installation requirements common to equipment sections.
 - 7. Painting and finishing.
 - 8. Concrete bases.
 - 9. Supports and anchorages.
- B. Related Requirements
 - 1. Section 013100 "Project Management & Coordination"

1.3 BASIS-OF-DESIGN

- A. Equipment manufacturers listed on the equipment schedules are the basis-of-design. Manufacturers listed in the specification other than the basis-of design manufacture are acceptable substitutions. Equipment schedules are on the drawings. Refer to specifications for unscheduled equipment.

1.4 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, 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 chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. CPVC: Chlorinated polyvinyl chloride plastic.
 - 2. PE: Polyethylene plastic.
 - 3. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Transition fittings.
 - 2. Dielectric fittings.
 - 3. Escutcheons.

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Equipment startup reports.
 - 1. Reports will indicate equipment was started and tested according to the manufactures recommendations and is operating as specified. Included test data.
- C. Coordination Drawings: Submit one digital copy that includes work from all disciplines.
- D. Pre-demolition test reports.

1.7 QUALITY ASSURANCE

- A. Comply with ASHRAE Guideline 4 – 2008 Preparation of operating and maintenance documentation for building systems.
- B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- C. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- D. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.8 GUIDELINES, CODES AND STANDARDS

- A. Refer to the most recently published edition for references to guidelines, and standards (examples: ASHRAE, NFPA, AWWA, ASTM) unless a specific edition is listed.
- B. Installation and materials shall comply with applicable national, state, and local codes and ordinances.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.
- C. Deliver ducts and air handling equipment with factory or shop applied protective covering. Protective covering shall remain until installation.
- D. Materials and equipment stored on site shall have a protective covering; open ends on equipment connections and ducts shall be covered. Duct liner shall be encapsulated.

1.10 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining Plastic Piping:
 - 1. CPVC Piping: ASTM F 493.
 - 2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.4 TRANSITION FITTINGS

- A. 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
 - 1. Manufacturers:
 - a. Eslon Thermoplastics.

- B. 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.
 - 1. Manufacturers:
 - a. Thompson Plastics, Incorporated
- C. 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.
 - 1. Manufacturers:
 - a. NIBCO Incorporated
 - b. NIBCO, Incorporated; Chemtrol Division

2.5 DIELECTRIC FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hart Industries, International, Incorporated (www.hartindustries.com)
 - 2. Pipeline Seal and Insulator, Incorporated (Pipeline Seal and Insulator, Incorporated)
 - 3. Watts Industries, Incorporated; Water Products Division (www.watts.com)
- B. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- C. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- D. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
- E. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 degrees F.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 degrees F.
- G. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 degrees F.

2.6 CONCRETE BASES

- A. Refer to Division 03 Section "Cast-in-Place Concrete".

2.7 GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.
 - 1)

PART 3 - EXECUTION

3.1 HVAC DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or 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.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual sections, and additionally where installation is not completely indicated on shop drawings, where limited space availability necessitate coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.

3.3 COORDINATION DRAWINGS

- A. Format:
1. Use scale not less than 1/4" = 1'-0".
 2. Detail complex areas at larger scale than typical floor plans.
- B. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data.
- C. 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. Planned piping hanger layout including building attachments and building structural coordination.
 3. Planned ductwork layout, including dampers, duct access doors, control device and specialty locations and damper movement.
 4. Planned ductwork hanger layout including building attachments and building structural coordination.
 5. Clearances for installing and maintaining insulation.
 6. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
 7. Equipment and accessory service connections and support details
 8. Exterior wall and foundation penetrations.
 9. Fire- and smoke-rated wall and floor penetrations.
 10. Sizes and locations of required concrete equipment curbs and bases.
 11. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
 12. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 13. Access door and panel locations.
 14. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.

- 15. Sizes and bottom elevations of ductwork, piping, equipment, and accessories, including insulation, bracing, flanges, and support systems.
- 16. Dimensions of major components, such as dampers, valves, diffusers, access doors and cleanouts.
- 17. Fire-rated enclosures around ductwork
- D. Refer to specification section 013100 "Project Management & Coordination" for additional coordination drawings requirements.

3.4 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. Sleeves are not required for core-drilled holes through walls.
- M. Verify final equipment locations for roughing-in.
- N. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.5 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or flanges.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.6 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 3. 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.
 - 4. PVC Non-pressure Piping: Join according to ASTM D 2855.
- J. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.
- K. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.7 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in steel 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. Wet Piping Systems: Install dielectric nipple fittings to connect piping materials of dissimilar metals.

3.8 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install HVAC equipment according to the equipment manufacturer's installation instructions and as indicated on the drawings. Resolve conflicting instructions, with the architect before mounting 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 HVAC 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. Refer to equipment shop drawings for rough in locations; do not scale drawings.

3.9 PAINTING

- A. Painting of HVAC systems, equipment, and components is specified in Division 09 Section "Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.10 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit. Refer to equipment shop drawings for exact dimensions of equipment to be installed.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete".

3.11 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- B. Field Welding: Comply with AWS D1.1.

3.12 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC 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.

3.13 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

3.14 SEALANTS

- A. Comply with joint-sealant materials and applications specified in Division 07.

END OF SECTION

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SECTION 230513 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with current IEEE 841 for severe-duty motors.
- C. All motors controlled by variable speed controllers shall be equipped with a shaft grounding ring.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.

- G. Bearings: Re-greasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F.
- J. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.
- L. Shaft grounding ring: Provide circumferential conduct micro fiber shaft grounding ring.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
 - 5. Shaft grounding ring: Provide circumferential conduct micro fiber shaft grounding ring.
 - 6. Braided bonding straps: When motors are provided with shaft ground rings and a motor frame ground lug furnish a braided high-frequency ground strap. Coordinate length of ground strap with field conditions or provide a minimum 12" ground strap. Ground strap is to be installed by the Division 26 contractor.
- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
 - 5. Brushless DC (ECM)
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.
- F. Brushless DC (ECM) motor requirements are specified in Division 23 equipment sections.

PART 3 - EXECUTION

END OF SECTION

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SECTION 230514 VARIABLE SPEED DRIVES FOR HVAC EQUIPMENT

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. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 26 Sections for power supply wiring; field installed disconnects, and required electrical devices.

1.3 DEFINITIONS

- A. ACS: Automatic Control System.
- B. BMS: Building Management System.
- C. IGBT: Integrated gate bipolar transistor.
- D. LAN: Local area network.
- E. PID: Control action, proportional plus integral plus derivative.
- F. PWM: Pulse-width modulated.
- G. VFD: Variable frequency (speed) drive.
- H. VSD: Variable speed drive.

1.4 SUBMITTALS

- A. Product Data: For each type of VSD. Include dimensions; mounting arrangements; location for conduit entries; shipping and operating weights; and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.
- B. Shop Drawings: For each VSD.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Nameplate legends.
 - c. Short-circuit current ratings of integrated unit.
 - d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
 - e. Features, characteristics, ratings, and factory settings of each unit.
 - 2. Wiring Diagrams: Power, signal, and control wiring for VSD. Provide schematic wiring diagram for each type of VSD.
- C. Coordination Drawings: Floor plans, drawn to scale showing dimensioned layout, required working clearances, and required area above and around VSD's where pipe and ducts are prohibited. Show VSD layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- D. Qualification Data: For manufacturer and service agency.
- E. Field quality control test reports.

- F. Manufacturer and service agency field service report.
- G. Startup Report.
- H. Operation and Maintenance Data: For VSD's, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Routine maintenance requirements for VSD's and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
- I. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

1.5 QUALITY ASSURANCE

- A. Manufacturer and Service Agency Qualifications: A qualified manufacturer's representative supported by a service agency capable of providing training, parts, and emergency maintenance and repairs. Service agency shall be maintained within 50 miles of the Project site.
- 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. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VSD's, minimum clearances between VSD's, and adjacent surfaces and other items. Comply with indicated dimensions and clearances.
- D. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store VSD's indoors in clean, dry space with uniform temperature to prevent condensation. Protect VSD's from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subject to weather, cover VSD's to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise noted.
 - 1. Ambient Temperature: 0 to 40 deg C.
 - 2. Humidity: Less than 90 percent (non-condensing).
 - 3. Altitude: Not exceeding 3300 feet.

1.8 COORDINATION

- A. Coordinate layout and installation of VSD's with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate installation of equipment support stands. Equipment supports for electrical devices are specified in Division 26 Sections.
- C. Coordinate features, accessories, and functions of each VSD and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB Power Distribution, Incorporated; ABB Control, Incorporated Subsidiary.
2. Cutler-Hammer; Eaton Corporation (www.eatonelectrical.com)
3. Danfoss Incorporated; Danfoss Electronic Drives Division.
4. Toshiba International Corporation.
5. Yaskawa Electric America Incorporated.

2.2 VARIABLE SPEED DRIVES

- A. Description: NEMA ICS 2, IGBT, PWM, VSD; listed and labeled as a complete unit and arranged to provide variable speed of a NEMA MG 1, Design B, 3-phase, energy efficiency induction motor by adjusting output voltage and frequency.
 1. Provide unit suitable for operation of premium-efficiency motor as defined by NEMA MG-1.
- B. 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.
 1. Specific electrical requirements for mechanical equipment are scheduled on the Drawings. Motor horsepower are scheduled on the Mechanical Drawings. Electrical characteristics (voltage, phase, frequency) are scheduled on the Electrical Drawings.
- C. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.
- D. Unit Operating Requirements:
 1. Input ac voltage tolerance of plus or minus 5 percent for 200 to 240 V, and plus or minus 10 percent for 460 to 480 V.
 2. Input frequency tolerance of 60 Hz, plus or minus 6 percent.
 3. Minimum Efficiency: 96 percent at 60 Hz, full load.
 4. Minimum Displacement Primary-Side Power Factor: 96 percent.
 5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
 6. Starting Torque: 100 percent of rated torque.
 7. Speed Regulation: Plus or minus 1 percent.
- E. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
- F. Internal Adjustability Capabilities:
 1. Minimum Speed: 5 to 25 percent of maximum RPM.
 2. Maximum Speed: 80 to 100 percent of maximum RPM.
 3. Acceleration: 2 to a minimum of 22 seconds.
 4. Deceleration: 2 to a minimum of 22 seconds.
 5. Current Limit: 50 to a minimum of 110 percent of maximum rating.
- G. Self-Protection and Reliability Features:
 1. Input transient protection by means of surge suppressors.
 2. Under- and over voltage trips; inverter over temperature, overload, and overcurrent trips.
 3. Motor Overload Relay: Adjustable and capable of NEMA 250, Class 10 performance.
 4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
 5. Instantaneous line-to-line and line-to-ground overcurrent trips.
 6. Loss-of-phase protection.
 7. Reverse-phase protection.
 8. Short-circuit protection.
 9. Motor over temperature fault.
- H. Automatic Reset and Restart: To attempt three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional auto speed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
- I. Torque Boost: Automatically vary starting and continuous torque to at least 1.5 times the minimum torque to insure high-starting torque and increased torque at slow speeds.

- J. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled fan-ventilated motors at slow speeds.
- K. Input Line Conditioning: Provide input line reactors and/or filters to limit total harmonic voltage distortion to less than 5 percent.
- L. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
 - 1. Power on.
 - 2. Run.
 - 3. Over voltage.
 - 4. Line fault.
 - 5. Overcurrent.
 - 6. External fault.
- M. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.
- N. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
 - 1. Output frequency (Hz).
 - 2. Motor speed (RPM).
 - 3. Motor status (running, stop, fault).
 - 4. Motor current (amperes).
 - 5. Motor torque (percent).
 - 6. Fault or alarming status (code).
 - 7. PID feedback signal (percent).
 - 8. DC-link voltage (VDC).
 - 9. Set-point frequency (Hz).
 - 10. Motor output voltage (V).
- O. Manual Bypass Starter: Magnetic contactor arranged to safely transfer motor between VSD controller outputs and bypass starter when motor is at zero speed.
 - 1. Unit shall be capable of stable operation (starting, stopping, and running), with motor completely disconnected from controller (no load).
 - 2. Provide manual bypass starters on equipment as indicated on the equipment schedules.
- P. Disconnect Switch: NEMA KS-1, nonfusible switch with lockable handle.
 - 1. Switch shall be configured such that with the switch closed, the VSD can be safely accessed for service and /or physically removed.
- Q. Isolating Switch: Non-load-break switch arranged to isolate VSD and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.
- R. Remote Indicating Circuit Terminals: Controller status and controller fault.

2.3 ENCLOSURES

- A. Enclosure: (Interior) NEMA 1, fully enclosed, vertically configured with front accessible controls and components to allow for wall, freestanding, or back-to-back mounting. Provide air inlet filters.
- B. Enclosure: (Exterior) Standard components and optional features shall be housed in a NEMA 3R enclosure.

2.4 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Selector Switches: NEMA ICS 2, heavy-duty type. Provide as required.
- C. Control Relays: Auxiliary and adjustable time-delay relays. Provide as required.
- D. Standard Displays:
 - 1. Output frequency (Hz).

2. Set-point frequency (Hz).
3. Motor current (amperes).
4. DC-link voltage (VDC).
5. Motor torque (percent).
6. Motor speed (RPM).
7. Motor output voltage (V).

E. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

2.5 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested VSD's before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VSD's for compliance with requirements, installation tolerances, and other conditions affecting performance.
- B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VSD installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION

- A. Select features of each VSD to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, drive, and load.
1. Refer to individual Sections in Division 23 for mechanical equipment requirements.
- B. Select rating of controllers to suit motors controlled.
- C. Assume single source responsibility for compatibility of VSD's with furnished equipment and systems and with load application.

3.3 INSTALLATION

- A. Installation: Roughing-in and installation of VSD's is specified in Division 26 Sections.
1. Assure proper placement of VSD and proper electrical roughing-in.
 2. Comply with mounting and anchoring requirements specified in Division 26 Sections.
 3. Mount units directly on walls, or on freestanding supports as indicated. Do not install on mechanical equipment.
 4. Locate VSD's not more than 50 feet from, and within sight of the controlled motor. Provide clearances required for electrical equipment.

3.4 CONNECTIONS

- A. Electrical Power Supply Wiring: Coordinate the installation and connection of power supply wiring.
1. Power supply wiring from the power source to the VSD and from the VSD to the controlled motor, including any field-installed disconnects, and required electrical devices is Work of Division 26. Refer to Division 26 Sections for requirements.
 2. The load side wiring between the VSD and the controlled motor shall be within a separate dedicated electrical conduit.
 3. Assure correct fuses are installed in each fusible switch.

4. Assure equipment is grounded according to Division 26 requirements.

3.5 CONTROL WIRING INSTALLATION

- A. Install wiring between VSD's and remote devices according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
 1. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 1. Test insulation resistance for each VSD element, bus, component supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 2. Assist in field testing of equipment including pre-testing and adjusting of solid-state controllers.
 3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 4. Startup report will indicate test results and confirm that the installation meets the manufactures installation instructions and the requirements of this section.

3.7 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain variable speed drives. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 230517 SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

2.2 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Incorporated (www.apsonline.com)
 - 2. CALPICO, Incorporated (www.calpicoinc.com)
 - 3. Metraflex Company (The). (www.metralflex.com)
 - 4. Pipeline Seal and Insulator, Incorporated (www.pipeline Seal.com)
 - 5. Proco Products, Incorporated (www.procoproducts.com)
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Carbon Steel.
 - 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Presealed Systems. (ps.holdrite.com)
- B. Description: Manufactured plastic, sleeve-type, water stop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber water stop collar with center opening to match piping OD.

2.4 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Sections.
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Sections.
- F. Acoustical Interior Wall Penetrations: Maintain indicated STC rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with acoustical sealant materials.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water stop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller than NPS 6: Sleeve-seal fittings.
 - b. Piping NPS 6 and larger: Galvanized-steel-pipe sleeves.
 2. Exterior Concrete Walls below Grade:
 - a. Piping Smaller than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 3. Concrete Slabs-on-Grade:
 - a. Piping or tubing smaller Than NPS 2:
 - 1) 1/2-in. thick, Pre-formed flexible elastomeric pipe insulation.
 - 2) Cast-iron pipe sleeves with sleeve seal system; steel pipe sleeves with sleeve-seal system; or sleeve-seal fittings.
 - (a) Select sleeve to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping or tubing NPS 3 and larger:
 - 1) Cast-iron pipe sleeves with sleeve seal system; steel pipe sleeves with sleeve-seal system; or sleeve-seal fittings.
 - (a) Select sleeve to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 4. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.
 5. Interior Stud Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves
 6. Interior Concrete or CMU Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves

END OF SECTION

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SECTION 230518 ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for exposed piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.

- e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.
- f. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.
- 2. Escutcheons for Existing Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.
 - f. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor-plate type.
 - 2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION

SECTION 230519 METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Light-activated thermometers.
 - 2. Thermowells.
 - 3. Dial-type pressure gages.
 - 4. Gage attachments.
 - 5. Test plugs.
 - 6. Test-plug kits.
 - 7. Venturi flowmeters.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Wiring Diagrams: For power, signal, and control wiring.
- C. Product Certificates: For each type of meter and gage, from manufacturer.
- D. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIGHT-ACTIVATED THERMOMETERS

- A. Direct-Mounted, Light-Activated Thermometers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flo Fab Incorporated
 - b. REOTEMP Instrument Corporation.
 - c. Terrice, H. O. Company
 - d. Weiss Instruments, Incorporated
 - e. WIKA Instrument Corporation - USA.
 - f. Winters Instruments - U.S.
 - 2. Case: Plastic; 7-inch nominal size unless otherwise indicated.
 - 3. Scale(s): Degrees F and degrees C.
 - 4. Case Form: Adjustable angle.
 - 5. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
 - 6. Stem: Aluminum and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
 - 7. Display: 3/8-inch high LCD Digital.
 - 8. Accuracy: Plus or minus 1 degrees F.

2.2 THERMOWELLS

- A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES or CSA.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMETEK, Incorporated; U.S. Gauge.
 - b. Ashcroft Incorporated
 - c. Ernst Flow Industries.
 - d. Flo Fab Incorporated
 - e. Marsh Bellofram.
 - f. Miljoco Corporation.
 - g. Noshok.
 - h. Palmer Wahl Instrumentation Group.
 - i. REOTEMP Instrument Corporation.
 - j. Tel-Tru Manufacturing Company.
 - k. Trerice, H. O. Company
 - l. Watts Regulator Company; a Division of Watts Water Technologies, Incorporated
 - m. Weiss Instruments, Incorporated
 - n. WIKA Instrument Corporation - USA.
 - o. Winters Instruments - U.S.
2. Standard: ASME B40.100.
3. Case: Sealed type; cast aluminum; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
- B. Siphons: Loop-shaped section of brass pipe with NPS 1/4 or NPS 1/2 pipe threads.
- C. Valves: Brass ball, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.5 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Flow Design, Incorporated

2. Miljoco Corporation.
 3. National Meter, Incorporated
 4. Peterson Equipment Company, Incorporated
 5. Sisco Manufacturing Company, Incorporated
 6. Trerice, H. O. Company
 7. Watts Regulator Company; a Division of Watts Water Technologies, Incorporated
 8. Weiss Instruments, Incorporated
- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 275 degrees F.
- F. Core Inserts: EPDM self-sealing rubber.

2.6 TEST-PLUG KITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Flow Design, Incorporated
 2. Miljoco Corporation.
 3. National Meter, Incorporated
 4. Peterson Equipment Company, Incorporated
 5. Sisco Manufacturing Company, Incorporated
 6. Trerice, H. O. Company
 7. Watts Regulator Company; a Division of Watts Water Technologies, Incorporated
 8. Weiss Instruments, Incorporated
- B. Furnish two test-plug kits containing one thermometers, one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
- C. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 degrees F.
- D. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be at least 0 to 200 psig.
- E. Carrying Case: Metal or plastic, with formed instrument padding.

2.7 FLOWMETERS

- A. Venturi Flowmeters:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB; Instrumentation and Analytical.
 - b. Gerand Engineering Company
 - c. Hyspan Precision Products, Incorporated
 - d. Preso Meters; a division of Racine Federated Incorporated
 - e. S. A. Armstrong Limited; Armstrong Pumps Incorporated
 - f. Victaulic Company.
 2. Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, fittings, valves, indicator, and conversion chart.
 3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
 4. Sensor: Venturi-type, calibrated, flow-measuring element; for installation in piping.
 - a. Design: Differential-pressure-type measurement for **water**
 - b. Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
 - c. Minimum Pressure Rating: **[250 psig] <Insert value>**.

- d. Minimum Temperature Rating: **[250 degrees F]** <Insert temperature>.
- e. End Connections for NPS 2 and Smaller: Threaded.
- f. End Connections for NPS 2-1/2 and Larger: Flanged or welded.
- g. Flow Range: Flow-measuring element and flowmeter shall cover operating range of equipment or system served.
- 5. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch- diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.
 - a. Scale: Gallons per minute.
 - b. Accuracy: Plus or minus **[1 percent between 20 and 80 percent of scale range]** <Insert accuracy>.
- 6. Portable Indicators: Hand-held, differential-pressure type, calibrated for connected flowmeter element and having two 12-foot hoses, with carrying case.
 - a. Scale: Gallons per minute.
 - b. Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.
- 7. Display: Shows rate of flow [, with register to indicate total volume in **gallons**].
- 8. Conversion Chart: Flow rate data compatible with sensor.
- 9. Operating Instructions: Include complete instructions with each flowmeter.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- G. Install valve and snubber in piping for each pressure gage for fluids (except steam).
- H. Install valve and syphon fitting in piping for each pressure gage for steam.
- I. Install test plugs in piping tees.
- J. Install flowmeter elements in accessible positions in piping systems.
- K. Install wafer-orifice flowmeter elements between pipe flanges.
- L. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
- M. Install connection fittings in accessible locations for attachment to portable indicators.
- N. Install thermometers in the following locations:
 - 1. Inlet and outlet of each hydronic boiler.
 - 2. Two inlets and two outlets of each chiller.
 - 3. Inlet and outlet of each hydronic coil in air-handling units.
 - 4. Two inlets and two outlets of each hydronic heat exchanger.
 - 5. Inlet and outlet of each thermal-storage tank.
- O. Install pressure gages in the following locations:
 - 1. Discharge of each pressure-reducing valve.
 - 2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
 - 3. Suction and discharge of each pump. Refer to piping detail.

4. Inlet and outlet of each side stream water filter. Refer to piping detail.

3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
- B. Connect flowmeter-system elements to meters.
- C. Connect flowmeter transmitters to meters.

3.3 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each hydronic zone shall be the following:
 1. Test plug with EPDM self-sealing rubber inserts.
- B. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be the following:
 1. Test plug with EPDM self-sealing rubber inserts. Air-handling units with multiple coils will have test plugs for each coil.
- C. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Condenser-Water Piping: zero to 160 degrees F and minus 20 to plus 50 degrees C.

3.6 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at suction and discharge of each pump shall be the following:
 1. Sealed, direct-mounted, metal case.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Condenser-Water Piping: 0 to 100 psi.

3.8 FLOWMETER SCHEDULE

- A. Flowmeters for Condenser-Water Piping: [Orifice] [Pitot-tube] [Turbine] [Venturi] [Vortex-shedding] type.

END OF SECTION

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SECTION 230523 GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Bronze ball valves.
 - 2. Bronze lift-check valves.
 - 3. Bronze swing-check valves.
 - 4. Bronze globe valves.
- B. Related Sections:
 - 1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
 - 2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Non-rising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 2. ASME B31.1 for power piping valves.
 - 3. ASME B31.9 for building services piping valves.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set angle, gate, and globe valves closed to prevent rattling.

4. Set ball and plug valves open to minimize exposure of functional surfaces.
 5. Set butterfly valves closed or slightly open.
 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
1. Maintain valve end protection.
 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to HVAC valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
1. Handwheel: For valves other than quarter-turn types.
 2. Hand lever: For quarter-turn valves NPS 6 and smaller.
 3. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 2. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
 2. Grooved: With grooves according to AWWA C606.
 3. Solder Joint: With sockets according to ASME B16.18.
 4. Threaded: With threads according to ASME B1.20.1.
- G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

- A. Two-Piece, Regular-Port, Bronze Ball Valves with Bronze Trim; MSS-SP110:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Incorporated; Apollo Valves. (Example 100-70-XX)
 - b. Crane Co.; Crane Valve Group; (Example 9210)
 - c. Hammond Valve. (Example 8501)
 - d. Milwaukee Valve Company. (Example BA-100)
 - e. NIBCO Incorporated. (Example T580-70)
 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.

- c. CWP Rating: 600 psig.
- d. Body Design: Two piece.
- e. Body Material: Bronze.
- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Bronze.
- i. Ball: Chrome-plated brass.
- j. Port: Regular.

2.3 BRONZE SWING CHECK VALVES

- A. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Company; Crane Valve Group; Crane Valves
 - b. Crane Company; Crane Valve Group; Jenkins Valves
 - c. Crane Company; Crane Valve Group; Stockham Division
 - d. Hammond Valve.
 - e. Kitz Corporation.
 - f. Milwaukee Valve Company. (Example 509T)
 - g. NIBCO Incorporated (Example T-413-BY)
 - h. Red-White Valve Corporation.
 - i. Watts Regulator Co.; a division of Watts Water Technologies, Incorporated.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 4.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: PTFE or TFE.
- B. Class 150, Bronze Swing Check Valves with Nonmetallic Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Company; Crane Valve Group; Crane Valves
 - b. Crane Company; Crane Valve Group; Jenkins Valves
 - c. Hammond Valve.
 - d. Milwaukee Valve Company. (Example #510T)
 - e. NIBCO Incorporated (Example #T433-Y)
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Incorporated.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 4.
 - b. CWP Rating: 300 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: PTFE or TFE.

2.4 BRONZE GLOBE VALVES

- A. Class 125, Bronze Globe Valves with Nonmetallic Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Crane Company; Crane Valve Group; Crane Valves (Example: 5TF)
 - b. Crane Company; Crane Valve Group; Stockham Division (Example: B13T)
 - c. NIBCO Incorporated (Example: T-211-Y)
2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: PTFE or TFE.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.
- B. Class 150, Bronze Globe Valves with Nonmetallic Disc:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Company; Crane Valve Group; Crane Valves (Example: 7TF)
 - b. Crane Company; Crane Valve Group; Stockham Division (Example: B22T)
 - c. NIBCO Incorporated (Example: T-235-Y)
 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: PTFE or TFE.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 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 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.

3.3 JOINT CONSTRUCTION

- A. Refer to Division 23 Section "Common Work Results for HVAC" for basic piping joint construction.
- B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

3.4 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.5 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, butterfly valves.
 - 2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
 - 3. Throttling Service except Steam: Globe, ball, or butterfly valves.
 - 4. Throttling Service, Steam: Globe valves.
 - 5. Pump-Discharge Check Valves:
 - a. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient-seat check valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 - 1. For Copper Tubing, NPS 3 and Smaller: Threaded ends.
 - 2. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 3. For Steel Piping, NPS 5 and Larger: Flanged ends.
 - 4. For Grooved-End Steel Piping except Steam and Steam Condensate Piping: Valve ends may be grooved.

3.6 GEOTHERMALWATER VALVE SCHEDULE

- A. Pipe NPS 3 and Smaller:
 - 1. Ball Valves, NPS 3 and Smaller: Two piece, 600-psig CWP rating, copper alloy.
 - 2. Bronze Swing Check Valves: Class 125, bronze disc.

END OF SECTION

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SECTION 230529 HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Equipment supports.
- B. Related Sections:
 - 1. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

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

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.7 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
- B. Copper Pipe Hangers:
 - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
 - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
 - 1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.
 - c. Flex-Strut Inc.
 - d. Thomas & Betts Corporation.
 - e. Unistrut Corporation; Tyco International, Ltd.
 - f. Wesanco, Inc.
 - 2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
 - 3. Standard: MFMA-4.
 - 4. Channels: Continuous slotted steel channel with in-turned lips.
 - 5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 - 6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.

2.4 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements provide products by one of the following:
 - 1. Carpenter & Paterson, Inc.
 - 2. Clement Support Services.
 - 3. ERICO International Corporation.
 - 4. National Pipe Hanger Corporation.
 - 5. PHS Industries, Inc.
 - 6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.

7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - c. MKT Fastening, LLC
 - d. Simpson Strong-Tie Co., Inc.
- B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper B-line; brand of Eaton, Electrical Sector.
 - b. Empire Tool and Manufacturing Co., Inc.
 - c. Hilti, Inc.
 - d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - e. MKT Fastening, LLC.
 2. Indoor Applications: Zinc-coated or stainless steel.
 3. Outdoor Applications: Stainless steel

2.6 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.7 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
 1. Properties: Non-staining, noncorrosive, and nongaseous.
 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Do not attach to metal decks.
- B. Metal Pipe-Hanger Installation: Comply with MSS SP-58 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- C. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- F. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- G. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
- H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- M. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- O. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

- b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
- 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
- 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
- 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
- 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
- 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

- A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099000 "Painting".
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
- F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
 - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.

15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- L. Building 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. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- N. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- P. Use powder-actuated fasteners instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 230548.13

VIBRATION CONTROLS FOR HVAC

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. Elastomeric hangers.
 - 2. Spring hangers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.

PART 2 PRODUCTS

2.1 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods: **Type E**
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ace Mountings Company Incorporated (www.acemount.com)
 - b. California Dynamics Corporation (www.caldyn.com)
 - c. Isolation Technology Incorporated (www.isolationtech.com)
 - d. Kinetics Noise Control, Incorporated (www.kineticsnoise.com)
 - e. Mason Industries, Incorporated (www.mason-ind.com) Example: HD
 - f. Vibration Eliminator Company Incorporated (www.veco-ny.com)
 - g. Vibration Isolation (www.vibrationiso.com)
 - 2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
 - 3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.2 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression: **Type D**
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ace Mountings Company Incorporated (www.acemount.com)
 - b. California Dynamics Corporation (www.caldyn.com)
 - c. Isolation Technology Incorporated (www.isolationtech.com)
 - d. Kinetics Noise Control, Incorporated (www.kineticsnoise.com)
 - e. Mason Industries, Incorporated (www.mason-ind.com) Example: 30N
 - f. Vibration Eliminator Company Incorporated (www.veco-ny.com)
 - g. Vibration Isolation (www.vibrationiso.com)

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
9. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation control devices 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 PERFORMANCE OF ISOLATORS

- A. General: Comply with minimum static deflections indicated on the Drawings and Schedules. If not indicated, comply with minimum static deflections as recommended by ASHRAE, for selection and application of vibration isolation materials and units as indicated.
- B. Manufacturers' Recommendations: Except as indicated, comply with manufacturers' recommendations for selection and application of vibration isolation materials and units.

3.3 VIBRATION CONTROL DEVICE INSTALLATION

- A. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

3.4 ADJUSTING

- A. Adjust isolators after piping systems have been filled and equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.

3.5 CLEANING

- A. After completing equipment installation, inspect vibration isolation control devices. Remove paint splatters and other spots, dirt, and debris.

END OF SECTION

SECTION 230553

IDENTIFICATION FOR HVAC DUCTWORK, PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Duct labels.
 - 5. Valve tags.
 - 6. Warning tags.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- C. Valve numbering scheme.
- D. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch or 1/8 inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: White.
 - 3. Background Color: Black
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- B. Label Content: Include equipment's Drawing designation or unique equipment number. Coordinate/verify label content with owner.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Refer to ANSI standards.
- C. Background Color: Refer to ANSI standards.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
 - 1. Pretensioned Pipe Labels: Pre-coiled, semi rigid plastic formed cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
 - 2. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - a. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - b. Lettering Size: At least 1-1/2 inches high for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
 - 3. All pipes 1" and larger shall have size identification at the same locations as service identification markers.

2.4 DUCT LABELS

- A. General Requirements for Manufactured duct Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Self-Adhesive Duct Labels: Printed plastic with contact-type, permanent-adhesive backing.
- C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

- E. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- G. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass (0.032-inch minimum thickness) or plastic laminated and engraved (0.06 inch minimum thickness), and having predrilled or stamped holes for attachment hardware.
 - 2. Tag Size: 1 inch x 2 inches or 2" round
 - 3. Fasteners: Brass wire-link or beaded chain.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - 1. Size: 4 by 7 inches minimum
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 25 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.
- B. Pipe Label Color Schedule:
1. Condenser-Water Piping:
 - a. Background Color: None.
 - b. Letter Color: White
 2. Refrigerant Piping:
 - a. Background Color: Blue.
 - b. Letter Color: White

3.4 DUCT LABEL INSTALLATION

- A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
1. Blue: For cold-air supply ducts.
 2. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
 3. Red: for exhaust air ducts
 4. ASME A13.1 Colors and Designs: For hazardous material exhaust.
- B. Direction Flow Arrows: Arrow shall be used to indicate direction of flow in ducts.
- C. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 25 feet in each space where ducts are exposed or concealed by removable ceiling system.
1. At both side of each penetration through walls, floors, ceilings and inaccessible enclosures.
 2. For identification of fire dampers, smoke dampers and combination fire and smoke dampers.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
1. Valve-Tag Size and Shape:
 - a. All valves: 1-1/2 inches round.
 2. Valve-Tag Color:
 - a. Chilled Water: Natural.
 - b. Condenser Water: Natural.
 - c. Refrigerant: Natural.
 - d. Hot Water: Natural.
 - e. Gas: Natural.
 - f. Low-Pressure Steam: Natural.
 - g. High-Pressure Steam: Natural.
 - h. Steam Condensate: Natural.
 3. Letter Color:

- a. Chilled Water: White.
- b. Condenser Water: White.
- c. Refrigerant: White.
- d. Hot Water: White.
- e. Gas: White.
- f. Low-Pressure Steam: White.
- g. High-Pressure Steam: White.
- h. Steam Condensate: White.

END OF SECTION

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SECTION 230593 TESTING, ADJUSTING, AND BALANCING FOR HVAC

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. Balancing Air Systems:
 - a. Variable-air-volume systems.
 - 2. Balancing Hydronic Piping Systems:
 - a. Variable-flow hydronic systems.
 - 3. HVAC equipment quantitative-performance settings.
 - 4. Existing systems TAB.
 - 5. Verifying that automatic control devices are functioning properly.
 - 6. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. Balance: To proportion flows within the distribution system, including sub mains, branches, and terminals, according to indicated quantities.
- C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
- D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
- E. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- F. Report Forms: Test data sheets for recording test data in logical order.
- G. Smoke-Control System: An engineered system that uses fans to produce airflow and pressure differences across barriers to limit smoke movement.
- H. Stair Pressurization System: A type of smoke-control system that is intended to positively pressurize stair towers with outdoor air by using fans to keep smoke from contaminating the stair towers during an alarm condition.
- I. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
- J. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- K. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- L. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- M. TAB: Testing, adjusting, and balancing.
- N. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

- O. Test: A procedure to determine quantitative performance of systems or equipment.
- P. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.
- Q. AABC: Associated Air Balance Council.
- R. NEBB: National Environmental Balancing Bureau.
- S. TAB: Testing, adjusting, and balancing.
- T. TABB: Testing, Adjusting, and Balancing Bureau.
- U. TAB Specialist: An entity engaged to perform TAB Work.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 90 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 90 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 90 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. System Readiness Checklists: Within 90 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.
- E. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.
- F. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- G. Sample Report Forms: Submit two sets of sample TAB report forms.
- H. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.
- I. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by either AABC, NEBB or TABB.
 - 1. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB, or TABB as a TAB technician.
- B. TAB Conference: If requested by the Owner, conduct a TAB conference with Architect and Owners representatives Commissioning Authority at Project site after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of seven days' advance notice of scheduled meeting time and location.
 - 1. Minimum Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Coordination and cooperation of trades and subcontractors.
 - d. Proposed procedures for documentation and communication flow.
- C. Coordination of documentation and communication flow. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems." or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
- E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems, "Section II, " Required Instrumentation for NEBB Certification."
- F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.
- G. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- H. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.6 FIELD CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

- E. Examine ceiling plenums and under floor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 "Metal Ducts" division 23 "Nonmetal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- J. Examine terminal units; such as variable-air-volume boxes and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work and prepare reports. Include, at a minimum, the following:
 - 1. General:
 - a. Permanent electrical-power wiring is complete.
 - b. Automatic temperature-control systems are operational.
 - c. Windows and doors can be closed so indicated conditions for system operations can be met.
 - 2. Airside:
 - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Volume, smoke, and fire dampers are open and functional.
 - d. Clean filters are installed.
 - e. Fans are operating, free of vibration, and rotating in correct direction.

- f. Variable-frequency controllers' startup is complete and safeties are verified.
 - g. Automatic temperature-control systems are operational.
 - h. Ceilings are installed.
 - i. Windows and doors are installed.
 - j. Suitable access to balancing devices and equipment is provided.
 - k. Equipment and duct access doors are securely closed.
3. Hydronics:
- a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
 - b. Piping is complete with terminals installed.
 - c. Water treatment is complete.
 - d. Systems are flushed, filled, and air purged.
 - e. Strainers are pulled and cleaned.
 - f. Control valves are functioning per the sequence of operation.
 - g. Shutoff and balance valves have been verified to be 100 percent open.
 - h. Pumps are started and proper rotation is verified.
 - i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
 - j. Variable-frequency controllers' startup is complete and safeties are verified.
 - k. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained AABC's "National Standards for Total System Balance" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
 - 1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 "Air Duct Accessories."
 - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 "Duct Insulation," Division 23 "HVAC Equipment Insulation," and Division 23 "HVAC Piping Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.

- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Division 23 "Metal Ducts."

3.5 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Adjust the variable-air-volume systems as follows:
 - 1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
 - 2. Verify that the system is under static pressure control.
 - 3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 - 4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
 - a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
 - b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
 - c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
 - d. Adjust controls so that terminal is calling for minimum airflow.
 - e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
 - 1) Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
 - 2) If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
 - f. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
 - 5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
 - c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 - 6. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report any artificial loading of filters at the time static pressures are measured.
 - 7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

- a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
 - b. Verify that terminal units are meeting design airflow under system maximum flow.
8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:
 - a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
 - b. Re-measure and confirm that total airflow is within design.
 - c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
 - d. Mark final settings.
 - e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
 - f. Verify tracking between supply and return fans.
- B. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
- C.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports for pumps, coils heat exchangers and other hydronic equipment with pertinent design data, and number in sequence starting at pump to end of system. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil, heat exchanger and other hydronic equipment flow rates with pump design flow rate. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. In addition to requirement sin "Preparation" Article, prepare hydronic systems for testing and balancing according to the following:
 1. Check liquid level in expansion tank.
 2. Check highest vent for adequate pressure
 3. Check flow-control valves for proper position as specified in sequence of operation and set at indicated flow.
 4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters
 5. verify that motor starters are equipped with properly sized thermal protection.
 6. Check that air has been purged from the system.
 - a. Check air vents for a forceful liquid flow exiting from vents when manually operated. Open all manual valves for maximum flow.
 7. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
 8. Set system controls so automatic valves are wide open to heat exchanger
 9. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 10. Check makeup water-station pressure gage for adequate pressure for highest vent.

3.7 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.
- B. Adjust the variable-flow hydronic system as follows:

1. Verify that the differential-pressure sensor is located as indicated.
 2. Determine whether there is diversity in the system.
- C. For systems with no diversity:
1. Adjust pumps to deliver total design gpm.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - b. Measure pump TDH except for positive-displacement pumps as follows:
 - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - 3) Convert pressure to head and correct for differences in gage heights.
 - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved. Note the point on the manufacturer's pump curve.
 - c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
 - d. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacture's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
 2. Measure flow at all automatic flow control valve to verify that valves are functioning as designed.
 3. Set calibrated balancing valves, if installed, at calculated pre-settings.
 4. Adjust flow-measuring devices installed in mains and branches to within specified tolerance of design water flows.
 - a. System components that have a Cv rating or accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
 - b. Measure flow in main and branch pipes.
 - c. Adjust main and branch balance valves for design flow.
 - d. Re-measure each main and branch after all have been adjusted.
 - e. Record settings and mark balancing devices.
 5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - a. System components that have a Cv rating or accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
 - b. Measure flow at terminals.
 - c. Adjust each terminal to design flow.
 - d. Re-measure each terminal after it is adjusted.
 - e. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
 - f. Perform temperature tests after flows have been balanced.
 - g. Record settings and mark balancing devices.
 6. For systems with pressure-independent valves at terminals:
 - a. Measure differential pressure and verify that it is within manufacturer's specified range.
 - b. Measure flow at all pressure-independent control valves with valves in the fully open position to verify that valves are functioning as designed.
 - c. Perform temperature tests after flows have been verified.
 7. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
 - c. Record settings and mark balancing devices.

8. Prior to verifying final system conditions, determine the system differential-pressure set point.
 9. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
 10. Mark final settings and verify that all memory stops have been set.
 11. Verify final system conditions as follows:
 - a. Re-measure, confirm and report final pump flow.
 - b. Re-measure, confirm and report that total water flow is within design.
 - c. Re-measure and report final pumps' operating data, TDH, volts, amps, rpm, and static profile.
 - d. Measure and report the final systems' pressures and temperatures including outdoor-air temperature.
 - e. Mark final settings.
 12. Mark final settings and verify that memory stops have been set.
 13. Measure and report the differential-pressure-control-valve settings existing at the conclusion of balancing.
 14. Check settings and operation of each safety valve. Record settings.
- D. For systems with diversity:
1. Determine diversity factor.
 2. Simulate system diversity by closing required number of control valves, as approved by the design engineer. Note the control valves that were closed to maintain diversity.
 3. Adjust pumps to deliver total design gpm.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - b. Measure pump TDH as follows except for positive-displacement pumps as follows:
 - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - 3) Convert pressure to head and correct for differences in gage heights.
 - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved. Note the point on the manufacturer's pump curve.
 - c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
 - d. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacture's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
 4. Measure flow at all automatic flow control valve to verify that valves are functioning as designed.
 5. Set calibrated balancing valves, if installed, at calculated pre-settings.
 6. Adjust flow-measuring devices installed in mains and branches to within specified tolerance of design water flows.
 - a. System components that have a Cv rating or accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
 - b. Measure flow in main and branch pipes.
 - c. Adjust main and branch balance valves for design flow.
 - d. Re-measure each main and branch after all have been adjusted.
 - e. Record settings and mark balancing devices.
 7. Adjust flow-measuring devices installed at terminals for each space to design water flows.

- a. System components that have a Cv rating or accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
 - b. Measure flow at terminals.
 - c. Adjust each terminal to design flow.
 - d. Re-measure each terminal after it is adjusted.
 - e. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 - f. Perform temperature tests after flows have been balanced.
 - g. Record settings and mark balancing devices.
 8. For systems with pressure-independent valves at terminals:
 - a. Measure differential pressure and verify that it is within manufacturer's specified range.
 - b. Measure flow at all pressure-independent control valves with valves in the fully open position to verify that valves are functioning as designed.
 - c. Perform temperature tests after flows have been verified.
 9. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
 - c. Record settings and mark balancing devices.
 10. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened. Note the control valves that were closed to maintain diversity.
 11. Prior to verifying final system conditions, determine system differential-pressure set point.
 12. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
 13. Mark final settings and verify that memory stops have been set.
 14. Verify final system conditions as follows:
 - a. Re-measure, confirm and report final pump flow.
 - b. Re-measure and confirm that total water flow is within design.
 - c. Re-measure final pumps' operating data, TDH, volts, amps, rpm, and static profile.
 - d. Measure and report the final systems' pressures and temperatures including outdoor-air temperature.
 - e. Mark final settings.
 15. Mark final settings and verify that memory stops have been set.
 16. Measure and report the differential-pressure-control-valve settings existing at the conclusion of balancing.
 17. Check settings and operation of each safety valve. Record settings.
- E. For geothermal borefield circuits:
1. Balance the borefield circuits such that each circuit carries an equal portion of the system flow.
 2. Balance the borefield circuits such that the circuit with the greatest pressure drop shall have its balancing valve fully open.
 3. Permanently mark the final settings on the balancing valves.
 4. Measure and report the initial and final settings, and report any observed deficiencies.

F.

3.8 PROCEDURES FOR TEMPERATURE MEASUREMENTS

- A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.
- B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.
- C. Measure outside-air, wet- and dry-bulb temperatures.

3.9 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
 - 1. Measure and record the operating speed, airflow, and static pressure of each fan.
 - 2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
 - 3. Check the refrigerant charge.
 - 4. Check the condition of filters.
 - 5. Check the condition of coils.
 - 6. Check the operation of the drain pan and condensate-drain trap.
 - 7. Check bearings and other lubricated parts for proper lubrication.
 - 8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
 - 1. New filters are installed.
 - 2. Coils are clean and fins combed.
 - 3. Drain pans are clean.
 - 4. Fans are clean.
 - 5. Bearings and other parts are properly lubricated.
 - 6. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
 - 1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
 - 2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
 - 3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
 - 4. Balance each air outlet.

3.10 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
 - 2. Air Outlets and Inlets: 0 to minus 10 percent.
 - 3. Geothermal-Water Flow Rate: 0 to minus 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.11 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: As work progress prepare progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.12 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
 - 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers.
 - 5. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB contractor.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB supervisor who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 12. Nomenclature sheets for each item of equipment.
 - 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 - 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 - 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
 - 1. Quantities of outdoor, supply, return, and exhaust airflows.
 - 2. Water and steam flow rates.
 - 3. Duct, outlet, and inlet sizes.
 - 4. Pipe and valve sizes and locations.
 - 5. Terminal units.
 - 6. Balancing stations.
 - 7. Position of balancing devices.
- E. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 - 1. Fan Data:

- a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 2. Motor Data:
 - a. Make and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - g. Number of belts, make, and size.
 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches w.g.
 - c. Fan rpm.
 - d. Discharge static pressure in inches w.g.
 - e. Suction static pressure in inches w.g.
- F. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
1. Report Data:
 - a. System and air-handling unit number.
 - b. Location and zone.
 - c. Traverse air temperature in degrees F.
 - d. Duct static pressure in inches w.g.
 - e. Duct size in inches.
 - f. Duct area in sq. ft.
 - g. Indicated airflow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- G. Air-Terminal-Device Reports:
1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Test apparatus used.
 - d. Area served.
 - e. Air-terminal-device make.
 - f. Air-terminal-device number from system diagram.
 - g. Air-terminal-device type and model number.
 - h. Air-terminal-device size.
 - i. Air-terminal-device effective area in sq. ft.
 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary airflow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final airflow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in degrees F.

- H. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Entering-water temperature in degrees F.
 - c. Leaving-water temperature in degrees F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in degrees F.
 - f. Leaving-air temperature in degrees F.
- I. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model and serial numbers.
 - f. Water flow rate in gpm.
 - g. Water pressure differential in feet of head or psig.
 - h. Required net positive suction head in feet of head or psig.
 - i. Pump rpm.
 - j. Impeller diameter in inches.
 - k. Motor make and frame size.
 - l. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.
 - p. Seal type.
 2. Test Data (Indicated and Actual Values):
 - a. Static head in feet of head or psig.
 - b. Pump shutoff pressure in feet of head or psig.
 - c. Actual impeller size in inches.
 - d. Full-open flow rate in gpm.
 - e. Full-open pressure in feet of head or psig.
 - f. Final discharge pressure in feet of head or psig.
 - g. Final suction pressure in feet of head or psig.
 - h. Final total pressure in feet of head or psig.
 - i. Final water flow rate in gpm.
 - j. Voltage at each connection.
 - k. Amperage for each phase.
- J. Geothermal Borefield Circuit Tests: For each circuit include the following:
1. Balancing valve manufacturer, make, and size
 2. Full-open flow rate in gpm
 3. Full-open pressure in feet of head or psig
 4. Final adjusted flow rate in gpm
 5. Final adjusted pressure in feet of head or psig
 6. Final valve setting

3.13 VERIFICATION OF TAB REPORT

- A. Initial Verification:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
 2. Check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure water flow of at least 5 percent of terminals.
 - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - d. Verify that balancing devices are marked with final balance position.
 - e. Note deviations from the Contract Documents in the final report.
- B. Final Verification:
1. Architect, Owner, or Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
 2. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
 3. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
 4. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report and request a second final inspection.
- C. Prepare test and inspection reports.

3.14 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

3.15

3.16 END OF SECTION

3.17

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SECTION 230713 DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulating the following duct services:
 - 1. Indoor, concealed supply and outdoor air.
 - 2. Indoor, exposed supply and outdoor air.
 - 3. Indoor, concealed return located in unconditioned space.
 - 4. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
- B. Related Sections:
 - 1. Section 230719 "HVAC Piping Insulation."
 - 2. Section 233113 "Metal Ducts" for duct liners.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; SoftTouch Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Friendly Feel Duct Wrap.
 - d. Manson Insulation Inc.; Alley Wrap.
 - e. Owens Corning; SOFTR All-Service Duct Wrap.
- F. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; Commercial Board.
 - b. Fibrex Insulations Inc.; FBX.
 - c. Johns Manville; 800 Series Spin-Glas.
 - d. Knauf Insulation; Insulation Board.
 - e. Manson Insulation Inc.; AK Board.
 - f. Owens Corning; Fiberglas 700 Series.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to it and to surfaces to be insulated unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company; CP-127. Eagle Bridges - Marathon Industries; 225.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company; 85-60/85-70. Mon-Eco Industries, Inc.; 22-25.
 - 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company; CP-82.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company; 85-50. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; 739, Dow Silicone.
 - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Polyco VP Adhesive.
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.4 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. Outdoor Jacket, Prefabricated, Self-Adhering, Sheet-Type Waterproofing Membrane: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross laminated polyethylene film covered with stucco-embossed aluminum-foil facing.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Polyguard Products, Inc.; Alumaguard All Weather.
- C. Outdoor Jacket, Prefabricated, Self-Adhering, Sheet-Type Waterproofing Membrane Jacket: thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground; consisting of 5 layers of aluminum foil and polyester film.
1. Products:
 - a. VentureClad 1577CW.
 2. Requirements:
 - a. Tear Resistance, ASTM D 1424, 2 kg.
 - b. Elongation, ASTM D 412, Minimum: 166 percent.
 - c. Application temperature: Minus 10 deg F to 248 deg F.
 - d. Maximum Temperature; Continuous Use: 330 deg F.
 - e. Water Vapor Transmission, ASTM E 96: 0 perms.
 - f. Flame Spread Index, ASTM E 84: 0.
 - g. Smoke Density Index, ASTM E 84: 0.
 - h. Wind-Driven Rain, SFBC TAS-110-95, 100 mph: No leakage or failure.
 - i. UV Stability: Excellent.

2.5 TAPES

- A. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABI, Ideal Tape Division; 488 AWF.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
 - c. Compac Corporation; 120.
 - d. Venture Tape; 3520 CW.
 2. Width: 2 inches.
 3. Thickness: 3.7 mils.
 4. Adhesion: 100 ounces force/inch in width.
 5. Elongation: 5 percent.
 6. Tensile Strength: 34-lbf/inch in width.

2.6 SECUREMENTS

A. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.105 inch diameter shank, length to suit depth of insulation indicated.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; CD.
 - 3) Midwest Fasteners, Inc.; CD.
 - 4) Nelson Stud Welding; TPA, TPC, and TPS.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.105 inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2 inch galvanized carbon-steel washer.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) AGM Industries, Inc.; CHP-1.
 - 2) GEMCO; Cupped Head Weld Pin.
 - 3) Midwest Fasteners, Inc.; Cupped Head.
 - 4) Nelson Stud Welding; CHP.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, and securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
 - 2) GEMCO; Perforated Base.
 - 3) Midwest Fasteners, Inc.; Spindle.
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106 inch diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, and securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) GEMCO; Nylon Hangers.
 - 2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
 - b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 - c. Spindle: Nylon, 0.106 inch diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, and securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
 - 2) GEMCO; Peel & Press.
 - 3) Midwest Fasteners, Inc.; Self Stick.
 - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106 inch diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive-backed base with a peel-off protective cover.

- B. Insulation-Retaining Washers: Self-locking washers formed from 0.016 inch thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. AGM Industries, Inc.; RC-150.
 - b. GEMCO; R-150.
 - c. Midwest Fasteners, Inc.; WA-150.
 - d. Nelson Stud Welding; Speed Clips.
 - 2. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- C. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016 inch thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. GEMCO.
 - b. Midwest Fasteners, Inc.
- D. Staples: Outward-clinching insulation staples, nominal 3/4 inch wide, stainless steel or Monel.
- E. Wire: 0.062 inch soft-annealed, stainless steel .
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. C & F Wire.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.

- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3 inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 75 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over compress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2 inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18 foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
 5. Overlap unraced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6 inch wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 75 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

- a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
- b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
- c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
- d. Do not over compress insulation during installation.
- e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2 inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18 foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6 inch wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.7 FIELD-APPLIED JACKET INSTALLATION

- A. Where FSK jackets are indicated, install as follows:
 1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with 1-1/2 inch laps at longitudinal seams and 3 inch wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- B. Where PVC jackets are indicated, install with 1 inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.8 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 1. Indoor, concealed supply and outdoor air.
 2. Indoor, exposed supply and outdoor air.
 3. Indoor, concealed return located in unconditioned space.
 4. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
- B. Items Not Insulated:
 1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 2. Factory-insulated flexible ducts.
 3. Factory-insulated plenums and casings.
 4. Flexible connectors.

5. Vibration-control devices.
6. Factory-insulated access panels and doors.

3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Concealed, rectangular, round, and flat-oval, plenum and supply-air duct insulation shall be one of the following:
 1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- B. Concealed, rectangular, round, and flat-oval, plenum and supply-air duct located in unconditioned spaces; insulation shall be the following:
 1. Mineral-Fiber Blanket: 3 inches thick and 0.75-lb/cu. ft. nominal density.
- C. Concealed, rectangular, round, and flat-oval, plenum and return-air duct located in unconditioned spaces; insulation shall be the following:
 1. Mineral-Fiber Blanket: 3 inches thick and 0.75-lb/cu. ft. nominal density.
- D. Concealed, rectangular, round, and flat-oval, plenum and outdoor-air duct insulation shall be one of the following:
 1. Mineral-Fiber Blanket: 3 inches thick and 0.75-lb/cu. ft. nominal density.
- E. Concealed, rectangular, round, and flat oval, plenum and exhaust-air duct insulation between isolation damper and penetration of building exterior (minimum length; 10 feet) shall be the following:
 1. Mineral-Fiber Blanket: 3 inches thick and 0.75-lb/cu. ft. nominal density.

3.10 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts and Plenums, Concealed:
 1. None.
- D. Ducts and Plenums, Exposed:
 1. None.

END OF SECTION

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SECTION 230716 HVAC EQUIPMENT INSULATION

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 insulating the following HVAC equipment that is not factory insulated:
 - 1. Air separators.
- B. Related Sections:
 - 1. Section 230719 "HVAC Piping Insulation."

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with equipment Installer for equipment insulation application.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.1 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. CertainTeed Corp.; CrimpWrap.
 - b. Johns Manville; MicroFlex.
 - c. Knauf Insulation; Pipe and Tank Insulation.
 - d. Manson Insulation Inc.; AK Flex.
 - e. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
 - d. Mon-Eco Industries, Inc.; 22-25.
 - 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
 - d. Mon-Eco Industries, Inc.; 22-25.
 - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Range: 0 to plus 180 deg F.
 - 4. Color: White.

2.3 SEALANTS

A. Joint Sealants:

1. Products: Subject to compliance with requirements, provide the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Eagle Bridges - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Pittsburgh Corning Corporation; Pittseal 444.
2. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.5 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide the following:
 - a. ABI, Ideal Tape Division; 428 AWF ASJ.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
 - c. Compac Corporation; 104 and 105.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.6 SECUREMENTS

A. Insulation Pins and Hangers:

1. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
 - a. Products: Subject to compliance with requirements, provide the following:
 - 1) GEMCO; Nylon Hangers.
 - 2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
 - b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 - c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
2. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
3. Products: Subject to compliance with requirements, provide the following:

- 1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers, Series.
- 2) GEMCO; Peel & Press.
- 3) Midwest Fasteners, Inc.; Self Stick.
- b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
- c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
- d. Adhesive-backed base with a peel-off protective cover.
4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Products: Subject to compliance with requirements, provide the following:
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - 4) Nelson Stud Welding; Speed Clips.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.

- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- O. For above ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.4 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

- A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
 - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
 - 2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
 - 3. Protect exposed corners with secured corner angles.

4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
 - d. Do not overcompress insulation during installation.
 - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - f. Impale insulation over anchor pins and attach speed washers.
 - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections: Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.6 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Geothermal Loop-water air-separator insulation shall be one of the following:
 1. Mineral-Fiber Pipe and Tank: 2 inches thick.

END OF SECTION

SECTION 230719 HVAC PIPING INSULATION

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 insulating the following HVAC piping systems:
 - 1. Condensate drain piping, indoors.
 - 2. Dual-service heating and cooling piping, indoors and outdoors.
- B. Related Sections:
 - 1. Section 237905 "Geothermal Heat Exchanger System"

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at pipe expansion joints for each type of insulation.
 - 3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 4. Detail removable insulation at piping specialties.
 - 5. Detail application of field-applied jackets.
 - 6. Detail application at linkages of control devices.

1.4 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.6 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. arma
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 1. Products: Subject to compliance with requirements provide one of the following:
 - a. Aeroflex USA, Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
 - 2. Thermal conductivity (k-value) at 75 degrees F is 0.28 Btu x in. /h x sq. ft. x degrees F or less.
- G. Phenolic:
 - 1. Products: Subject to compliance with requirements provide one of the following:
 - a. ITW Insulation Systems; Trymer Green.
 - b. Kingspan Tarec Industrial Insulation NV; Koolphen KPolyguard Products; Poly Phen.
 - c. Resolco International BV; Insul-phen.
 - 2. Thermal conductivity (k-value) at 75 degrees F is 0.175 Btu x in. /h x sq. ft. x degrees F or less.
 - 3. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
 - 4. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
 - 5. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
 - 6. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
 - a. Preformed Pipe Insulation: ASJ.
- H. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
 - 1. Products: Subject to compliance with requirements provide one of the following:
 - a. Armacell LLC; Tubolit.
 - b. ITW Insulation Systems

- c. Nomaco Insulation; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.
- 2. Thermal conductivity (k-value) at 75 degrees F is 0.25 Btu x in. /h x sq. ft. x degrees F or less.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Phenolic Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 degrees F.
 - 1. Products: Subject to compliance with requirements provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company; CP-96.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company; 81-33.
 - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Products: Subject to compliance with requirements provide one of the following:
 - a. Aeroflex USA, Inc.; Aeroseal.
 - b. Armacell LLC; Armaflex 520 Adhesive.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company; 85-75.
 - d. K-Flex USA; R-373 Contact Adhesive.
 - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products: Subject to compliance with requirements provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company; CP-82.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company; 85-50.
 - d. Mon-Eco Industries, Incorporated; 22-25.
 - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
 - 1. Products: Subject to compliance with requirements provide one of the following:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company; 30-80/30-90.
 - b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 3. Service Temperature Range: Minus 20 to plus 180 degrees F.
 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
1. Products: Subject to compliance with requirements provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company; CP-30.
 - b. Eagle Bridges - Marathon Industries; 501.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company; 30-35.
 - d. Mon-Eco Industries, Inc.; 55-10.
 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
 3. Service Temperature Range: 0 to 180 degrees F.
 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 5. Color: White.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
1. Products: Subject to compliance with requirements provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company; Encacel.
 - b. Eagle Bridges - Marathon Industries; 570.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company; 60-95/60-96.
 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
 3. Service Temperature Range: Minus 50 to plus 220 degrees F.
 4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
 5. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
1. Products: Subject to compliance with requirements provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company; CP-10.
 - b. Eagle Bridges - Marathon Industries; 550.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company; 46-50.
 - d. Mon-Eco Industries, Inc.; 55-50.
 - e. Vimasco Corporation; WC-1/WC-5.
 2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625 inch dry film thickness.
 3. Service Temperature Range: Minus 20 to plus 180 degrees F.
 4. Solids Content: 60 percent by volume and 66 percent by weight.
 5. Color: White.

2.4 SEALANTS

- A. Joint Sealants:
1. Products: Subject to compliance with requirements provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company; CP-76.
 - b. Eagle Bridges - Marathon Industries; 405.

- c. Foster Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company; 30-45.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Pittsburgh Corning Corporation; Pittseal 444.
 2. Products: Subject to compliance with requirements provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company; CP-70.
 - b. Eagle Bridges - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company; 30-45.
 - d. Mon-Eco Industries, Inc.; 44-05.
 3. Materials shall be compatible with insulation materials, jackets, and substrates.
 4. Permanently flexible, elastomeric sealant.
 5. Service Temperature Range: Minus 100 to plus 300 degrees F.
 6. Color: White or gray.
 7. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. FSK and Metal Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company; CP-76.
 - b. Eagle Bridges - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company; 95-44.
 - d. Mon-Eco Industries, Inc.; 44-05.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 degrees F.
 5. Color: Aluminum.
- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company; CP-76.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 degrees F.
 5. Color: White.
 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
6. Products: Subject to compliance with requirements provide one of the following:
 - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
7. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
8. Products: Subject to compliance with requirements provide one of the following:
 - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
9. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
10. Products: Subject to compliance with requirements provide one of the following:
 - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
11. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.
- 12.

2.6 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements provide one of the following:
 - a. ABI, Ideal Tape Division; 428 AWF ASJ.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836
 - c. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements provide one of the following:
 - a. ABI, Ideal Tape Division; 491 AWF FSK
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827
 - c. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ
 2. Width: 3 inches.
 3. Thickness: 6.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 - 1. Products: Subject to compliance with requirements provide one of the following:
 - a. ABI, Ideal Tape Division; 370 White PVC tape
 - b. Venture Tape; 1506 CW NS
 - 2. Width: 2 inches.
 - 3. Thickness: 6 mils.
 - 4. Adhesion: 64 ounces force/inch in width.
 - 5. Elongation: 500 percent.
 - 6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 - 1. Products: Subject to compliance with requirements provide one of the following:
 - a. ABI, Ideal Tape Division; 488 AWF
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
 - c. Venture Tape; 3520 CW.
 - 2. Width: 2 inches.
 - 3. Thickness: 3.7 mils.
 - 4. Adhesion: 100 ounces force/inch in width.
 - 5. Elongation: 5 percent.
 - 6. Tensile Strength: 34 lbf/inch in width.
- E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
 - 1. Products: Subject to compliance with requirements provide one of the following:
 - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.
 - 2. Width: 3 inches.
 - 3. Film Thickness: 4 mils.
 - 4. Adhesive Thickness: 1.5 mils.
 - 5. Elongation at Break: 145 percent.
 - 6. Tensile Strength: 55 lbf/inch in width.
- F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
 - 1. Products: Subject to compliance with requirements provide one of the following:
 - a. Dow Chemical Company (The); Saran 560 Vapor Retarder Tape.
 - 2. Width: 3 inches.
 - 3. Film Thickness: 6 mils.
 - 4. Adhesive Thickness: 1.5 mils.
 - 5. Elongation at Break: 145 percent.
 - 6. Tensile Strength: 55 lbf/inch in width.

2.7 SECUREMENTS

- A. Bands:
 - 1. Products: Subject to compliance with requirements provide one of the following:
 - a. ITW Insulation Systems; Gerrard Strapping and Seals.
 - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
 - 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal.
 - 3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, **[1/2 inch] [3/4 inch]** wide with **[wing seal] [or] [closed seal]**.
 - 4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

- B. Staples: Outward-clinching insulation staples, nominal 3/4 inch wide, stainless steel or Monel.
- C. Wire: 0.062 inch soft-annealed, stainless steel.
 - 1. Products: Subject to compliance with requirements provide one of the following:
 - a. C & F Wire.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 degrees F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing; that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3 inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Section 078400 "Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078400 "Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF PHENOLIC INSULATION

- A. General Installation Requirements:
1. Secure single-layer insulation with stainless-steel bands at 12 inch intervals and tighten bands without deforming insulation materials.
 2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062 inch wire spaced at 12 inch intervals. Secure outer layer with stainless-steel bands at 12 inch intervals.
- B. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- C. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
- D. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
- E. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.8 INSTALLATION OF POLYOLEFIN INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
 1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install mitered sections of polyolefin pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.10 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below 60 Degrees F:
 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Polyolefin: 3/4 inch thick.
- B. Geothermal-Water Heating and Cooling, 25 to 100 Degrees F:
 1. NPS: All sizes
 - a. Phenolic: 1-1/2 inch thick.
 - b. Polyolefin: 1-1/2 inch thick.

END OF SECTION

SECTION 230800 COMMISSIONING OF HVAC

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 DEFINITIONS

- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. Commissioning Authority: Owners representative who leads, plans, schedules, and coordinates the commissioning team to implement the commissioning process.
- C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.
- D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.3 INFORMATIONAL SUBMITTALS

- A. Certificates of readiness.
- B. Certificates of completion of installation, prestart, and startup activities.

1.4 SUMMARY

- A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.5 ALLOWANCES

- A. Labor, instrumentation, tools, and equipment costs for technicians for the performance of commissioning testing are covered by the "Schedule of Allowances" Article in Division 01 Section "Allowances."

1.6 UNIT PRICES

- A. Commissioning testing allowance may be adjusted up or down by the "List of Unit Prices" Article in Division 01 Section "Unit Prices" when actual man-hours are computed at the end of commissioning testing.

1.7 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the Commissioning Authority.
- B. Attend construction phase controls coordination meeting.
- C. Attend testing, adjusting, and balancing review and coordination meeting.
- D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the Commissioning Authority.
- E. Provide information requested by the Commissioning Authority for final commissioning documentation.

- F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.8 COMMISSIONING AUTHORITY'S RESPONSIBILITIES

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Direct commissioning testing.
- C. Verify testing, adjusting, and balancing of Work are complete.
- D. Provide test data, inspection reports, and certificates in Systems Manual.

1.9 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the Commissioning Authority for inclusion in the commissioning plan:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
 - 4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
 - 5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
 - 6. Test and inspection reports and certificates.
 - 7. Corrective action documents.
 - 8. Verification of testing, adjusting, and balancing reports.

1.10 SUBMITTALS

- A. Certificates of readiness.
- B. Certificates of completion of installation, prestart, and startup activities.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 TESTING PREPARATION

- A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the Commissioning Authority.

3.2 TESTING AND BALANCING VERIFICATION

- A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the Commissioning Authority.
- B. Notify the Commissioning Authority at least 10 days in advance of testing and balancing Work and provide access for the Commissioning Authority to witness testing and balancing Work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the Commissioning Authority.
 - 1. The Commissioning Authority will notify testing and balancing Subcontractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
 - 2. The testing and balancing Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
 - 3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
 - 4. Remedy the deficiency and notify the Commissioning Authority so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the Commissioning Authority.
- B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The Commissioning Authority along with the HVAC&R Subcontractor, testing and balancing Subcontractor, and HVAC&R Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the Commissioning Authority and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The Commissioning Authority may direct that set points be altered when simulating conditions is not practical.
- H. The Commissioning Authority may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls." Assist the Commissioning Authority with preparation of testing plans.
- B. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of gas systems and equipment at the direction of the Commissioning Authority. The Commissioning Authority shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- C. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The Commissioning Authority shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- D. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.
- E. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation controls.

END OF SECTION

SECTION 230900 INSTRUMENTATION AND CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes control and monitoring equipment for HVAC and other systems and components identified in this specification section.
 - 1. The documentation contained in this section and other Contract Documents pertaining to HVAC Controls is schematic in nature. The Contractor shall provide hardware and software necessary to implement the functions shown and as implied by the Contract Documents.
- B. Related Sections include the following:
 - 1. Refer to Division 21, 22, and 23 sections for required control and alarm points.
 - 2. Division 23 Section "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.
 - 3. Division 23 Section "Sequence of Operations for HVAC Controls" for requirements that relate to this Section.
- C. Refer to Division-26 Sections for the following work.
 - 1. Power from the power source to the power connection on control panels as indicated on the Electrical Drawings.
 - 2. Interlock wiring between electrically operated equipment units, and between equipment and field installed control devices as indicated on the Electrical Drawings.
- D. Refer to Division-27 Sections for the following work.
 - 1. Structured cabling and low voltage cabling requirements.

1.3 DEFINITIONS

- A. Acceptance Date: The date that the installer demonstrates, to the owner or the owner's representative, that all system components are functioning properly. Refer to demonstration article for demonstration requirements.
- B. AI: Analog Input.
- C. AO: Analog Output.
- D. Application Specific Controller (ASC): A controller that controls specific pieces of complex or custom equipment, such as a cooling tower or rooftop unit, that includes preprogrammed routines prepared by the manufacturer. The user may select the appropriate sequence from a menu. The ASC is typically dedicated to the piece of equipment it controls.
- E. Building Controller: A general purpose term used to describe a variety of controller types, depending on the environment, protocol, vendor, or integrator terms.
- F. Configurable Controller: A basic controller that can have a variety of uses and can be configured using selectable controls options and buttons built into the controller hardware without requiring a software programming tool. A configurable controller lacks the fully programmable features available in a programmable controller.

- G. Daisy Chain: Is a type of network configuration in which each device is connected to exactly two other devices, forming a linear chain where the last device is only connected to the previous device, also known as series connection or a linear bus topology.
- H. DI: Discrete Input, also referred to as a Binary Input (BI) or Digital Input
- I. DO: Discrete Output, also referred to as a Binary Output (BO) or Digital Output
- J. Field Terminal Controller: A device that serves as an interface between the control system and field devices like sensors, actuators, and other instruments.
- K. Haystack: The industry standard administered by the Project Haystack organization that is used to define a library of semantic tags for defining machine-readable contextual data about physical equipment and attributes.
- L. Gateway: A device that provides routing of communication signals and enables translation of communication protocols between devices or networks that use different protocols to communicate.
- M. GUI: Graphical User Interface.
- N. I/O (or IO): Physical Input/Output connections or points that provide analog or digital interface to sensors, actuators, or other physical hardware.
- O. License Holder: The Owner shall be considered the license holder for all software used, for all custom system programming applications, scripts, and files, and for all work performed under this section.
- P. Mbps: Megabits per second
- Q. NC: Normally closed position of switch after control signal is removed or normally closed position of manually operated valves or dampers.
- R. NO: Normally open position of switch after control signal is removed; or the open position of a controlled valve or damper after the control signal is removed; or the usual position of a manually operated valve.
- S. OPC: An industrial connectivity standard based on client/server technology that enables the transfer of automation data between automation hardware and software.
- T. PID: Proportional plus integral plus derivative control loop. Derivative component is not always used.
- U. Programmable Controller: A flexible controller that can have a variety of uses and can be fully programmed by a qualified individual.
- V. RTD: Resistance temperature detector.
- W. Supervisory Controller: A device that performs a higher-level function or set of functions for a system, subsystem, or set of equipment and provides for communication between the field level controllers and the Owner's wide and/or local area IT network.
- X. TCP/IP: Transmission Control Protocol/Internet Protocol. The standard for transmitting data over networks, typically made up of many different protocols.

1.4 SEQUENCE OF OPERATION

- A. Refer to Section 230993 "Sequence of Operation for HVAC Controls"

1.5 SUBMITTALS

- A. Bid Submittals
- B. Construction Submittals
 - 1. Re-submit required Bid Submittals materials as part of Construction Submittal.
 - 2. Qualification Data
 - a. For firms and persons specified in "Quality Assurance" Article.

- b. Product Data: Include manufacturer's technical literature for each control device. On product sheets with multiple part numbers or accessory options, indicate which models/model numbers are being supplied on the project. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated; and indicate where it will be applied.
 - c. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
 - 3. 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.
 - a. Floor plans indicating anticipated locations for; control panels, temperature sensors, thermostats, humidity sensors, and humidistats.
 - b. Anticipated elevations of locations for; temperature sensors, thermostats, humidity sensors, and humidistats with all wall mounted devices shown.
 - c. Bill of materials of equipment indicating quantity, manufacturer, and model number.
 - d. Schematic diagrams showing fans, pumps, heat pumps, coils, dampers, valves, and control devices. Each shall have a schedule of components including all analog and binary input and outputs with spares shown.
 - e. Details of control panel faces, including controls, instruments, and labeling.
 - f. Wiring Diagrams: Power, signal, and control wiring. Detailed system communications network architecture including connectivity needed to Owner equipment or networks, server equipment (supplied under this scope or by the Owner), supervisory controller(s), field controller bus architecture, and instrumentation connections.
 - g. Written description of sequence of operation.
 - h. Schedule of dampers including size, leakage, and flow characteristics.
 - i. Schedule of valves including flow characteristics.
 - j. Controlled Systems:
 - 1) Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
 - 2) Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
 - 3) Written description of sequence of operation including schematic diagram.
 - 4) Points list.
 - k. Controllers: Identify any controllers provided under the contract. Submit the specifications for each type of controller. Indicate that each controller has an open license.
 - 4. Samples for Selection: For each color required, of each type of thermostat or space temperature sensor with factory-applied color finishes.
- C. Submittals after Construction
 - 1. The following is a list of post construction submittals that shall be updated to reflect any changes during construction and re-submitted as "As-Built". As-Built drawings will each be stamped "As-Built" and have the as-built date on them. The As-Built drawings will contain at a minimum:
 - a. Detailed drawings for each piece of controlled and monitored equipment
 - 1) Layout drawing for each control panel.
 - 2) Wiring diagram for each control panel.
 - 3) Wiring diagram for individual components.
 - 4) Point lists
 - 5) Room Schedules
 - 6) Sequence of operation
 - 7) Hardware with part number information
 - 8) System flow diagram for each controlled system.
 - 2. Operation and Maintenance Manuals:
 - a. The controls contractor will provide an electronic (PDF) copy.

- b. Maintenance and Operating Manual will include the following type of information:
 - 1) One copy of the executed Certificate(s) of Substantial Completion. This document will be used to communicate to all necessary Owner personnel the starting date of the one-year Warranty period.
 - 2) Signed record copy of bonds, guarantees, and warranties required by the Contract Documents.
 - 3) Manufacturer's required preventative maintenance inspections, testing, service, lubrication, maintenance instructions, and schedules.
 - 4) Parts lists, including spare parts, and local service organization.
 - 5) As-built wiring and piping diagrams.
 - 6) System architecture diagram for components within the building annotated with specific location information.
 - 7) As-built drawing for each control panel.
 - 8) As-built wiring design diagram for each control panel.
 - 9) As-built wiring design diagram for all components.
 - 10) Installation design details for each I/O device.
 - 11) As-built system flow diagram for each system.
 - 12) Sequence of control for each system.
 - 13) Room schedules.
 - 14) Binding map for the building.
 - 15) Product data sheet for each component.
 - 16) Installation data sheet for each component.
 - 17) Calibration records and list of set points.
 - 18) Other information required by the Specifications.
- c. Instruct Owner personnel in the use of Maintenance and Operating Manuals.
- 3. Training Resources: A list of training courses available for the Owner's maintenance team to attend and the associated cost.

1.6 QUALITY ASSURANCE

- A. General - The HVAC Control System shall be furnished, engineered, and installed by a qualified Controls System Integrator (SI). All work provided under this section shall be provided by direct employees of the SI or under the direct supervision of the SI personnel.
- B. Hardware and Software Component Manufacturer Qualifications
 - 1. The manufacturer of the hardware and software components must be primarily engaged in the manufacture of BACnet based systems as specified herein and must have been so for a minimum of three (3) years.
 - 2. The manufacturer of the hardware and software components as well as its subsidiaries must be a member in good standing of the BACnet International, and the BACnet Manufacturers Association.
 - 3. The manufacturer of the hardware and software components shall have a technical support group accessible via a toll-free number that is staffed with qualified personnel, capable of providing instruction and technical support service for networked control systems.
- C. Electrical Components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with ASHRAE 135-2020 for DDC system components.
- E. All BACnet components shall be BTL listed.
- F. Startup Personnel Qualifications: Factory trained personnel who are experienced with the installation and startup of automatic control systems installations similar to those required for this Project.

- G. Codes and Standards: Equipment, materials, and labor; provided as work of this section shall comply with federal, state, and local standards, codes, and ordinances.

1.7 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 equipment manufacturer.

1.8 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate the location and installation of automatic control dampers, instruments, and air control accessories. Automatic control dampers, instruments, and air control accessories will be installed according to Division 23 Section Duct Accessories.
- C. Coordinate the location and installation of automatic control valves, instrument wells, and hydronic accessories. Control valves, instrument wells, and hydronic control accessories will be installed according to Division 23 Section Hydronic Piping.
- D. Coordinate panel locations with Division 26 for power. Locations shown on floor plans are an estimate intended to address general scope. Specific locations, quantities, and power/data requirements must be determined and coordinated by the SI.

1.9 WARRANTY

- A. Components, system software, parts and assemblies will be guaranteed against defects in materials and workmanship for two years from the acceptance date.
- B. Labor and material to troubleshoot, repair, reprogram, or replace system components will provide, at no charge to the owner during the warranty period.
- C. Corrective software modifications made during warranty service periods will be updated on all user documentation and on user and manufacturer archived software disks. Provide the owner with a new compact disc whenever software changes are required.
- D. The installer will be capable of doing any repairs with factory trained technicians operating out of a local service office.
- E. The installer will furnish the Owner with a local telephone number where a factory-trained technician may be reached at all times.
- F. The factory-trained technician will arrive at the job-site ready to service the system within two hours upon receiving a request for repairs and will prosecute the work continuously until the system is back in proper reliable operating condition.
- G. The installer will keep a permanent maintenance record at the local service office of all repairs performed and all service calls responded to during the warranty period (including labor and material used); copy of record will be presented to Owner's representative at completion of each service call.
- H. Permanent maintenance records will include all service calls made.
- I. Ball Valves, Ball Valve Actuators and Electronic Valve Actuators for Butterfly Valves shall be covered by a 4 year product warranty from the date of substantial project completion. Industrial-type Electronic Valve Actuators and Butterfly Valves shall be covered by a 36 month product warranty from date of substantial project completion.
- J. All labor to replace failed Valves and Actuators shall be provided during the first 12 months of the warranty starting from the date of project completion.
- K. System components and local service will be available for a total of seven years.

- L. The warranty shall extend to material that is supplied and installed by the Contractor. Material supplied but not installed by the Contractor shall be covered per the above to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 ENCLOSURES AND CONTROL PANELS

- A. Control Panels: All controllers for a particular piece of mechanical equipment shall be mounted in the same control panel. For example, all controllers and IO modules for a central heating/cooling plant shall be in a single panel, along with the required transformers, power supplies, and any necessary communication devices.
 - 1. A perforated back panel shall be included within the enclosure to allow for easy installation.
 - 2. Wire duct shall be included to maintain an organized and tidy appearance.
 - 3. DIN rail shall be mounted to the perforated back panel to allow for easy installation of controllers and other devices.
- B. Controller Enclosures: All controllers shall be mounted inside a metal enclosure with sufficient protection to environmental elements.
 - 1. Controllers mounted in areas exposed to spraying or splashing liquids as well as outdoor conditions shall be mounted in enclosures with NEMA 4X ratings.
 - 2. Controllers mounted in other areas shall be mounted in enclosures with NEMA 1 or higher ratings.
 - 3. Controllers mounted in areas exposed to extreme temperature variation, such as outdoors, shall include necessary devices to maintain interior conditions within the acceptable specified range of all control devices. This may include heating elements and/or fans.
- C. Device Enclosures: All control devices shall be inside enclosures appropriate to their location.
 - 1. Control valves, actuators, or other devices mounted outdoors shall include weatherproof enclosures with NEMA 4 ratings. Devices mounted in these locations must be rated for the temperature range to which they will be exposed.
 - 2. Actuators and other control devices mounted indoors shall include plastic or metal enclosures to protect electronic elements from dust and debris.
 - 3. Transformer panels for distributing power to terminal controllers shall be properly ventilated to prevent transformers from overheating.

2.3 ELECTRICAL POWER

- A. Controllers shall be powered by the same source of power as the equipment they control to ensure continued operation of critical equipment.
- B. Uninterruptible Power Supplies (UPSs): All network controllers managing communication between field controllers shall be powered through UPSs. All field controllers controlling equipment that is backed up by generator power shall be powered through UPSs. Size the UPS for a minimum of 1 hour of runtime assuming a fully loaded downstream circuit. In the cases of circuits served by generator power, a minimum of 10 minutes of runtime is sufficient.

2.4 ACTUATORS

- A. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Manufacturers:
 - a. Belimo Aircontrols (USA), Incorporated
 - b. Bray International Incorporated.
 - c. Delta Control Products.
 - d. Honeywell, Incorporated; Home & Building Control.
 - e. Siemens Building Technologies
 - f. Johnson Controls, Incorporated; Controls Group.
2. Valves: Size for torque required for valve close off at maximum pump differential pressure. Actuators shall be provided factory assembled with control valves whenever possible.
3. Dampers: Size for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
 - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
 - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
4. Coupling: V-bolt and V-shaped, toothed cradle.
5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators. Electronic failsafe (super capacitor) actuators will be considered based on application.
7. Power Requirements (Two-Position Spring Return): 24 VAC.
8. Power Requirements (Modulating): Maximum 10 VA at 24 VAC or 8 W at 24 VDC.
9. Proportional Signal: 2-10 VDC or 4-20 mA, with 2-10 VDC position feedback signal.
10. Temperature Rating: -22 to +122°F.
11. Full Range Stroke Time: 90 seconds.
12. Fail Safe Stroke Time: 15 seconds.

2.5 DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide control damper products by one of the listed manufacturers:
 1. Arrow United Industries
 2. Cesco Products
 3. Johnson Controls, Incorporated; Controls Group.
 4. Ruskin Manufacturing Company
 5. Tamco Dampers
 6. Vent Products Co., Incorporated
- B. Standard Control Dampers
 1. Construction:
 - a. Frames: Roll formed galvanized sheet channels, 13 gauge, all welded joints.
 - b. Blades: Two roll formed galvanized steel sheets, 22 gauge, spot welded together to form air foil shape, 6 inch maximum blade width.
 - c. Hardware: Molded synthetic bearings. Zinc plated steel axles, linkage brackets, connecting rods, and mounting bolts.
 - d. Seals: Flexible metal compression seals on the frame at blade end; extruded vinyl inflatable blade edge seals.
 - e. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
 2. Operating Limits:
 - a. Temperature: -20 to 200 degrees F.
 - b. Pressure: 6 inches w.g. differential.
 - c. Velocity: Up to 4000 FM.
 3. Select opposed blade dampers for modulating service. Parallel blade dampers shall be used for two-position service, or in mixed air application that promotes air mixing.

4. Damper sizes will be provided as indicated on the drawings. Damper sizes may be provided differently from those shown on the drawings if improved performance can be demonstrated with calculations.

2.6 WIRE, CABLE, AND TRANSFORMERS

- A. Refer to Division 26 for conduits and conductors, except as noted.
- B. Provide low voltage interlock wiring between supply and exhaust fans, electrical wiring for relays for temperature and pressure indication.
- C. Provide wiring, conduit and connections for low temperature thermostats, high temperature thermostats, alarms, flow switches, actuating devices for temperature, humidity, pressure and flow indication, point resets and user disconnect switches for electric heating, appliances controlled by this Section.
- D. Provide all other wiring required for the complete operation of the specified systems. Wire and cable shall meet the requirements of NFPA 70 and NFPA 90A.
- E. Terminal blocks, which are not integral to other equipment, shall be insulated, modular, feed-trough, clamp style with recessed captive screw-type clamping mechanism, shall be suitable for rail mounting, and shall have end plates and partition plates for separation or enclosed sides.
- F. Control wiring for binary sensors shall be 18 AWG copper and shall be rated for 300-volt service.
- G. Wiring for 120-volt circuits shall be 18 AWG or thicker stranded copper and shall be rated for 600-volt service.
- H. Control wiring for continuous analog signals shall be 18 AWG, copper, single or multiple strand, twisted (minimum 50 mm lay of twist), 100% shielded pairs and shall have 300 volt insulation. Each pair shall have a 20 AWG tinned-copper drain wire and individual overall pair insulation.
- I. Transformers shall be UL 1585 approved and shall be sized so that the connected load is no greater than 80% of the transformer rated capacity.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Site: The contractor shall assist in coordinating space conditions to accommodate the work of each trade where work will be installed near or will possibly interfere with work of other trades. If installation with coordination causes interference with work of other trades, the contractor shall correct conditions without extra charge.
 - a. Coordinate and schedule work with work in the same area and with work that is dependent upon other work to facilitate mutual progress.
- B. Coordination with other controls specified in other sections or divisions: Other sections and/or division of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. The contractor shall coordinate his/her integration of these devices as follows.
 1. Each supplier of a controls product is responsible for the configuration, programming, start-up and testing of that product to meet the sequence of control.
 2. The contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this section and those provided under other sections or divisions of this specification.
 3. The contractor is responsible for providing all controls described in the Contract Documents regardless of where within the Contract Documents these controls are described.

4. The contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the Contract Documents.

C. Site Meetings

1. The project manager shall attend a weekly site coordination meeting that will be attended by all of the contractors involved in the project.
2. The contractor shall allocate at least 2 hours per week for this meeting.

3.2 EXAMINATION

- A. Verify that power supply is available to control units and operator workstation.
- B. Verify existing conditions before starting work. The beginning of installation implies that the contractor accepts the existing conditions.
- C. Verify that duct-mounted, pipe-mounted, and equipment-mounted devices are installed before proceeding with installation.
- D. The contractor shall thoroughly examine the project plans for control device and equipment locations, and any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.
- E. The contractor shall inspect the site to verify that equipment is installable as shown, and any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.
- F. The contractor shall examine the drawings and specifications and if head room or space conditions appear inadequate or if any discrepancies occur between the plans for work under this contract and the plans for the work of others, the discrepancies shall be reported to the Engineer and the contractor shall obtain written instructions for any changes necessary to accommodate the work under this contract with the work of others.

3.3 INSTALLATION

- A. Install equipment level and plumb.
- B. Install software in control units and operator workstations. 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 temperature sensors, humidity sensors, thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation.
 1. Install adjustable devices 48 inches above the floor.
 2. Install non-adjustable devices 60 inches above the floor.
 3. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- E. Install room thermostats where indicated on the drawings.
- F. Install guards on thermostats in the following locations:
 1. Entrances.
 2. Public areas.
 3. Where indicated.
- G. Install a minimum of one "unitary controller" in each mechanical equipment room.
- H. Connect manual reset limit controls, such as low limit thermostats, and high limit pressure controls, directly (hard-wired) to motor-starters (or variable speed drives). Connect limit controls to stop the fans or pumps in both the "Hand" and the "Auto" selector switch positions.
- I. Install automatic dampers according to Division 23 Section "Air Duct Accessories."

- J. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- K. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- L. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."
- M. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.
- N. Install fan inlet air flow measuring stations according to the manufacturer's instructions.
- O. Install duct mounted air flow measuring stations according to the manufacturer's instructions. Comply with manufactures mounting requirements to achieve specified instrument accuracy.

3.4 CONTROL VALVES, CONTROL DAMPERS AND ACTUATORS

- A. Control Valves:
 - 1. Control valves shall be installed by the Mechanical contractor.
 - 2. Coordinate with the Mechanical contractor and verify that each control valve can be serviced, including adjustment and removal of the actuator.
 - 3. All control valves shall have unions installed at each inlet and outlet to permit removal of the valve for servicing.
 - 4. Valves shall be installed with stems vertical where possible. Where space conditions require valves to be mounted with stems greater than 45° off vertical the actuator shall be externally supported. In no case will the control valve be mounted with the stem greater than 90° off of vertical.
- B. Control Dampers:
 - 1. Control dampers shall be installed by Mechanical contractor.
 - 2. Coordinate with the Mechanical contractor the service access requirements of the control dampers, and verify that each control damper can be serviced, including adjustment and removal of the actuator.
 - 3. Mechanical Contractor shall provide necessary blank-off plates required for installation of reduced-size dampers (dampers that are smaller than duct size).
 - 4. Furnish interconnecting hardware, linkages, etc. for installation of multiple section dampers by Mechanical Contractor.
 - 5. Control dampers installed in aluminum ducts shall be aluminum unless noted otherwise.
 - 6. Control campers installed in stainless steel ducts shall be stainless steel unless noted otherwise.

3.5 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Comply with all Division 26 Installation Requirements.
- B. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
- C. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- D. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."
 - 1. Wiring exposed to view or concealed in an inaccessible space: Run cabling within electric metallic tubing.
 - 2. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 - 3. Install exposed cable in raceway.

4. Install concealed cable in raceway.
 5. Bundle and harness multi-conductor instrument cable in place of single cables where several cables follow a common path.
 6. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 7. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 8. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
 9. Provide enclosures for terminal strips and similar devices.
 10. Cabling above accessible ceilings not supported by Cable Tray shall be supported via J-hooks every 4-feet to 5-feet and at every change in direction.
 11. Cabling may not be supported by or zip-tied to piping, ductwork, equipment, or similar.
- E. Refer to Mechanical Electrical Coordination Schedules for additional details on electrical information, disconnects, starters, controls, devices, interlocks and accessories.
- F. Provide low voltage interlock wiring between supply and exhaust fans, electrical wiring for relays for temperature and pressure indication.
- G. Provide wiring, conduit and connections for low temperature thermostats, high temperature thermostats, alarms, flow switches, actuating devices for temperature, humidity, pressure and flow indication, point resets and user disconnect switches for electric heating, appliances controlled by this Section.
- H. Provide all other wiring required for the complete operation of the specified systems.
- I. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- J. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.
- K. Install power supply wiring in addition to, or different from electrical power supply wiring specifically shown on the electrical drawings. Include disconnects and required electrical devices. Power supply wiring for controls will extend from separate circuits on emergency power panels located as indicated on the electrical drawings.
- L. Install control wiring between field-installed sensing and control devices' controlled equipment and unit control panels. Include disconnects and required electrical devices.
- M. Install interlock wiring between electrically-operated equipment units, and between equipment and field installed control devices in addition to, or different from, interlock wiring specifically shown on the electrical drawings.
- N. Where required install all wiring raceway systems complying with the requirements of the National Electrical Code. All required conduit shall be installed in EMT.
- O. Provide electrical disconnecting means for servicing, for each control panel, digital controller, transformer, power supply, and other devices that are served by 120VAC or higher voltage.
- P. Enclosures shall be fabricated of 14ga. steel with sub-panels for component mounting and have removable, hinged doors. Enclosures shall be sized to house the controllers, power supplies, transformers, wire duct and miscellaneous equipment required to support the application. Enclosures shall be provided for all controllers that are not located within an OEM provided mechanical equipment or on a VAV box. Control panels shall be fabricated as UL-508A listed assemblies.
- Q. Input/Output Control Wiring
1. Wiring shall be minimum number 18 wire gauge, stranded, twisted pair, shielded.
- R. Conduit and Fittings

1. Conduit for Control Wiring, Control Cable and Transmission Cable: Electrical metallic tubing (EMT) with compression fittings, cold rolled steel, zinc coated or zinc-coated rigid steel with threaded connections.
 2. Outlet Boxes (Dry Location): Sheradized or galvanized drawn steel suited to each application, in general, four inches square or octagon with suitable raised cover.
 3. Outlet Boxes (Exposed to Weather): Threaded hub cast aluminum or iron boxes with gasket device plate.
 4. Pull and Junction Boxes: Size according to number, size, and position of entering raceway as required by National Electrical Codes. Enclosure type shall be suited to location.
 5. Install low voltage power, input/output and network communication trunks in conduit in the following locations regardless of local building code allowances otherwise.
 - a. Mechanical rooms.
 - b. Electrical rooms.
 - c. Vertical risers (exception: fire rated continuous closet like a telephone closet).
 - d. Open Areas where the wiring will be exposed to view, tampering, or accidental damage.
 - e. Enclosed or inaccessible locations such as wall cavities.
 6. Conceal conduit within finished shafts, ceilings and wall as required. Install exposed conduit parallel with or at right angles to the building walls.
- S. Where Class 2 wires are in concealed and accessible locations including ceiling return air plenums, approved cables not in raceway may be used provided that:
1. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)
 2. All cables shall be UL listed for application, i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose.
- T. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).
- U. Where Class 2 wiring is run exposed, wiring to be run parallel along a surface or perpendicular to it, and neatly tied at 3m (10 ft.) intervals.
- V. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to-wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- W. Plug or cap all unused conduit openings and stub-ups. Do not use caulking compound.
- X. Route all conduit to clear beams, plates, footings and structure members. Do not route conduit through column footings or grade beams.
- Y. Set conduits as follows:
1. Expanding silicone fire stop material sealed watertight where conduit is run between floors and through walls of fireproof shaft.
 2. Oakum and lead, sealed watertight penetration through outside foundation walls.
- Z. Cap open ends of conduits until conductors are installed.
- AA. Where conduit is attached to vibrating or rotating equipment, flexible metal conduit with a minimum length of 18 inches and maximum length of 36 inches shall be installed and anchored in such a manner that vibration and equipment noise will not be transmitted to the rigid conduit.
- BB. Where exposed to the elements or in damp or wet locations, waterproof flexible conduit shall be installed. Installation shall be as specified for flexible metal conduit.

- CC. Provide floor, wall, and ceiling plates for all conduits passing through walls, floors or ceilings. Use prime coated cast iron, split-ring type plates, except with polished chrome-plated finish in exposed finished spaces.

3.6 FIELD EQUIPMENT ENCLOSURES

- A. Securely mount all control panels and enclosures to wall or structure using bolts, anchors, etc. Mount enclosures and control panels with top at 72 inches above finished floor, unless noted otherwise. Locate enclosures and control panels to ensure full door swing with a minimum of 3 feet clearance in front of cabinet.
- B. Wiring shall be installed in a neat and organized manner. Bundle cables and route cabling within enclosures using fingerduct or channel raceway. Route cables at 90 degree angles throughout the enclosure.
- C. Splicing of cabling using wirenuts is unacceptable. Cable splicing shall take place on screw termination blocks.
- D. Maintain the UL listed environmental rating of each control panel by using the correct fittings and hardware for conduit penetrations into enclosures.
- E. Locate enclosures indoors where possible.

3.7 IDENTIFICATION OF HARDWARE AND WIRING

- A. All wiring and cabling, including that within factory-fabricated panels shall be labeled at each end within 2" of termination with a cable identifier and other descriptive information.
- B. Permanently label or code each point of field terminal strips to show the instrument or item served.
- C. Identify control panels with nameplates.
- D. Identify all other control components with permanent labels. Identifiers shall match record documents.
- E. Identify room sensors relating to terminal box or valves.
- F. Provide j-box covers that are color coded for Building Automation / Controls. Coordination color standard/preference with the Owner. The color shall be blue if the Owner has no preference or standard.

3.8 ACCESS DOORS

- A. Mechanical Contractor shall provide access doors or other approved means of access through ducts for service to control equipment.

3.9 CLEANING

- A. The contractor shall clean up all debris resulting from his or her activities daily. The contractor shall remove all cartons, containers, crates, etc. under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a location designated by the Construction Manager or General Contractor.
- B. At the completion of work in any area, the Contractor shall clean all of his/her work, equipment, etc., making it free from dirt and debris, etc.
- C. At the completion of work, all equipment furnished under this Section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any metal cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.10 PROTECTION

- A. The Contractor shall protect all work and material from damage by his/her work or workers, and shall be liable for all damage thus caused.
- B. The Contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The Contractor shall protect his/her work against theft or damage, and shall carefully store material and equipment received on-site that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.11 FIELD QUALITY CONTROL

- A. All work, materials and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this Section.
- B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship. All visible piping and/or wiring runs shall be installed parallel to building lines and properly supported.
- C. Contractor shall arrange for field inspections by local and/or state authorities having jurisdiction over the work.
- D. Manufacturer's Field Service: Engage a factory service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- E. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 - 2. Test and adjust controls and safeties.
 - 3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 - 4. Test each point through its full operating range to verify that safety and operating control set points are as required.
 - 5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 - 6. Test each system for compliance with sequence of operation.
 - 7. Test software and hardware interlocks.
- F. De-activate all occupied / unoccupied settings, set-back etc. functions during start-up and testing activities. Re-activate these functions as directed by the Owner's representative during Owner training activities.
- G. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.12 VALIDATION

- A. The contractor shall furnish all labor and test apparatus required to execute a start up testing plan. Key tasks to be executed and documented in the start up testing report include:
 - 1. Verification of all primary and secondary voltages.
 - 2. Verification that power wiring for all devices conforms to manufacturer's instructions.
 - 3. Verification that all labeling is in place.
 - 4. Inspection of wiring for loose strands and tight connections.
 - 5. Analog sensors calibrated with high quality instrumentation suitable for the sensor being calibrated.

- a. The instruments shall display a current (12 month) NIST traceable calibration sticker. Associated instrument calibration certificates shall be made available within 24 hours of a request.
 - b. The measured value, reported value, and the calculated offset that was entered into the database shall be recorded.
 - c. The calibration criteria shall be:
 - 1) Space Temperature: +/- 0.5 degrees F
 - 2) Air Temperature: +/- 0.5 degrees F
 - 3) Fluid Temperature: +/- 0.5 degrees F
 - 4) Air Flow Rate: +/- 5 %
 - 5) Liquid Flow Rate: +/- 5 %
 - 6) Differential Pressure: +/- 3 %
 - 7) Gauge Pressure: +/- 5%
 - 8) Relative Humidity: +/- 3 % relative humidity
 - 9) CO2: +/- 2 %
- B. Validation report: The validation report shall include all testing activities and test reports.
- C. Entire automatic control system / building automation system including graphical user interface (GUI) shall be complete and fully functional prior to any inspections, demonstrations or acceptance testing including punch list activities.

3.13 ADJUSTING

- A. Calibrating and Adjusting:
1. Calibrate instruments.
 2. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
 3. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- B. Adjust initial temperature and humidity set points.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.14 DEMONSTRATION

- A. General: Acceptance of the control system depends in part upon successful demonstration of control system performance:
1. Sequence of Operation - Demonstrate all sequences of operation.
 2. Test Documentation - Provide standard formatted documentation for each controlled system and element test.
 3. Pre-Testing - The control system installer shall have performed pre-testing of all tests on all components before final testing. If during final testing more than 10 percent of the points or sequences checked are found to be faulty, the Contractor shall halt the test and re-check all parts of the system test.
- B. Testing - Inform the Engineer and Owner of all test dates for attendance, so that the Engineer and/or Owner may attend the test if desired. Perform all tests. Correct all system maladies found in the testing procedure. Retest as required. If Owner's representative does not witness test, provide performance certification.

- C. Acceptance- The control systems will not be accepted as meeting the requirements of Completion until all tests described in this specification have been performed to the satisfaction of both the Engineer and Owner. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the completion requirements if stated as such in writing by the Owner's representative.
- D. Engage a factory service representative to demonstrate, to the owner and engineer, that all system components have been calibrated and adjusted and are functioning properly.
- E. Engage a factory 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' dedicated instructor time on-site.
 - 3. Review data in maintenance manuals. Refer to Division 1 Section "Closeout Submittals."
 - 4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

3.15 TRAINING

- A. Meet all applicable Training requirements of Division 1, Division 21-23, and the following:
 - 1. Provide training for the Owner's building personnel in procedures for start-up, testing and operating the Automatic Control System.
 - 2. During the startup phase of the installation, and when acceptable performance of the overall system's hardware and software has been established. The contractor will provide on-site operator instruction for the Owner's operating personnel.
 - 3. Instruct the operators how to accomplish control of the system. Include basic troubleshooting and override of equipment and controls in the event of system failure. Operator instruction about the automatic control system will include, but not be limited to:
 - a. the overall operational program, equipment functions (both individually and as part of the total integrated system), commands, system generation, advisories, and appropriate operator intervention required in responding to the automatic control system operation, a description of the chronological information flow from field sensors, contacts and devices and an overview of the automatic control system communication network explaining the interplay between initiating devices, field data-gathering panels, trending logs and report generation, system communications and their importance within the operating system
 - 4. Provide on-site operator instruction during normal working hours. Instruction will be performed by experienced factory trained technical representatives familiar with the overall system's software, hardware and accessories. Provide a minimum of forty (40) hours of total on-site training for three (3) of the Owner's designated operating personnel in a minimum of three sessions scheduled on three separate dates. The last session shall be scheduled for 6-9 months after final acceptance.
 - a. Additional training shall be available for purchase and attendance by the Owner or designee. This additional training shall be of the same curriculum as the training courses provided by the manufacturer to the System Integrator. An advanced manufacturer-certified instructor shall give all training classes. A list of training courses and the associated cost shall be provided as part of the BAS submittals.
 - 5. Training Manuals: Include the following in training manuals.
 - a. Manufacturer's training brochures.
 - b. Operation and maintenance manuals.
 - c. Completed Field Acceptance Test Procedure.
 - d. "As-installed" Drawings.
 - e. Manufacturer's Operation Manuals.

- f. Software interaction sheets to be used in instructing students how to use the control system, on a command-by-command basis.
- 6. Training Classes: Prior to conducting training, prepare and submit for approval the proposed training literature and topics. Submit this information at least two weeks prior to the first class.
- 7. Provide approved training manuals to the Owner at least one week prior to the first class.
- 8. Provide multimedia Tutorials both in a USB drive format and on the manufactures website instructing on the operation of the programming software tools as provided under this specification.
 - a. As part of the training deliverable provide short video clips (each clip shall be a file) of various procedures such as but not limited to the following: Changing a Set point, Making Schedule Adjustments, Modifying Holiday Schedules Adding Special Events, Creating a Backup of the Database Running on the Supervisor, Adding a Schedule to the Database and Linking the Schedule to a Piece of Equipment, Adding a new Schedule to the Graphical User Interface, Using History Chart Builder to Save Your Trends on the Supervisor, Adding a Point on the supervisory controller to the Existing System, Adjusting the Value of a Point that has been Added to the System, Adding ModBus Points (if applicable) and/or Controllers to a supervisory network.
 - b. Video files shall be accessible thru the terminal in such a manner to allow for viewing in order to perform such changes on the BAS.

3.16 SERVICE AND SPARE PARTS

- A. After the warranty period, the controls contractor shall provide service on hardware and software components with technical staff located in a local service office.
- B. All service items and spare parts shall be available from the manufacturer or Contractor's stock for a minimum of seven (7) years following the expiration of the warranty period.

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SECTION 230993 SEQUENCE OF OPERATION FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes control sequences for HVAC and plumbing systems, subsystems, and equipment.
 - 1. Temperature and pressure set points listed shall be adjustable.
 - 2. Provide the building automation system operator with manual over-ride for automatic control valves and dampers. The over-ride shall allow the operator to command open or close valves and dampers.
- B. Related Sections include the following:
 - 1. Division 23 Section "Instrumentation and Control for HVAC" for control equipment and devices and for submittal requirements.

1.3 DEFINITIONS

- A. Air terminal damper open: The damper will open to the scheduled maximum air flow.
- B. Damper or valve full open: Damper or valve will be 100 percent open.
- C. Modulate: Proportionally position.
- D. Set points: Set points will be operator adjustable unless noted as fixed.
- E. Temperature: Air and liquid temperatures are in degrees F.

1.4 TIME SCHEDULE

- A. HVAC equipment will be scheduled for occupied and unoccupied status. Occupancy Schedule to be set based on individual zone requirements as coordinated with owner.
- B. Zone thermostats shall have local occupied override with adjustable time delay to return to unoccupied mode.

1.5 GEOTHERMAL WATER PUMP CONTROL SEQUENCES

- A. Pump: Integral pump logic controller shall start, unload, stop, alternate (lead/stand-by) pumps. Controller will adjust variable speed drive to maintain external differential pressure of system.
 - 1. Pump shall be enabled as commanded by heat pump systems.
 - 2. Alternate pumps per start-up.
 - 3. Failure of lead pump shall enable stand-by pump and enable local alarm at unitary controller.
 - 4. Unitary Controller Display:
 - a. Operating status on/off(s).
 - b. Pump motor speed: Hz
 - c. Pump Flow: GPM.
 - d. Water pressure indication.
 - e. Water pressure set point.
 - f. Water Supply Temperature.
 - g. Warning Lights

1.6 ENERGY RECOVERY VENTILATION SEQUENCES

- A. Enable ERV when associated heat pump(s) (HP-1, HP-2) is in occupied mode.
- B. Outside Air Damper: The normally closed outside air damper will be modulated open to minimum position by ERV enable and single HP enable. Modulate to maximum position by both HP enable.
- C. Relief Air Damper: The normally closed outside air damper will be modulated open to minimum position by ERV enable and single HP enable. Modulate to maximum position by both HP enable.
- D. Supply Fan: The supply fan will be modulate to low speed with minimum damper position and high speed with maximum damper position to maintain specified minimum and maximum airflow.
- E. Exhaust Fan: The supply fan will be modulate to low speed with minimum damper position and high speed with maximum damper position to maintain specified minimum and maximum airflow.
- F. Frost Prevention: Timed Exhaust shall be provided for frost control of the energy core.

1.7 TERMINAL UNIT OPERATING SEQUENCES

- A. Radiators and Convectors, Electric:
 - 1. Room Temperature: An electronic sensor will indicate space temperature; the control system will enable electric heating element to maintain the space temperature set point.
 - 2. Initial set point 65°F (adj.).
- B. Heat Pump Unit Control Sequences
 - 1. Description: Variable capacity water source heat pump unit with the following components: ECM - Variable Speed Blower, Variable Capacity Compressor, Integral Unitary Controller. Occupancy Schedule to be set based on individual zone requirements as coordinated with owner.
 - 2. Ventilation Control:
 - A. Minimum Position: Open the normally closed outside air damper to its minimum position 30 seconds after system startup.
 - B. Interlock outside air damper to be open with heat pump occupied mode enable.
 - C. Outside air damper shall be closed when system is unoccupied.
 - 3. Electronic space thermostat will provide input for unitary controller to modulate fan speed, compressors, reversing valve, and hot gas reheat as necessary to maintain space temperature control after pump operation is enabled.
 - A. Space thermostat shall be used to maintain occupancy schedule.
 - 4. Fan operation:
 - A. Fan speed adjustment.
 - B. Modulate fan as required to accommodate heating or cooling demand.
 - 5. Initial space temperature set points
 - A. Occupied Temperature (cooling): 75 degrees F (adj.).
 - B. Occupied Temperature (heating): 72 degrees F (adj.).
 - C. Unoccupied Temperature (cooling): 85 degrees F (adj.).
 - D. Unoccupied Temperature (heating): 65 degrees F (adj.).
 - 6. Dehumidification: Hot gas reheat shall be used to maintain space temperature during dehumidification mode. Maintain leaving air temperatures above wet bulb between 60% RH (adj.) and 40% (adj.).

PART 2 - PRODUCTS

PART 3 - EXECUTION

END OF SECTION

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SECTION 232113 HYDRONIC PIPING

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 pipe and fitting materials and joining methods for the following:
 - 1. Geothermal Loop-Water piping.
 - 2. Condensate-drain piping.
 - 3. Safety-valve-inlet and -outlet piping.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Chemical treatment.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

1.6 COORDINATION

- A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate pipe sleeve installations for foundation and exterior wall penetrations. Coordinate with requirements specified in Division 7 Sections for sealing pipe penetrations through exterior and foundation walls.
- C. Coordinate pipe fitting pressure classes with products specified in related Sections.
- D. Coordinate power requirements for hydronic specialties with Division 26 installer.
- E. Coordinate the installation of hydronic control devices with Section 230900 "Instrumentation and Controls for HVAC".

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
 - 1. Geothermal Loop-Water Piping: 125 psig at 150 degrees F.
 - 2. Condensate-Drain Piping: 150 degrees F.
 - 3. Air-Vent Piping: 200 degrees F.
 - 4. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide copper tubing and fittings manufactured by one of the following:
 - a. Cambridge-Lee Industries Incorporated.
 - b. Cerro Flow Products Incorporated.
 - c. Mueller Industries Incorporated.
 - d. Nibco Incorporated
- B. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- C. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- D. DWV Copper Tubing: ASTM B 306, Type DWV.
- E. Wrought-Copper Unions: ASME B16.22.

2.3 STEEL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide steel pipe manufactured by one of the following:
 - 1. American Steel Pipe; Division of American Cast Iron Pipe Company.
 - 2. Central Steel and Wire Company.
 - 3. LaBarge Pipe and Steel Company.
- B. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.
- C. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.
- D. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.
- E. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.
- F. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.
- G. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- H. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt welding.
 - 3. Facings: Raised face.
- I. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- E. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.5 BYPASS CHEMICAL FEEDER

PART 3 EXECUTION

3.0 PIPING APPLICATIONS

- A. Geothermal Loop-water piping, aboveground, NPS 2 and smaller, shall be any of the following:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 - 2. Schedule 40, Grade B, Type 96 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
- B. Geothermal Loop-water piping, aboveground, NPS 2.5 and 3, shall be any of the following:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 - 2. Schedule 40 steel pipe, wrought-steel fittings, wrought-cast or forged-steel flanges, flange fittings, and welded and flanged joints.
- C. Geothermal Loop-water piping, aboveground, NPS 4 and larger shall be the following:
 - 1. Schedule 40 steel pipe, wrought-steel fittings, wrought-cast or forged-steel flanges, flange fittings, and welded and flanged joints.
- D. Geothermal Loop-water piping, below ground, refer to Section 23 79 05.
- E. Makeup-water piping installed aboveground shall be the following:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- F. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- G. Air-Vent Piping:
 - 1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
 - 2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.
- H. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

3.1 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- N. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- O. Install valves according to Section 230523 "General-Duty Valves for HVAC Piping."
- P. Install unions in steel piping, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- R. Install shutoff valve immediately upstream of each dielectric fitting.
- S. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.
- T. Install sleeve seals for piping penetrations of concrete slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."
- V. Install drain traps for each condensate drain pan for cooling coils in air handling units and heat pump units. Provide vented water seal and terminate with a turned-down elbow at a floor drain.

3.2 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or flanges.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

3.3 HANGERS AND SUPPORTS

- A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
- C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/4: Maximum span, 7 feet.
 - 2. NPS 1: Maximum span, 7 feet.
 - 3. NPS 1-1/2: Maximum span, 9 feet.
 - 4. NPS 2: Maximum span, 10 feet.
 - 5. NPS 2-1/2: Maximum span, 11 feet.
 - 6. NPS 3 and Larger: Maximum span, 12 feet.
- D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 - 4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - 7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.

3.4 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- E. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
- F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.5 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."

3.6 CHEMICAL TREATMENT

- A. Fill systems indicated to have antifreeze or glycol solutions with deionized water and the following concentrations:
 - 1. Geothermal Loop-Water Piping: Minimum 25 percent propylene glycol.

3.7 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
 - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
 - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
 - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 - 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 - 3. Isolate expansion tanks and determine that hydronic system is full of water.
 - 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
 - 5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
 - 6. Prepare written report of testing.
- C. Perform the following before operating the system:
 - 1. Open manual valves fully.
 - 2. Inspect pumps for proper rotation.
 - 3. Clean all strainers.
 - 4. Set makeup pressure-reducing valves for required system pressure.
 - 5. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
 - 6. Set temperature controls so all coils are calling for full flow.
 - 7. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
 - 8. Verify proper chemical treatment for each system.
 - 9. Verify lubrication of motors and bearings.

END OF SECTION

SECTION 232116 HYDRONIC PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes special-duty valves and specialties for the following:
 - 1. Geothermal Loop-water piping.
 - 2. Makeup-water piping.
 - 3. Condensate-drain piping.
 - 4. Safety-valve-inlet and -outlet piping.
 - 5. Air-vent piping.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
 - 2. Air-control devices.
 - 3. Hydronic specialties.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Differential Pressure Meter: For each type of balancing valve, include flow meter, probes, hoses, flow charts, and carrying case.

1.5 QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
 - 1. Geothermal Loop-Water Piping: 125 psig at 150 deg F.
 - 2. Makeup-Water Piping: 80 psig at 150 deg F.
 - 3. Condensate-Drain Piping: 150 deg F.
 - 4. Air-Vent Piping: 200 deg F.
 - 5. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 VALVES

- A. Check, Ball, and Butterfly Valves: Comply with requirements specified in Section 230523 "General-Duty Valves for HVAC Piping."

- B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 230900 "Instrumentation and Control for HVAC."
- C. Bronze, Calibrated-Orifice, Balancing Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Armstrong Pumps, Incorporated.
 - b. Bell & Gossett Domestic Pump.
 - c. Flow Design, Incorporated.
 - d. Gerand Engineering Co.
 - e. Griswold Controls.
 - f. Nibco, Inc.
 - g. Nexus Valve, Incorporated.
 - h. Oventrop Corporation.
 - i. Taco Incorporated.
 - j. Tour & Andersson; available through Victaulic Company.
 - 2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
 - 3. Ball: Brass or stainless steel.
 - 4. Plug: Resin.
 - 5. Seat: PTFE.
 - 6. End Connections: Threaded or socket.
 - 7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
 - 8. Handle Style: Lever, with memory stop to retain set position.
 - 9. CWP Rating: Minimum 125 psig.
 - 10. Maximum Operating Temperature: 250 deg F.
- D. Diaphragm-Operated Safety Valves: ASME labeled.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Amtrol, Incorporated.
 - b. Armstrong Pumps, Incorporated.
 - c. Bell & Gossett Domestic Pump.
 - d. Conbraco Industries, Incorporated.
 - e. Spence Engineering Company, Incorporated.
 - f. Watts Regulator Co.
 - 2. Body: Bronze or brass.
 - 3. Disc: Glass and carbon-filled PTFE.
 - 4. Seat: Brass.
 - 5. Stem Seals: EPDM O-rings.
 - 6. Diaphragm: EPT.
 - 7. Wetted, Internal Work Parts: Brass and rubber.
 - 8. Inlet Strainer: Stainless steel removable without system shutdown.
 - 9. Valve Seat and Stem: Noncorrosive.
 - 10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

2.3 FLOW MEASURING DEVICES

- A. Manufacturers:
 - 1. Calibrated Balancing Valves
 - a. Gerand Engineering Company.
 - b. Griswold Controls.
 - c. Hays Fluid Controls.
 - d. Flow Design, Incorporated.
 - e. Taco, Incorporated.
- B. Venturi:
 - 1. Description: Differential-pressure-design flow-element.

2. Construction: Cast-brass 2 inches and smaller, (Steel 2-1/2 inches and larger) flow element body, brass nipples, brass ball valves and push-type disconnect for connection to a differential pressure meter; threaded or flanged ends.
3. Calibrated Nameplate: Chained metal tag with element size, location, GPM, and differential pressure at design flow condition.
4. Permanent Head Loss: Not more than 25 inches w.g.
5. Pressure Rating: 250 psig.
6. Temperature Rating: 250 deg.
7. Accuracy: Plus or minus 1.0 percent.

2.4 AIR-CONTROL DEVICES

A. Manual Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Amtrol, Incorporated.
 - b. Armstrong Pumps, Incorporated.
 - c. Bell & Gossett Domestic Pump.
 - d. Nexus Valve, Incorporated.
 - e. Taco, Incorporated.
2. Body: Bronze.
3. Internal Parts: Nonferrous.
4. Operator: Screwdriver or thumbscrew.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/8.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Amtrol, Incorporated.
 - b. Armstrong Pumps, Incorporated.
 - c. Bell & Gossett Domestic Pump.
 - d. Nexus Valve, Incorporated.
 - e. Taco, Incorporated.
2. Body: Bronze or cast iron.
3. Internal Parts: Nonferrous.
4. Operator: Noncorrosive metal float.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/4.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 240 deg F.

C. Bladder-Type Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Amtrol, Incorporated.
 - b. Armstrong Pumps, Incorporated.
 - c. Bell & Gossett Domestic Pump.
 - d. Taco, Incorporated.
2. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

D. Micro-Bubble -Type Air Separators:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Spirovent

- b. Thrush Aar-O-Vent (www.thrushco.com)
- c. Bell & Gossett Domestic Pump
- 2. Tank: Welded steel; ASME constructed and labeled for 150-psig maximum working pressure and 270 deg F maximum operating temperature.
- 3. Air Collector: Woven copper wire attached to copper tubes, constructed to direct released air through the automatic air vent.
- 4. Automatic Air Vent: Integral.
- 5. Manual air vent: Integral.
- 6. Tangential Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
- 7. Blowdown Connection: Threaded.
- 8. Size: Match system flow capacity.

2.5 GLYCOL

- A. Glycol Solution:
 - 1. Minimum 25% propylene glycol and deionized water.
 - 2. Glycol Manufacturer: Dow Chemical DowFrost* or approved equivalent.
 - 3. Glycol Product used in the building piping and geothermal borefield must be the same manufacturer and product.
 - 4. The heat transfer fluid shall be mixed to meet a propylene glycol concentration of 25% by volume and only de-ionized water may be used for dilution of the fluid. The final mixed fluid freezing ("slush") point shall be no greater than +14°F.
 - 5. The fluid must be approved by the State of Wisconsin Department of Natural Resources for the application of ground-coupled closed-loop geothermal heat exchange systems.
 - 6. Industrially inhibited (phosphate-based) propylene glycol-based heat transfer fluid designed to provide freeze protection below -60 deg. F. Inhibitors specifically formulated to keep piped free from corrosion without fouling.
 - 7. Fluid must pass ASTM D1384 and have a reserved alkalinity of at least 15.
 - 8. All fluid introduced into the system must be of the exact same manufacturer, product type, and concentration. This includes applying to instances where fluid is provided to the system under different scopes of work (for example, geothermal and mechanical) and/or at different times of the project where the fluids will come into direct contact and mix when the work is connected into one system.

2.6 AUTOMATIC GLYCOL FEED EQUIPMENT (LARGE SYSTEMS)

- A. General: Prefabricated, automatic and autonomous hydronic glycol system make up package capable of producing 1.8 GPM at 70 psig to glycol system(s). With controls to automatically maintain hydronic system fill pressure.
- B. Equipment Tags: Applies to Glycol Fill Pumps.
- C. Manufacturer: Wessels Company.
- D. Model No.: GMP 13050.
- E. Chemical Solution Tank:
 - 1. Chemical-resistant reservoir fabricated from graduated polyethylene with removable lid mounted on a sturdy steel frame.
 - 2. Capacity: 50 gallon.
 - 3. Outlet valve with hose end connection.
- F. Chemical Solution Pump:
 - 1. Brass rotary vane pump mounted below solution tank on sturdy steel frame.
 - 2. 1/3 HP, 115v, fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- G. Controls:
 - 1. Magnetic starter.

2. Low water cut off alarm automatically shuts off pump and initiates audio and visual alarm.
3. Pressure tank with pressure control.
4. Pressure reducing valve.
5. Pressure gauge.
6. 110v signal for remote alarm.
7. System isolation valve on discharge side of pump.
8. Assembly Pressure/Temperature Rating: Minimum 125 psig at 160 deg F.

2.7 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Start-up Strainer Screen: 60-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

B. Water Filters:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Commercial Filters (Carborundum).
 - b. Pall Trinity Micro Corporation.
 - c. Dover Corporation/Ronningen-Peter Division
2. Housing: Carbon steel rated for 125 psig at 250 deg F. ASME pressure vessel stamp. Bottom drain connection. Floor mounting support stand.
3. Cover: Cast iron or steel bolted cover with "O" ring gasket. Positive seal on filter cartridge stack to minimize bypass.
4. Pipe Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
5. Filter Media: Three sets of disposable cartridge filters. Two capable of removing 98 percent of all solids 5 microns and larger in size and one capable of removing 98 percent of all solids 75 microns and larger in size. Suitable for temperatures up to 200 deg F and pressures up to 125 psig. Assembly to function properly with pressure differentials up to 75 psig.

C. Flexible Hose Connectors:

1. Manufacturers: Subject to compliance with requirements, provide corrugated metal, braided hose flexible connectors manufactured by one of the following:
 - a. Metraflex.
2. Description:
 - a. Flexible hose connectors shall be manufactured complete with section of corrugated metal hose, compatible braid, with inlet and outlet connections as required.
 - b. For flammable liquid or gas service up to 4 inches flexible hose connector shall be CSA/AGA certified.
 - c. Corrugated Hose
 1. Bronze.
 - d. Braid
 - 1) Bronze braid shall be used for any bronze hose.
 - e. Capable of 3/4 inch misalignment.
 - f. Maximum Operating Temperature: 250 deg F.
 - g. Fittings Materials of construction and end fitting type shall be consistent with pipe material and equipment/pipe connection fittings. Copper fittings shall not be attached to stainless steel hose.
 - h. Flexible hose connector(s) shall be rated with an operating pressure in accordance with the table below. The operating pressure shall be based on burst pressure with a 4 to 1 safety factor.
3. Pressure rating:
 - a. Flexible Hose Connector with Stainless Steel Hose:

	Working Pressure at 70 deg F	Working Pressure at 70 deg F
<u>Size</u>	<u>Single Braid</u>	<u>Double Braid</u>
1/2"	1100 PSI	1525 PSI
3/4"	792	1267
1"	571	914
1-1/4"	531	850
1-1/2"	472	755
2"	500	750
2-1/2"	387	600
3"	288	431
4"	232	371

PART 3 EXECUTION

3.1 VALVE APPLICATIONS

- A. Install shut-off duty valves at each branch connection to supply mains and at supply and return connections to each piece of equipment.
- B. Install calibrated balancing valves in the return pipe from all hydronic heat pump units with inlets 1-1/2 inches and smaller. Refer to drawing details for additional information.
- C. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- D. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.2 AUTOMATIC GLYCOL FEED EQUIPMENT INSTALLATION

- A. Install automatic glycol feed equipment level and plumb in accordance with manufacturers recommendations on concrete housekeeping pad.

3.3 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and as required for system air venting. Install manual air vents as indicated on the piping details. Use 3/8 inch ball valves for manual air vents on main piping and heat-transfer coils. Air vent valves shall be vertically mounted with a discharge tube curved 180 degrees.
- B. Install automatic air vents in mechanical equipment rooms only.
- C. Install micro-bubble air separator in pump suction. Install blow down piping with full-port ball valve; extend full size to nearest floor drain.
- D. Install side stream water filters in each hydronic system where indicated, in upright position with top not more than 48 inches above the floor. Install filter in bypass line with full-size, full-port, ball valves on inlet and outlet of filter housing. Install NPS 3/4 full port ball valve in drain and pipe to nearest floor drain.
 1. Install single pressure gage with multiple-input selector valve piped to inlet and outlet of each side stream filter.
- E. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above the floor. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.

- F. Install bladder type expansion tanks on the floor or suspended from the structure above as indicated on the drawings. Vent and purge air from hydronic system and ensure that tank is properly charged with air to suit system Project requirements.
 - 1. Install expansion tank isolation valve, manual air vent, and pressure gauge adjacent to tank pipe connection.
- G. Install strainers on inlet side of each pump, and elsewhere as indicated. Install nipple and ball valve on threaded strainer blowdown outlets and globe valve on flanged blowdown outlets. Blowdown valves shall be equal to the strainer threaded or flanged outlet connection size. Locate blowdown valve so it is orientated at the bottom of the strainer. Provide start-up screens in strainers and remove screens after start-up. Do not provide strainers in pump suction diffusers, provide wye-strainers upstream of suction diffusers.
- H. Install flexible corrugated braided hose connectors according to the manufacture's installation instructions. Provide flexible connectors for connection to pumps, chillers, and other vibration producing equipment.
- I. Flow measuring device: Install differential-pressure-type venturi's where indicated on the drawings with straight lengths of pipe upstream and downstream from element as prescribed by manufacturer's written instructions.

END OF SECTION

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SECTION 232123 HYDRONIC PUMPS

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. Separately coupled, horizontally mounted, in-line centrifugal pumps.

1.3 DEFINITIONS

- A. Buna-N: Nitrile rubber.
- B. EPT: Ethylene propylene terpolymer.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
- B. Shop Drawings: For each pump.
 - 1. Show pump layout and connections.
 - 2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
 - 3. Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.
- B. Startup Report.

PART 2 - PRODUCTS

2.1 SEPARATELY COUPLED, HORIZONTALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Armstrong Pumps Incorporated
 - 2. ITT Corporation; Bell & Gossett.
 - 3. TACO Incorporated.
 - 4. Grundfos Pumps Corporation.
 - 5. Approved Equal.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.
- C. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded companion-flange connections.
 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. For pumps not frequency-drive controlled, trim impeller to match specified performance.
 3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
 4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
 5. Pump Bearings: Permanently lubricated ball bearings
- D. Shaft Coupling: Molded-rubber insert with interlocking spider capable of absorbing vibration.
- E. Motor: Self-sensing variable speed electronically commutated motor and rigidly mounted to pump casing.
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - a. Enclosure: Totally enclosed, fan cooled.
 - b. Enclosure Materials: Cast iron.
 - c. Motor Bearings: Permanently lubricated ball bearings.
- F. Variable Frequency Drive:
- a. Integral programable VFD with display interface.
 - b. Automatic energy optimization features.
 - c. Controls pump speed to constant differential pressure.
- G. Refer to drawing schedules for capacities and characteristics:

2.2 AUTOMATIC CONDENSATE PUMP UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Beckett Corporation.
 2. Hartell Pumps Div.; Milton Roy Co.
 3. Little Giant Pump Co.
 4. Mepco, LLC.
- B. Description:
1. Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve.
- C. Electrical Connection:
1. 72-inch-minimum, electrical power cord with plug when located in an exposed space.
 2. Hard-wired when located above a ceiling. Cords with plug connections are not permitted above ceilings.
- D. Capacities and Characteristics:
1. Refer to mechanical Equipment Schedules.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- D. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.
- E. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and spring hangers with vertical-limit stop of size required to support weight of in-line pumps.
 - 1. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
 - 2. Comply with requirements for hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

3.3 ALIGNMENT

- A. Engage a factory-authorized service representative to perform alignment service.
- B. Comply with requirements in Hydronic's Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.
- C. Comply with pump and coupling manufacturers' written instructions.
- D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill base-plate with non-shrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 CONNECTIONS

- A. Where installing piping adjacent to pump, allow space for service and maintenance.
- B. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- D. Install check valve, calibrated balancing valve, and flow measuring device on discharge side of pumps.
- E. Install Y-type strainer and suction diffuser and shutoff valve on suction side of pumps.
- F. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

- G. Install single pressure gage with multiple-input selector valve piped to suction and discharge of pumps.
- H. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- I. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service and startup report.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping.
 - 4. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 - d. Verify fluid pH; do not operate pumps outside of the manufacturer's limitations.
 - 5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
 - 6. Start motor.
 - 7. Open discharge valve slowly.
 - 8. Measure water flow, gallons per minute, and include in startup report.
 - 9. Measure pump pressure, feet of head, and include in startup report.
 - 10. Measure motor amp draw; include in startup report.
- B. Startup reports shall indicate that items listed in this article have been completed and include required data.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION

SECTION 233113 METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Single-wall rectangular ducts and fittings.
 - 2. Single-wall round and flat-oval ducts and fittings.
 - 3. Sheet metal materials.
 - 4. Sealants and gaskets.
 - 5. Hangers and supports.
- B. Related Sections:
 - 1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
 - 2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 PERFORMANCE REQUIREMENTS

- A. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:
 - 1. Liners and adhesives.
 - 2. Sealants and gaskets.
- B. Sustainable Design Submittals:
- C. Shop Drawings:
 - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 2. Factory- and shop-fabricated ducts and fittings.
 - 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
 - 4. Elevation of top of ducts.
 - 5. Dimensions of main duct runs from building grid lines.
 - 6. Fittings.
 - 7. Reinforcement and spacing.
 - 8. Seam and joint construction.
 - 9. Penetrations through fire-rated and other partitions.
 - 10. Equipment installation based on equipment being used on Project.
 - 11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
 - 12. Hangers and supports, including methods for duct and building attachment, and vibration isolation.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
 2. Suspended ceiling components.
 3. Structural members to which duct will be attached.
 4. Size and location of initial access modules for acoustical tile.
 5. Penetrations of smoke barriers and fire-rated construction.
 6. Items penetrating finished ceiling including the following:
 - a. Luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings.
- B. Welding certificates.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
 - 1. Manufacturers:
 - a. Ductmate Industries, Incorporated.
 - b. Elgen Manufacturing.
 - c. McGill AirFlow Corporation.
 - d. MKT Metal Manufacturing.
 - e. Semco Incorporated.
 - f. Sheetmetal Connectors Incorporated.
 - g. Spiral Manufacturing Company.
 - h. Stamped Fittings Inc.
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Transverse Joints in Ducts Larger Than 60 in Diameter: Flanged.
- D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - 2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- D. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 2. Tape Width: 4 inches.
 3. Sealant: Modified styrene acrylic.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 7. Service: Indoor and outdoor.
 8. Service Temperature: Minus 40 to plus 200 deg F.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
- C. Water-Based Joint and Seam Sealant:
 1. Application Method: Brush on.
 2. Solids Content: Minimum 65 percent.
 3. Shore A Hardness: Minimum 20.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. VOC: Maximum 75 g/L (less water).
 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 8. Service: Indoor or outdoor.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Flanged Joint Sealant: Comply with ASTM C 920.
 1. General: Single-component, acid-curing, silicone, elastomeric.
 2. Type: S.
 3. Grade: NS.
 4. Class: 25.
 5. Use: O.
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- F. Round Duct Joint O-Ring Seals:
 1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.5 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Duct dimensions indicated on drawings are clear airway dimensions. Overall duct dimensions to be increased to account for duct liner thickness in order to maintain clear airway dimensions.
- C. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- D. Install ducts in maximum practical lengths.
- E. Install ducts with fewest possible joints.
- F. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- G. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- I. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- J. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- K. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- L. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.

- M. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

- A. Seal ducts at a minimum to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Outdoor, Supply-Air Ducts: Seal Class A.
 - 3. Outdoor, Exhaust Ducts: Seal Class C.
 - 4. Outdoor, Return-Air Ducts: Seal Class C.
 - 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
 - 6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
 - 7. Unconditioned Space, Exhaust Ducts: Seal Class C.
 - 8. Unconditioned Space, Return-Air Ducts: Seal Class B.
 - 9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
 - 10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
 - 11. Conditioned Space, Exhaust Ducts: Seal Class B.
 - 12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Do not attach to metal decks.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099000 "Painting."

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
- C. Maximum Allowable Leakage: Comply with requirements for Leakage Class 3 for ducts with a Duct Pressure Classification greater than 2-inches, and for Leakage Class 6 for ducts with duct pressure classification 2-inches or less.
 - a. For a duct section with 4-inch Duct Pressure Classification or greater and Duct Leakage Class 3, leakage shall not exceed 7.5 CFM per 100 sq. ft. of duct surface area.
 - b. For a duct section with a 2-inch Duct Pressure Classification and Duct Leakage Class 6, leakage shall not exceed 9.5 CFM per 100-sq. ft. of duct surface area.
 - c. For positive pressure exhaust ducts, leakage shall be zero at 4.0 inches wg.
- D. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.
 - 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- E. Duct system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

3.8 DUCT CLEANING

- A. Clean new and existing duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
 - 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
 - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 - 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
 - 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 - 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
 - 1. Air outlets and inlets (registers, grilles, and diffusers).
 - 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 - 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 - 4. Coils and related components.
 - 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
 - 6. Supply-air ducts, dampers, actuators, and turning vanes.
 - 7. Dedicated exhaust and ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:
 - 1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
 - 2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 - 3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
 - 4. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
 - 5. Provide drainage and cleanup for wash-down procedures.
 - 6. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.9 START UP

- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.10 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

1. Underground Ducts: Refer to specification Section 233116 "Nonmetal Ducts".
- B. Supply Ducts:
 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units.
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
 2. Ducts Connected to Variable-Air-Volume Air-Handling Units
 - a. Pressure Class: Positive 4-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 3.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.
 3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: 4-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 3.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.
- C. Return Ducts:
 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
 2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
 3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
- D. Exhaust Ducts:
 1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative: 2-inch wg.
 - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
 2. Ducts Connected to Air-Handling Units.
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
 3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 6.

- d. SMACNA Leakage Class for Round and Flat Oval: 6.
- E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
 - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
 - 2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
 - 3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
- F. Intermediate Reinforcement:
 - 1. Galvanized-Steel Ducts: Galvanized steel.
 - 2. Aluminum Ducts: Aluminum.
- G. Liner:
 - 1. Transfer Ducts: Fibrous glass, Type I, 1 inch thick.
- H. Elbow Configuration:
 - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 - 2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Radius-to Diameter Ratio: 1.5.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam or Welded.
- I. Branch Configuration:
 - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
 - 2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

- a. Velocity 1000 fpm or Lower: 90-degree tap.
- b. Velocity 1000 to 1500 fpm: Conical tap.
- c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION

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SECTION 233300 AIR DUCT 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. Manual volume dampers.
 - 2. Fire dampers.
 - 3. Turning vanes.
 - 4. Duct-mounted access doors.
 - 5. Flexible connectors.
 - 6. Flexible ducts.
 - 7. Duct accessory hardware.
 - 8. Fixed extruded-aluminum louvers
- B. Related Requirements:
 - 1. Section 283111 "Digital, Addressable Fire-Alarm System" for duct-mounted fire and smoke detectors.
 - 2. Section 283112 "Zoned (DC-Loop) Fire-Alarm System" for duct-mounted fire and smoke detectors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
 - 1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Fire-damper, including sleeves; and duct-mounted access doors
 - d. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers: Maximum velocity 1500 fpm.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Air Balance Incorporated; a Division of Mestek, Incorporated.
 - b. American Warming and Ventilating; a Division of Mestek, Incorporated.
 - c. Flexmaster U.S.A., Incorporated.
 - d. McGill AirFlow LLC.
 - e. Nailor Industries Incorporated.
 - f. Pottorff.
 - g. Ruskin Company.
 - h. Trox USA Incorporated.
 - i. Vent Products Company, Incorporated.
 - 2. Standard leakage rating, with linkage outside airstream.
 - 3. Maximum air velocity: 1500 fpm.
 - 4. Suitable for horizontal or vertical applications.
 - 5. Frames:
 - a. Frame: 5-inches wide, Hat-shaped, 0.064-inch- thick, galvanized sheet steel with reinforced corners.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 6. Blades:
 - a. Multiple or single blade.
 - b. 6-inches wide.
 - c. Parallel- or opposed-blade design.
 - d. Stiffen damper blades for stability.
 - e. Galvanized-steel, 0.064 inch thick.
 - 7. Blade Axles: ½-inch Galvanized steel.
 - 8. Bearings:
 - a. Molded synthetic.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axle's full length of damper blades and bearings at both ends of operating shaft.
 - 9. Tie Bars and Brackets: Galvanized steel.

2.3 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance Incorporated; a Division of Mestek, Incorporated.
 - 2. Arrow United Industries; a Division of Mestek, Incorporated.
 - 3. Cesco Products; a Division of Mestek, Incorporated.
 - 4. Greenheck Fan Corporation.
 - 5. Nailor Industries Incorporated.
 - 6. NCA Manufacturing, Incorporated.
 - 7. Pottorff.
 - 8. Prefco; Perfect Air Control, Incorporated.
 - 9. Ruskin Company.
 - 10. Vent Products Company, Incorporated.
- B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.
 - 1. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
 - 2. Fire Rating: 1-1/2 and 3 hours.
 - 3. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
 - 4. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 - a. Minimum Thickness: 0.064 thick, as indicated, and of length to suit application.
 - b. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
 - 5. Mounting Orientation: Vertical or horizontal as indicated.
 - 6. Blades: Roll-formed, interlocking, 0.064 thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
 - 7. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
 - 8. Heat-Responsive Device: replaceable link and switch package, factory installed, 165 deg F rated.

2.4 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Incorporated.
 - 2. Elgen Manufacturing.
 - 3. Sheetmetal Connectors Incorporated.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
 - 1. Vane Construction: Single and Double wall.
 - 2. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.5 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Warming and Ventilating; a Division of Mestek, Incorporated.
 - 2. Cesco Products; a Division of Mestek, Incorporated.
 - 3. Ductmate Industries, Incorporated.
 - 4. Elgen Manufacturing.
 - 5. Flexmaster U.S.A., Incorporated.
 - 6. Greenheck Fan Corporation.
 - 7. McGill AirFlow LLC.
 - 8. Nailor Industries Incorporated.
 - 9. Pottorff.
 - 10. Ventfabrics, Incorporated.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
 - 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
 - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges or Continuous and two sash locks.
 - c. Access Doors up to 24 by 48 Inches: Three hinges or Continuous and two compression latches with outside and inside handles.
 - d. Access Doors Larger than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.6 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flexmaster U.S.A., Incorporated.
 - 2. McGill AirFlow LLC.
 - 3. *ThermaFlex*
- B. Insulated-Flexible Duct: UL 181, Class 1, heavy-coated fiberglass cloth liner supported by helically wound, spring-steel wire. Fiberglass insulation R-4.2 with aluminized vapor barrier, permeability 0.2 perms or lower.
 - 1. Pressure Rating:
 - a. Sizes 2-inches to 10-inches: 16-inch wg positive and 1.0-inch wg negative.
 - b. Sizes 12-inches to 20-inches: 10-inch wg positive and 1.0-inch wg negative.
 - 2. Maximum Air Velocity: 5000 fpm.
 - 3. Temperature Range: Minus 20 to plus 250 Degrees
- C. Flexible Duct Connectors:
 - 1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2.7 DUCT ACCESSORY HARDWARE

1. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
2. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.8 FIXED EXTRUDED-ALUMINUM LOUVER

- A. Subject to compliance with specified requirement, provide Basis of Design or provide equivalent products by one of the following:
 1. Airolite Company
 2. Construction Specialties, Inc.
 3. Greenheck Fan Corporation
 4. Industrial Louvers, Inc.
 5. Nystrom Building Products.
 6. Ruskin Company; Tomkins PLC.
- B. Horizontal Drainable-Blade Louver, Extruded Aluminum:
 1. Basis of Design: Greenheck ESD-435
 2. Louver Depth: 4 inches.
 3. Free Area: Sized at max 1000 FPM at 1200 CFM.
 4. Point of Beginning Water Penetration: Not less than 950 fpm.
 5. Air Performance:
 - 1) Not more than 0.1-inch wg static pressure drop at 1000-fpm free-area exhaust velocity.
 6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install manual volume dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff. Install manual volume dampers as indicated on the Drawings and Details, and as necessary to accomplish system air balancing. As a minimum, manual volume dampers will be provided at every divided flow main or branch duct, at every branch duct take off, and every duct extending to individual register, grille, or diffuser. Manual volume dampers are not required upstream of variable volume air terminal units.
 1. Install steel volume dampers in steel ducts.
 2. Install remote damper operators for volume dampers located above gypsum board, plaster, and other hard ceilings.
 3. Set dampers to fully open position before testing, adjusting, and balancing.
- D. Install test holes at fan inlets and outlets and elsewhere as indicated.

- E. Install fire dampers according to manufacturer's UL-approved written instructions. Refer to the architectural drawings for fire rating requirements. Provide 1-1/2 hour rated fire dampers for wall and floor assemblies rated for 3 hours or less. Provide 3 hour rated fire dampers for wall and floor assemblies rated for more than 3 hours. Fire dampers will have 165-degree F links except as noted.
- F. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. At outdoor-air intakes and mixed-air plenums.
 - 2. Downstream from manual volume dampers, control dampers, and equipment.
 - 3. Adjacent to and close enough to fire dampers, to reset or reinstall fusible links. Access doors for access to fire dampers having fusible links shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - a. At each change in direction and at maximum 50-foot spacing.
 - b. Upstream and downstream from turning vanes.
 - c. Control devices requiring inspection.
 - 4. Install access doors with swing against duct static pressure.
 - 5. Access Door Sizes:
 - a. One-Hand or Inspection Access: 8 by 5 inches.
 - b. Two-Hand Access: 12 by 6 inches.
 - c. Head and Hand Access: 18 by 10 inches.
 - d. Head and Shoulders Access: 21 by 14 inches.
 - e. Body Access: 25 by 14 inches.
 - f. Body plus Ladder Access: 25 by 17 inches.
 - 6. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- G. Install flexible connectors to connect ducts to equipment.
- H. Installation of Flexible Ducts
 - 1. Install flexible ducts according to the manufacturer's instructions, applicable SMACNA standards, drawing details, and as follows:
 - a. Duct Collars: Provide tap-in collars 4-inches minimum in length with a formed bead 1-inch from the end for attachment of flexible duct. Extend minimum collar length for manual volume dampers.
 - b. Connections: Attach flexible duct to the tap-in collars and to sleeves with a duct clamp (draw band) around the inner liner and a second draw band around the insulation jacket. Position duct clamps behind the beads on the collar or sleeve. Duct clamps may be screwed stainless steel bands or nylon straps tightened with a compression tool.
 - c. Duct Supports: Support flexible duct at the manufacturer's recommended interval, but not less than every 5 feet. Maximum permissible sag is 1/2-inch per foot of spacing between supports (maximum of 1-1/4-inches over five feet).
 - d. Duct Hangers: Provide hanger straps in contact with the flexible duct at least 2-inch wide so the internal diameter of the duct is not reduced at the point of support.
 - e. Duct Bends: Make bends or turns in flexible ducts with not less than a one-duct diameter throat radius.
 - f. Connect diffusers, registers, grilles, and light troffer boots to low pressure ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place. Refer to drawing details for additional requirements.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Install duct test holes where required for testing and balancing purposes.
6. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION

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SECTION 233713 DIFFUSERS, REGISTERS, AND GRILLES

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. Rectangular and square ceiling diffusers.
 - 2. Linear slot diffusers.
 - 3. Fixed face grilles.
- B. Related Sections:
 - 1. Section 089116 "Operable Wall Louvers" and Section 089119 "Fixed Louvers" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
 - 2. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, mounting surface, border, frame, and accessories furnished.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 5. Duct access panels.
- B. Source quality-control reports.

1.5 COORDINATION

- A. Review the architectural drawings for diffuser, register, and grille mounting surfaces.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

- A. Rectangular and Square Ceiling Diffusers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Anemostat Products; a Mestek company.
 - b. Hart & Cooley Inc.
 - c. Krueger.
 - d. METALAIRE, Inc.
 - e. Nailor Industries Inc.
 - f. Price Industries.
 - g. Raymon
 - h. Titus.
 - i. Tuttle & Bailey.
2. Face Style: three cones.
3. Accessories: Refer to the drawings and equipment schedules for accessories.
 - a. Equalizing grid.
 - b. Plaster ring.

2.2 CEILING LINEAR SLOT OUTLETS

- A. Linear Slot Diffuser:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anemostat Products; a Mestek company.
 - b. Hart & Cooley Inc.
 - c. Krueger.
 - d. METALAIRE, Inc.
 - e. Nailor Industries Inc.
 - f. Price Industries.
 - g. Raymon
 - h. Titus.
 - i. Tuttle & Bailey.

2.3 REGISTERS AND GRILLES

- A. Adjustable Blade Register:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anemostat Products; a Mestek company.
 - b. Hart & Cooley Inc.
 - c. Krueger.
 - d. METALAIRE, Inc.
 - e. Nailor Industries Inc.
 - f. Price Industries.
 - g. Raymon.
 - h. Titus.
 - i. Tuttle & Bailey.
 2. Frame: Minimum 20 gauge steel.
 3. Mounting: Concealed.
 4. Damper Type: Adjustable opposed blade .
- B. Fixed Face Register:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anemostat Products; a Mestek company.
 - b. Hart & Cooley Inc.
 - c. Krueger.

- d. Nailor Industries Inc.
 - e. Price Industries.
 - f. Raymon.
 - g. Titus.
 - h. Tuttle & Bailey.
 2. Material: Steel.
 3. Finish: Baked enamel, white.
 4. Face Arrangement: Refer to register schedule.
 5. Core Construction: Refer to register schedule.
 6. Frame: Minimum 20 Gauge Steel.
 7. Mounting: Concealed.
 8. Damper Type: Adjustable opposed blade.
- C. Fixed Face Grille:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anemostat Products; a Mestek company.
 - b. Hart & Cooley Inc.
 - c. Krueger.
 - d. Nailor Industries Inc.
 - e. Price Industries.
 - f. Raymon.
 - g. Titus.
 - h. Tuttle & Bailey.
 2. Material: Steel.
 3. Finish: Baked enamel, white.
 4. Face Arrangement: Refer to grille schedule.
 5. Core Construction: Refer to grille schedule.
 6. Frame: Minimum 20 Gauge Steel.
 7. Mounting: Lay in.

2.4 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Provide the appropriate mounting frame or border for each diffuser register or grille location. Verify ceiling grid type for lay-in type inlets and outlets. Non-lay-in diffusers, registers, and grilles will have frames or borders for surface mounting.

3.2 INSTALLATION

- A. Diffuser, register, and grille sizes and locations are indicated on the drawings and schedules.
- B. Install diffusers, registers, and grilles level and plumb.

- C. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- D. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.
- E. Install equalizing grids on round neck ceiling diffusers with an inlet duct of less than one diameter in length.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 237219

FIXED PLATE AIR-TO-AIR ENERGY RECOVERY UNITS

PART 1 - GENERAL

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fixed-plate total heat exchangers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: For air-to-air energy recovery equipment.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
 - 2. Support location, type, and weight.
 - 3. Field measurements.
- B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-to-air energy recovery equipment to include in maintenance manuals.

1.6 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store products in a clean, dry place.
- B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.
- C. Handle products carefully to prevent damage, breakage, denting, and scoring. Do not install damaged products.
- D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.
 - 1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.

2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remove coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.
3. Replace installed products damaged during construction.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of air-to-air energy recovery equipment that fail in materials or workmanship within specified warranty period.
 1. Warranty Period for Fixed-Plate Total Heat Exchangers: 10 years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.
- C. ASHRAE Compliance:
 1. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
 2. Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat/Energy Exchangers."
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- E. Comply with ASTM E 84 or UL 723.

2.2 CAPACITIES AND CHARACTERISTICS

- A. Refer equipment schedules on drawings.

2.3 FIXED-PLATE TOTAL HEAT EXCHANGERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Mitsubishi Electric Sales Canada Incorporated (www.mitsubishielectric.ca).
 2. Dais Analytic Corporation
 3. DPoint Technologies Inc.
 4. Innergy Tech, Inc.
 5. Xetex (www.xetex-inc.com)
 6. Greenheck Fan Corporation
- B. Casing: Aluminum Galvanized steel.
- C. Drain Pan: Same material as casing, with drain connections on exhaust and supply side. Molded ABS covering bottom of case, with drain connections on exhaust and supply side.
 1. Comply with requirements in ASHRAE 62.1.
- D. Plates: Evenly spaced, sealed, and arranged for counter airflow.
 1. Plate Material and Coating: Chemically treated paper, or polymer on aluminum, with selective hygroscopicity, moisture permeability, and gas barrier properties.
- E. Bypass Plenum: Within casing, with gasketed face-and-bypass dampers having operating rods extended outside casing.
- F. Controls: Factory supplied programmable controller with integral display.

1. Normally closed outdoor air and relief air dampers to open to maintain minimum ventilation setpoint of connected heat pump units when heat pumps commanded ON. When both heat pumps commanded OFF outside air and relief air dampers to close.

G. Maximum Differential Pressure: Suitable for maximum 6-inch wg.

H. Maximum Temperature: Suitable for maximum 194 deg F

2.4 SOURCE QUALITY CONTROL

- A. AHRI 1060 Certification: Certified according to AHRI 1060.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine 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 electrical services to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fixed-plate heat exchangers so supply and exhaust airstreams flow in opposite directions.
1. Install duct access doors in both supply and exhaust ducts, both upstream and downstream, for access to heat exchanger. Access doors and panels are specified in Section 233300 "Air Duct Accessories."
- B. Install suspended units from structure with all-thread hanger rods spring hangers with vertical-limit stop. Hanger rods and attachments to structure are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- C. Install units with clearances for service and maintenance.
- D. Comply with requirements for ductwork specified in Section 233113 "Metal Ducts."

3.3 ELECTRICAL CONNECTIONS

- A. Connect wiring according to Section 260529 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 250526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
1. Operational Test: After electrical circuitry has been energized, start units to confirm proper water wash control and unit operation.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 3. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- B. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform > Perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Verify that shipping, blocking, and bracing are removed.
 3. Verify that unit is secure on mountings and supporting devices and that connections to electrical systems are complete. Verify that proper thermal-overload protection is installed.
 4. Verify water wash mechanism operation.
- B. Starting procedures for air-handling units include the following:
1. Energize water wash motor and verify proper operation of motor and water wash system.
 2. Measure and record motor electrical values for voltage and amperage.

3.7 ADJUSTING

- A. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.8 CLEANING

- A. After completing system installation and testing, adjusting, and balancing air-to-air heat recovery unit, and after completing startup service, clean unit to remove foreign material and construction dirt and dust.

3.9 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain fixed-plate air-to-air energy recovery units.

END OF SECTION

SECTION 237905 GEOTHERMAL HEAT EXCHANGER SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the requirements for installing the geothermal heat exchanger system including all underground vertical and horizontal piping, circuit header manifolds, drilling, earthwork, testing, flushing, filling, and all other work up to the point of connection to the building mechanical piping in order to provide a fully functioning geothermal heat exchanger system.
- B. The Contractor shall provide a base bid price for installing all required bores as shown on the drawings. The Contractor shall, if practical, integrate the test bore(s) into the geothermal field and provide a credit to the owner for the value of the bore(s). Identify the value of this credit to re-use the test bore(s) on the bid.

1.3 REFERENCES

- A. International Ground Source Heat Pump Association (IGSHPA): Closed Loop / Geothermal Heat Pump Systems Design and Installation Standards – 2017
- B. International Ground Source Heat Pump Association (IGSHPA): Grouting Procedures for Geothermal Heat Pump Systems – 2000
- C. American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE): Geothermal Heating and Cooling, Design of Ground-Source Heat Pump Systems – 2014
- D. American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE): 2019 ASHRAE Handbook – HVAC Applications, Chapter 35 Geothermal Energy
- E. Plastics Pipe Institute (PPI): Handbook of Polyethylene Pipe – 2nd Edition
- F. National Ground Water Association (NGWA): Guidelines for the Construction of Vertical Boreholes for Closed Loop Heat Pump Systems
- G. State of Wisconsin: NR 146 Water Well Driller, Heat Exchange Driller, and Pump Installer Licensing and Registration; Drilling Rig Operator Registration
- H. State of Wisconsin: NR 812 Well Construction and Pump Installation
- I. American Society of Testing and Materials (ASTM): D2610 Solid Wall HDPE Conduit Based on Controlled Outside Diameter
- J. American Society of Testing and Materials (ASTM): D2683 Socket Fusion Fittings
- K. American Society of Testing and Materials (ASTM): D3261 Butt/Saddle Fusion Fittings
- L. American Society of Testing and Materials (ASTM): D3350-93 Polyethylene Plastic Pipe and Fittings

1.4 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the minimum working pressure and temperature:
 - 1. Horizontal Geothermal Piping: 200 psig
 - 2. Vertical Geothermal Piping: 200 psig (net pressure based on internal minus external pressure)
 - 3. All Geothermal Piping: 24 to 105°F

1.5 ACTION SUBMITTALS

- A. The Contractor shall not fabricate or purchase materials or equipment until corresponding submittals have been approved by the Engineer.
- B. Clearly highlight or otherwise indicate which product(s) are being included in the project. Strike out language and/or diagrams that are not relevant to the project.
- C. Identify deviations, if any, from the requirements outlined by the Contract. When alternate products are proposed, provide a full analysis of cost impacts, schedule impacts, and other tradeoffs to the proposed alternate. Additional substitution procedures may apply according to the Contract.
- D. Shop Drawings and Product Data:
 - 1. Grout
 - 2. Vertical pipe and U-bend assemblies
 - 3. Horizontal pipe and fittings
 - 4. Manifold headers, valves, instruments, test ports, and other accessories
 - 5. Warning tape
 - 6. Locating wire and locating wire access points
 - 7. Heat transfer fluid
 - 8. Sand/bedding material
 - 9. Testing, flushing, and filling plan

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data:
 - 1. The Contractor shall not begin work until qualification data has been reviewed by the Engineer.
 - 2. The Contractor shall provide the names and addresses of 3 similar projects that each installation supervisor, including lead pipefitter(s) and lead driller(s), working on the project has experience within the last 5 years.
 - 3. For all pipefitting technicians performing heat fusion of pipe joints, submit a copy of the technician's fusion training certificate from IGSHPA or equivalent training organization.
 - 4. Submit a copy of the drilling personnel's certification as a Heat Exchange Driller from the State of Wisconsin.
- B. Permits:
 - 1. The Contractor shall not begin work until approved permits have been reviewed by the Engineer.
 - 2. Contractor shall contact all authorities having jurisdiction, including local unit of government, to confirm permit process and all approval conditions.
 - 3. Submit a copy of the approved Wisconsin Department of Natural Resources (WDNR) Bored Geothermal Heat Exchanger Construction Permit Application.
- C. Startup, Testing, and Flushing Results:
 - 1. Grout Sample Tests: Submit the thermal conductivity test results of grout mixture samples to the Engineer as they become available. Reports shall indicate the date the sample was taken, date the lab received the sample, date of the test, borehole the sample was taken from, and certification of results.
 - 2. Pressure Tests: Submit test records for the geothermal piping system prepared during pressure/leak testing, indicating date of test, identification of piping system tested, test media, test pressure, and the witness's signature of results.
 - 3. Flushing Results: Submit flushing records for the geothermal piping system indicating date of flushing, identification of piping system flushed, velocities achieved, final glycol concentration achieved, and the witness's signature of results.

1.7 CLOSEOUT SUBMITTALS

- A. Submit all closeout documents in accordance with this specification section and as required by the General Conditions sections of these specification documents.
- B. As-Built Drawings:

1. A clean, full size contract site plan shall be used by the Contractor to indicate field changes. All field changes are to be incorporated on the red-lined drawings in a timely fashion as they occur (pipe routing, bore locations, dimensions, sizes, notes, etc.). All changes must be shown clearly.
 2. The Contractor shall submit the completed red-lined drawings to the Engineer for review. Electronic versions (.dwg, .pdf) may be accepted in lieu of hard copy originals in the condition that they are legible.
 3. If the submitted red-lined drawings are found to be incomplete or inaccurate by the Engineer, the drawings shall be returned to the Contractor for corrections and resubmittal.
- C. Bore Log Data: Submit the following data for each vertical borehole in table form.
1. Borehole reference number
 2. Date drilled
 3. Depth drilled (and piped, if different)
 4. Quantity of grout used
 5. Surveyed GPS coordinates
 6. Bore pressure test results
- D. Warranty: Provide a copy of all warranties related to the geothermal system.
1. 100% Parts and Labor – The Contractor shall provide a 100% parts and labor warranty for the functional integrity of the outside piping system for a period of 5 years after date of Substantial Completion of the project, as determined by the Owner. The warranty shall state that the Contractor agrees to repair or replace pipe that fails in materials or workmanship within the warranty period.
 2. Piping – Provide a 50-year non-prorated warranty on piping materials, including fittings, both inside and outside the manifold header.

1.8 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms shall be regularly engaged in manufacture of geothermal heat exchanger products, including materials and sizes specified, for not less than 5 years.
- B. Contractor shall have a minimum of 5 years' experience of installing vertical geothermal heat exchangers for ground source heat pumps.
- C. Each on-site supervisor directly overseeing the geothermal work shall have been regularly employed by a company performing geothermal work for a minimum of 5 years.
- D. All pipefitting technicians performing heat fusion of pipe joints shall be certified by IGSHPA or equivalent training organization. Qualifying training requires that participants have performed heat fusion procedures under direct supervision of a qualified IGSHPA heat fusion technician, and have had formal training and testing at an IGSHPA approved heat fusion training session under direct supervision of an IGSHPA approved instructor.

1.9 PROTECTION

- A. Protect benchmarks, survey control points, existing structures, fences, sidewalks, paving and curbs from equipment and vehicular traffic.
- B. Protect above and below grade utilities that are to remain.
- C. Protect trees, shrubs, lawns, and other features designated to remain as final landscaping. Minimum protection shall consist of physical barriers to prevent damage to trees, plant growth, soil, and associated root systems. Soil compaction from vehicular traffic and construction activities shall be prevented.

1.10 SEQUENCING AND SCHEDULING

- A. The Contractor shall coordinate a Pre-Drilling Geothermal Construction Meeting before any work commences. The required participants of the Pre-Drilling Meeting include the Geothermal Design Engineer, the Geothermal Contractor, and the General Contractor. Additional parties shall be invited and may participate at their option, including any local and state regulatory representatives, the Owner and Owner's Representative(s), the Architect, the Civil Engineer, the Mechanical Engineer, the Site/Civil Contractor, and the Mechanical Contractor.
- B. Provide written notification of proposed date and time of all tests as required in this specification to the Engineer at least two (2) working days before starting each test. Failure to notify may result in the Engineer directing a new test.
- C. All flushing and testing work must be witnessed and signed off by the General Contractor's site superintendent, MEP coordinator, or quality-control agent.
- D. The geothermal field is not to be used for temporary heating or cooling of the facility during construction.

1.11 WATER, SILT, AND SOIL CONTAINMENT AND REMOVAL

- A. The Contractor shall meet all required local and state erosion control requirements, as well as all project-specific erosion control requirements detailed in the Contract.
- B. The Contractor shall generate a site erosion control plan. The site erosion control plan shall be approved by all regulatory agencies prior to any site work.
- C. The Contractor shall be responsible for containing and removing all water runoffs created by the vertical bore drilling and piping installation in accordance with the regulatory requirements. The contractor shall provide silt fence, silt socks, straw bales, berms, or other methods required to manage the water runoff.
- D. All drilled cuttings shall be removed from the site. Cuttings shall be placed into canvas-type bags or other containers for transport and proper disposal at the Contractor's expense.
- E. All excess excavated material shall be removed from the site, including but not limited to, drilling cuttings, asphalt and other surface materials, and uncompactable soils.

1.12 FORMATION THERMAL CONDUCTIVITY TEST RESULTS

- A. A vertical test bore was drilled by G.O. Loop of Fox Lake, WI on May 29, 2025. A Geothermal Resource Technologies (GRTI) test unit was attached on June 3, 2025. The formation thermal conductivity results and reported bore data are as follows:

- 1. Record Location Measured by GPS: N 45.06598°, W 87.12402°
- 2. Formation from Drill Log:

Geological Material	Depth (Ft)	
	From	To
Topsoil	0	2
Broken Limestone	2	10
Limestone	10	320
Shale	320	325

- 3. Drilling Notes
 - a. Drilling Method: Air rotary
 - b. Borehole Diameter: 6 inches
 - c. Casing: None
 - d. Other drilling notes and challenges: Numerous fractures were discovered during drilling throughout the limestone. This resulted in significant grout loss (30-40%) to the formation. Large flow rates of groundwater were produced from air-rotary drilling. Drilling stopped at the shale layer because it is anticipated that this confines a deeper aquifer that exists at a higher pressure, and it was desired to avoid possible upflow.

4. Piping Notes
 - a. 1-1/4 inch HDPE SDR 11 pipe with manufactured U-bend was installed.
 5. Grouting Notes
 - a. Grout mix used was thermally enhanced bentonite: 1400 lbs of bentonite (TG Lite), 462 lb graphite (PowerTEC), and 448 gallons of water.
 - b. Expected Grout Conductivity = 1.0 BTU/hr-ft-°F
 6. Estimated Formation Thermal Conductivity = 2.00 BTU/hr-ft-°F
 7. Estimated Formation Thermal Diffusivity = 1.34 ft²/day
 8. Estimated Undisturbed Soil Temperature = 49.4°F
- B. The Contractor is to review geological survey data and well construction logs recorded in the immediate area of the borefield to understand probable formation and drilling conditions. No allowances will be made for additional cost requests due to unforeseen geological formation conditions. Test bore information is to be used as a guide only.

PART 2 - PRODUCTS

2.1 PIPE & PIPE FITTING MATERIALS

- A. These pipe material specifications apply to the vertical heat exchanger piping, lateral circuit and main piping, and the manifold header piping.
- B. Pipe and pipe fittings shall be as manufactured by Centennial Plastics LLC, CB Supplies (formerly Vanguard Plastics Co.), Oil Creek Plastics, VersaProfiles, or Engineer-approved equivalent in accordance with these specifications.
- C. Pipe to comply with IGSHPA Standard 1C for polyethylene with a pipe material of PE4710 with cell classification of 445474C per ASTM D-3350. Pipe shall be manufactured to SDR 11 dimensions with a pressure rating of 200 psi when tested at 73°F according to ASTM D638. Pipe shall be marked with the manufacturer's name and product name, nominal size, ASTM dimensional standard, PPI material classification, cell classification, sequential footage and manufacturer's data code. Print line shall repeat every two feet.
- D. A 50-year non-prorated warranty must be provided by the pipe manufacturer.
- E. Fittings shall be compatible with the pipe material and from the same material as the pipes. Each fitting shall be identified with the manufacturer's name, nominal size, pressure rating, date of manufacturer and relevant ASTM standard (ASTM D2683 for socket fusion fittings and ASTM D3261 for butt/saddle fusion fittings).
- F. Joints shall be thermally fused per IGSHPA standards. No joints in vertical tubing other than factory installed U-bend with anti-buoyancy port.
- G. The piping and fittings shall be packaged, handled and stored in accordance with the approved manufacturer's general guidance and recommendations.
- H. The pipe and fitting manufacturer shall have in place a functional quality assurance program. Such QC/QA programs shall deal with quality and workmanship, QA verification, QA rejection, and have QA record retention systems in place.

2.2 SLEEVES & MODULAR WALL/FLOOR SEALS FOR PIPING

- A. Reference Section 230517 "Sleeves and Sleeve Seals for HVAC Piping" for geothermal pipe sleeve and seal requirements and schedule.

2.3 EXTRUDED POLYSTYRENE (XPS) RIGID FOAM BOARD INSULATION

- A. Extruded polystyrene (XPS) rigid foam board insulation shall meet standard specifications of ASTM C578-10 Classification Type VI.
 1. Compressive Resistance: 40 psi at yield or 10% deformation (whichever occurs first)
 2. Density: 1.8 lb/ft³
 3. Thermal Resistance: 5.0 hr-ft²-°F/BTU per inch of thickness (R-5.0 per inch)

4. Flexural Strength: 90.0 psi
5. Water Vapor Permeance: 1.1 perms per inch
6. Water Absorption: 0.3

- B. Available Products: Foamular 400 Extruded Polystyrene by Owens Corning Corporation, or approved equal.

2.4 THERMAL GROUT AND DRILLING FLUIDS

A. General Requirements:

1. All grout and drilling fluid products used shall meet all state and local regulatory requirements and conditions.
2. The grouting material shall be a thermally enhanced bentonite based grout (either Bentonite-Sand or Bentonite-Graphite) per the following specifications.
3. All grout and drilling fluid products used shall be approved by WDNR for the application of ground-coupled closed-loop geothermal heat exchange systems.
4. Provide the grout mix required to achieve the minimum thermal conductivity as indicated on the drawings. Refer to specific definitions and requirements below.
5. Water for grout mixtures shall meet the grout product manufacturer's requirements, but at the minimum have the following properties:
 - a. pH value between 5.0 and 9.0.
 - b. Dissolved salt less than 0.5 g/L.
 - c. Chlorine content less than 20 ppm.

B. Bentonite-Sand Grout Mixtures:

1. Bentonite product shall be a high-solids, thermally enhanced bentonite grout similar to TG Lite or TG Select manufactured by GeoPro, Inc. or approved equal.
2. A bentonite-sand grouting material shall have the following properties:
 - a. Thermal Conductivity of the minimum value shown on the drawings.
 - b. Permeability less than 1.0×10^{-7} cm/sec.
 - c. Percentage of Solids as specified by manufacturer to achieve the thermal conductivity.
 - d. Grout Weight as specified by manufacturer to achieve the thermal conductivity.
3. Sand for grout mixtures shall have the following properties:
 - a. AFS Grain Fineness Number (AFS-GFN) as required by the grout product manufacturer. AFS-GFN shall be between 40 and 60 for GeoPro TG Lite, and between 60 and 80 for GeoPro TG Select.
 - b. No more than 5% of sand particles shall pass through a 40 or coarser mesh sieve.
 - c. No more than 2.5% of sand particles shall pass through a 200 or finer mesh sieve.
 - d. Washed & dried.
 - e. Silica dioxide (SiO₂) content 99% or greater.

C. Bentonite-Graphite Grout Mixtures:

1. Bentonite product shall be a high-solids, thermally enhanced bentonite grout similar to TG Lite or TG Select manufactured by GeoPro, Inc. or approved equal.
2. Graphite thermal enhancement compound shall be an engineered compound similar to PowerTEC manufactured by GeoPro, Inc. or approved equal.
3. A bentonite-graphite grouting material shall have the following properties:
 - a. Thermal Conductivity of the minimum value shown on the drawings.
 - b. Permeability less than 1.0×10^{-7} cm/sec.
 - c. Percentage of Solids as specified by manufacturer to achieve the thermal conductivity.
 - d. Grout Weight as specified by manufacturer to achieve the thermal conductivity.

2.5 HEADER MANIFOLD REQUIREMENTS

A. Pipe and Pipe Fittings

1. Pipe and fittings used shall be of HDPE and meet all specified requirements within this Section.

B. Valves

1. General Requirements

- a. Provide all isolation valves and balancing valves on circuit and main piping as noted on the drawings.
 - b. Valves shall be suitable for use at temperatures of a minimum range of 0° F to 180° F, and shall be suitable for pressures and vacuums experienced in the piping.
 - c. Valves shall have a position indicator.
 - d. Valves shall be provided with stem extensions for insulation clearance. Coordinate with mechanical insulation thickness.
 - e. Valves shall be located to allow access and full operation.
 2. Isolation and Flushing/Purging Valves, 2 ½" through 8":
 - a. Valves to be butterfly valves constructed with Class 125/150 flanges, lug style ductile iron body, aluminum bronze disc, EPDM liner and seal, 416 stainless steel stem, rated at 200 psi, and rated for bi-directional dead-end service. Valves to be selected for line size unless otherwise noted on drawings. Acceptable product: Apollo LD141, Nibco LD-2000, or approved equivalent.
 - b. Valves to have a lever operator.
 3. Isolation and Flushing/Purging Valves, 2" and smaller: Valves to be ball valves constructed with 2-piece bronze body, full port, threaded connections. Valve to contain a chrome-plated solid brass ball with reinforced PTFE seat rings, blowout-proof silicon bronze stem, and rated at 600 psi CWP. Valves to be selected for line size unless otherwise noted on drawings. Acceptable product: Apollo 77C-100, Nibco T-585-70, or approved equivalent.
 4. Balancing Valves, 2½" and larger: Valves to be globe-style with ductile iron body and seat, EPDM seals, and handwheel with visual position indicator. Valve size to be selected for flow rate as noted on drawings. Acceptable product: Victaulic/TA Series 788.
 5. Balancing Valves, 2" and smaller: Valves to be globe-style with copper alloy Ametal body and seat, EPDM seals, and handwheel with visual position indicator. Valve size to be selected for flow rate as noted on drawings. Acceptable product: Victaulic/TA Series 787.
- C. Instruments and Accessories
1. Thermometers
 - a. Furnish industrial type thermometers with separable sockets and provide extension necks on thermometers and sockets for piping with 2" or thicker insulation.
 - b. Pipeline mounted thermometers – 9" scale cast aluminum case and frame, clear acrylic plastic window front, permanently stabilized glass tube with non-mercury oil-based indicating fluid, black etched figures and graduations, adjustable angle stem, and compatible with brass construction sockets.
 - c. Thermometers shall be accurate +/- 1 scale division.
 - d. Range of thermometer shall be 0°F to 160°F with 2°F increment.
 - e. Acceptable thermometer products: HO Trerice BX9-1-40X-04, or approved equal.
 - f. Acceptable thermowell products: HO Trerice, or approved equal.
 2. Pressure Gauges
 - a. Furnish gauges with a minimum face diameter of 4-1/2", with cast aluminum case with black finish and black finish case ring, glass or acrylic plastic window, white background and black figures on dial face, bronze bushing movement, and ¼" NPT forged brass socket.
 - b. Gauges shall be accurate +/- 1.0% full scale, ASME B40.100 Grade 1A.
 - c. Range of pressure gauge shall be at least 0 psig to 100 psig with 1 psig increment.
 - d. Snubbers and gauge cocks shall be provided with all pressure gauges.
 - e. Acceptable products: HO Trerice 600CB-45-02-L-A-110, or approved equal.
 3. Pressure/Temperature Test Ports
 - a. Test ports shall be suitable for use with temperature range, pressure range, and fluid type experienced in geothermal applications. At a minimum, (1) test port shall be located on the return and supply main piping, and (1) test port on each of the circuit piping with flow coming from the bore field.
 - b. Test ports shall be capable of receiving a thermometer probe with a minimum diameter of 1/16" and a maximum diameter of 1/8".
 - c. The test ports shall be capable of allowing the injection/extraction of liquids through an inducement probe not to exceed 1/8" in diameter.

- d. The test ports outer body shall be of all brass construction including a 9/16" knurled cap with a plastic retainer.
- e. Test ports shall have a dual seal core design of Nordel allowing sealing of the system before complete removal of any probe, good up to 350° F for water.
- f. Core membrane shall be of a design that maintains proper alignment for increase ease when inserting probes. Test ports shall be rated zero leakage from full vacuum to 1000 PSIG.
- g. Owner shall be provided with one (1) master test kit. Kit shall contain one 2-1/2" pressure gauge with range 0-100 psi, one 1-3/4" dial thermometer range 25-125 °F, and one 1-3/4" dial thermometer range 20-240 °F. Acceptable product: HO Trerice #D3750 or approved equivalent.

2.6 BEDDING MATERIAL & BACKFILL

- A. The bedding material for the pipes shall be a granular fill that includes clean sands with little or no fines.
- B. Bedding material shall be free of ice, clay, organic matter or other objectionable material, and shall conform to the following standards or approved equal:
 - 1. Gradation per ASTM C136 (Sieve Size – Percent by Weight Passing Sieve):
 - a. 3/8" – 100
 - b. #4 – 90-100
 - c. #50 – 10-40
 - d. #100 – 3-20
 - e. #200 – 0-15
 - 2. Sand Equivalent per ASTM D2419: 25 minimum
 - 3. Plasticity Index per ASTM D4318: Non Plastic
 - 4. Moisture – Density per ASTM D1557: Maximum +2% of optimum, Minimum -5% of optimum.
- C. Any pipe sand bedding material retained on a #4 sieve shall not contain angular material as described in ASTM D2488. Pipe sand bedding material which contains subangular, subrounded, or rounded material and conforms to the standards above is acceptable.
- D. Reference drawings for bedding depths.

2.7 MARKING TAPE

- A. Marking tape shall be of the type specifically manufactured for marking and locating underground utilities. The tape shall be acid, alkali, chemical, and oil resistant polyethylene film, 6 inches wide with minimum thickness of 5.0 mils and shall have a minimum strength of 4200 psi lengthwise with an elongation factor of 80 percent. Tape shall be brightly colored and shall bear a continuous printed inscription describing the geothermal piping buried below, such as "CAUTION: BURIED GEOTHERMAL LINE BELOW." Tape shall have a solid metal core to enable detection. The metallic core shall be encased in a protective jacket or provided with other means to protect it from corrosion. Acceptable product: Pro-Line Safety Products Detectable Tape 5.0 Mil, or approved equivalent.

2.8 LOCATING/TRACER WIRE

- A. Provide tracer wire to be used with active, conductive locating methods.
- B. Tracer wire shall be insulated with 45 mil high-density, high molecular weight polyethylene (HDHMWPE) insulation suitable for direct burial and rated at 600 volts as defined by the National Electrical Code. The insulation shall be moisture, chemical, oil, and sunlight resistant and impact, crush, and abrasion resistant. THHN and other insulations not rated for the application are not acceptable.
- C. For open trench pipes:
 - 1. Tracer wire shall be a 10 AWG solid copper or copper-clad steel conductor manufactured for the purpose of locating buried water pipes.

2. Acceptable Product: Pro-Line Safety Products #PE45, #HF-CCS PE45, or approved equivalent.

2.9 HEAT TRANSFER SYSTEM FLUID

- A. The fluid must be approved by the State application of ground-coupled closed-loop geothermal heat exchange systems.
- B. All fluid introduced into the system must be of the exact same manufacturer, product type, and concentration. This includes applying to instances where fluid is provided to the system under different scopes of work (for example, geothermal and mechanical) and/or at different times of the project where the fluids will come into direct contact and mix when the work is connected into one system.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clear areas required for access to site and execution of work.
- B. Verify that survey benchmark and intended elevation of grade at borefield prior to beginning work.
- C. Identify required lines, levels, contours, and datum.
- D. Contact Digger's Hotline to locate public utility locations with required notice prior to commencing work.
- E. Verify exact locations of all existing public and private utilities on site that may conflict with the installation of the geothermal bores and piping, including underground, above ground, and aerial utilities. Some areas may require hydro-excavation and/or hand digging to locate underground utilities. Stake and flag locations and record on as-built drawings.
- F. Coordinate and provide any piping offsets required to route over, under, or around utilities.
- G. Notify the Owner and coordinate the removal or relocation of utilities conflicting with the installation of the geothermal borefield.

3.2 GENERAL

- A. The geothermal heat exchange system shall be installed in accordance with the rules and regulations for all federal, state and local regulatory authorities. The Contractor shall use only registered/licensed drilling contractors in accordance with applicable regulations. The Contractor will be responsible for obtaining all necessary permits to perform the work, including but not limited to, any drilling permits.
- B. The Contractor shall contact the appropriate local unit of government and request locations of any municipal well systems in the area, determine if the borefield is within a wellhead protection plan area, and follow all relevant regulations.
- C. Protection of Existing Utilities: Identify and protect the existing or newly installed utilities from damage during excavation and backfilling of trenches. If damaged, repair them at no expense to the owner. All repairs shall be performed under the supervision of the utility or installing contractor concerned.
- D. Maintain designated site access for vehicular and pedestrian traffic.

3.3 DRILLING

- A. The vertical boreholes shall be drilled in a square grid pattern at a minimum spacing according to construction drawings. The Contractor may locate the vertical boreholes in locations other than shown on the drawings to avoid conflicts with other utilities or trades provided that review and approval has been obtained from the Engineer.

- B. Provide and use temporary casings as necessary to support unstable soils and achieve drilling to the design depth.
- C. The Contractor is responsible for securing water supply required for all drilling and grouting activities.
- D. The Contractor is to perform the first two boreholes under supervision of the Engineer and/or Engineer's site representative, unless otherwise directed by the Engineer. The locations of these boreholes are to be determined by the Engineer. Notify the Engineer before beginning drilling as required in this Section.
- E. Notify Engineer immediately of unexpected subsurface conditions.
- F. Drilling fluids and cuttings shall be confined to the site and disposed of in accordance with the local environmental regulations.

3.4 VERTICAL LOOP INSTALLATION

- A. Vertical loops must be installed from a mechanical device specifically designed for this application so as to prevent contact with the ground and prevent twisting, kinking, or other damage to the pipe.
- B. Inability to fully insert the piping to the specified minimum depth shall be reported to the Engineer upon discovery.
- C. During piping installation, the Engineer or Engineer's agreed representative has the option to test the depth of up to ten holes or 10% of the holes (whichever is greater) at random. If the lengths are as specified, the piping may be connected, tested, and covered. If shorter than the length specified, the heat exchanger field or the individual heat exchanger shall be increased as specified by the Engineer. In addition, all heat exchanger holes must be uncovered and have their lengths verified. At the Engineer's discretion, the heat exchanger field will be required to be increased to the specified lengths or replaced.

3.5 GROUTING

- A. The drilled vertical bores shall be grouted in accordance with IGSHPA standards and applicable state and local regulations.
- B. The thermal grouting material shall be mixed according to manufacturer's written instructions. The grout shall be mixed by a paddle type mixing device or by manufactured portable grouting unit specifically designed for the vertical ground heat exchanger industry. Jet-mixing and recirculation are not allowed.
- C. The Contractor shall monitor the grouting operation to ensure grout is properly mixed and the viscosity is adequately maintained for pumping.
- D. The Contractor shall accurately measure and completely mix all grout materials to ensure the desired thermal conductivity value.
- E. Water volume, temperature, quality, and other characteristics shall be carefully considered and maintained within the requirements of the grout product manufacturer(s) and supplier(s) during grout mixing and pumping.
- F. If problems with the grout are observed, notify Engineer before proceeding further.
- G. Grouting shall immediately follow the drilling and installation of the vertical loop piping. No more than four boreholes shall be un-grouted at any one time and no borehole shall remain un-grouted for more than 24 hours. The Engineer shall be notified immediately if exceptions to these requirements are felt necessary.
- H. The Contractor will employ an approved method of grouting to ensure that there are no air voids forming as a result of the grout placement.

- I. Grout material shall be pressure pumped through a 1", 1-1/4" or 1-1/2" inside diameter tremie pipe and placed in the bore column from the bottom to top. Completed grouted surfaces shall be placed at ground level to ensure complete fill of the bore column. A positive displacement pump shall be used for placing the grout in the borehole. Minimum pump suction and discharge lines shall be 3 inches and 1-1/2" respectively.
- J. The Contractor shall take special precautions as necessary to avoid collapse/bucking of the vertical HDPE piping and u-bend. Filling the pipe with water and pressurizing may be necessary to overcome the external pressure created by the weight of the grout.
- K. Since some settling may occur after the placement of the grout material, the Contractor shall monitor each borehole and continue adding grout as required for a period of no less than 30 minutes and no longer than 6 hours. Contractor shall top off any observed settling in all boreholes for at least 24 hours after the final borehole is grouted.
- L. The Contractor shall maintain a ready supply of spare grout pipes, hoses and fittings on the site.
- M. Refer to "Testing Requirements" within this Section for minimum grout sampling intervals and thermal conductivity tests.
- N. If conductivity of one or more samples is less than specified, the Contractor shall contact the Engineer for review. The Engineer may direct changes to be covered at the Contractor's expense, such as but not limited to: additional bores to be drilled, increased conductivity for the remaining bores, or other engineered solutions to correct the total borefield heating and cooling capacity.

3.6 FIELD AND BORE LOCATION SURVEY

- A. Bore locations shall be individually surveyed with GPS coordinates after drilling is complete, but prior to horizontal trenching.

3.7 EARTHWORK – TRENCHING/EXCAVATION, BACKFILLING, AND COMPACTION

- A. Excavation
 - 1. Perform all excavation work in accordance with OSHA and all other applicable regulations.
 - 2. Provide all shoring, bracing, sheet piling, underpinning, and/or other methods required to prevent cave-in or loose soil from falling into the excavation. Widen excavation to provide space occupied by shoring and sheeting.
 - 3. Prevent water from accumulating in excavation. Grade as necessary to prevent surface water from flowing into the trenches or other excavations and remove any surface or subsurface water accumulating therein by pumping or by other acceptable method.
 - 4. During excavation, deposit material suitable for backfill in an orderly manner at a sufficient distance from the excavation banks to avoid over-loading and to prevent slides or cave-ins. Dispose of material unsuitable for backfill.
 - 5. Excavate true-to-line to an elevation required to provide a clear space on either side of pipe to facilitate bedding.
 - 6. Where the bottom of trench is found to be unstable or to include ashes, cinders, refuse, vegetable or organic matter, or large pieces of inorganic material, excavate and remove such material to a minimum depth of 12 inches below the pipe.
 - 7. Backfill the trench with approved bedding material and compact to provide uniform and continuous bearing for the pipe.
- B. Backfilling and Compaction
 - 1. Do not backfill trenches until all required inspections are made and tests are performed.
 - 2. Provide locating/tracer wire above all underground piping. The tracer wire shall be terminated in a location so as to be easily accessible by locating contractor, such as an irrigation box flush with grade or an outdoor electrical box on the exterior wall where the main piping enters the building. Run tracer wire continuously (no splices) and install tracer wire access points no more than five hundred (500) feet apart. The tracer wire shall be installed above all horizontal piping in the circuit trenches around the edge of the bore field. The locating wire shall also be installed above the main geothermal supply and return pipes from the building to the geothermal vault.

3. Provide detectable marking tape above all underground piping. The tape shall be installed directly above the pipe as shown in the drawings or at a depth that allows for detection by an appropriate metal detector as recommended by the tape manufacturer. The marking tape shall be installed such that it can be located using inductive locating methods (approximately 15-18 inches below grade). Refer to the manufacturer's installation instructions on recommendations for installation of tape.
4. Backfill using the required materials, lifts, compaction, and methods as described in Section 31 23 33 "Trenching and Backfilling."

3.8 UNDERGROUND PIPING INSTALLATION

- A. Install piping in accordance with manufacturer's written instructions. The pipe and fittings must be joined using the butt, socket, electrofusion or fusion process. No other method is acceptable. The vertical loop takeoff fittings may be made using tees or the saddle fusion process on header piping 1-1/4" and above. Exercise extreme caution to completely remove the cut-out of saddle tees. Bell reductions shall be used at all pipe reductions to eliminate trapped air.
- B. Use reducing socket tees when fabricating socket type reducing headers. Consult with manufacturer for available fittings and fabrication headers.
- C. The connections between the borehole seal and the circuit piping shall be free of high points. Circuit piping to be at a higher elevation than all borehole seals to remove air. Fusion elbows at borehole seal can be used but are not required if minimum bending radius is maintained.
- D. Avoid sharp bends in piping. The minimum bend radius for each pipe size shall be 25 times the nominal pipe diameter or the pipe manufacturer's minimum bend radius, whichever is greater.
- E. The piping shall be supported before and after backfilling with a suitable means of support to prevent undue stresses on the pipe and pipe fittings.
- F. Horizontal pipe spacing:
 1. For supply and return piping in the circuit trench, the supply and return pipes shall be separated by at least 24 inches clear at all locations.
 2. When routing groups of all return piping or all supply piping in the trenches maintain at least 6 inches between each return pipe or each supply pipe.
 3. Wherever supply and return spacing cannot be maintained, contact Engineer. 2-inch rigid extruded polystyrene (XPS, R-10) may be used to thermally isolate the piping systems.
- G. Utility spacing: Follow all required regulatory setbacks for utility spacing, but in all other cases maintain at least 24 inches horizontal and vertical spacing from all utilities. Wherever water main, sanitary sewer, storm sewer, or other water piping is encountered and spacing cannot be maintained, contact Engineer. 2-inch rigid extruded polystyrene (XPS, R-10) may be used to thermally isolate the piping systems.
- H. Underground wall penetrations shall be not less than 72 inches below grade, measured from final grade to the top of the penetration, and use a pre-manufactured sleeve and sealant device. The sleeve shall be set prior to pouring concrete and cast-in-place. In existing construction, the penetration shall be core-drilled and no sleeve is necessary. The pipe seal shall be installed with bolts on inside so it can be adjusted from inside the building.
- I. Opened ends of all pipes shall be sealed to prevent entry of contaminants until final connections are made. Tape over ends of piping is not allowed.

3.9 HEADER MANIFOLD PIPING INSTALLATION

- A. All pipe to be properly supported according to the requirements in 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. All pipe, pipe fittings, and valves interior to the building shall be insulated, jacketed, and labeled or tagged in accordance with the requirements in 230719 "HVAC Piping Insulation" and 230553 "Identification for HVAC Piping and Equipment."
- C. Provide labeling of circuits with circuit number.

- D. All valves, test ports, and other components shall be installed in an accessible manner.
- E. All thermometers and pressure gauges shall be installed in a location readable by a person standing on the floor.

3.10 PURGING, FLUSHING, AND FILLING

A. General Requirements:

- 1. The Contractor shall perform purging, flushing, and filling of the exterior geothermal piping while isolated (and bypassed) from the building piping.
- 2. Purging, flushing, and filling of the first completed circuit or piping section shall be performed before backfilling under observation by the Engineer and/or Engineer's site representative, unless otherwise directed by the Engineer. Notify the Engineer before beginning purging, flushing, and filling as required in this Section.
- 3. The Contractor shall be responsible for correcting any problems and/or paying for any damage to the mechanical piping system – internal or external to the building – caused by debris left in the horizontal or vertical borefield piping. Damage includes plugging strainers or otherwise negatively impacting the performance of the building systems.

B. Flushing Debris and Purging Air:

- 1. Flushing shall be performed by maintaining a minimum of 4 feet per second in the most controlling pipe section or at the design flow rate, whichever is greater.
- 2. Flushing shall be performed using a 25-micron filter.
- 3. Flushing duration shall be at least 30 minutes per pipe section, or as needed until no bubbles are observed and the water and filter are clean.
- 4. Each circuit and main piping between building and borefield is to be individually flushed. Other circuits and piping are to be isolated, and the borefield is to be isolated from the building during all flushing and purging activities.
- 5. Flush lines in both directions to remove dirt and contaminants and any possible obstructions.
- 6. Contractor shall not use a cleaning agent to flush the HDPE pipes.

C. Filling System:

- 1. The flushing water is to be fully displaced by heat transfer fluid.
- 2. The Contractor shall add the required amount of propylene glycol to the system for the portion of the system exterior to the building to achieve the final concentration.
- 3. The Contractor shall coordinate to ensure that the heat transfer fluid of the entire mechanical piping system (interior and exterior to the building) shall contain the same manufacturer, product, and concentration of propylene glycol and contain only those inhibitors that are approved by the state.
- 4. The Contractor shall coordinate to ensure the exterior geothermal and interior building piping systems have each been tested, cleaned, flushed, and filled according to all requirements of the Contract before opening the isolation valves between the geothermal borefield and the building piping.

3.11 TESTING REQUIREMENTS

A. Grout Testing:

- 1. The Contractor shall have the samples tested by an approved, independent grout testing agency to determine thermal conductivity. All costs associated with this testing, including container costs, shipping, testing fees, etc., shall be borne by the Contractor.
- 2. The Contractor shall collect grout mixture samples for thermal conductivity testing at equally spaced intervals during construction and use consistent grouting techniques between tests.
- 3. The minimum sampling and testing requirements are:
 - a. Sampling and testing intervals:
 - 1) One sample and test from first borehole drilled.
 - 2) One sample and test every 10 boreholes drilled thereafter.
 - 3) One sample and test for last borehole drilled.
 - b. Minimum number of total samples and tests = $(\text{total \# boreholes} / 10) + 1$

4. If the grout recipe or mixing methodology is changed, take additional samples and perform tests before and after.
5. Submit results as specified in this Section.

B. Pressure Testing:

1. General Requirements:

- a. Notify the Engineer a minimum two (2) working days advance of all pressure tests.
- b. All pressure tests are to be witnessed and the results signed by the Engineer, Owner's Representative, or the Engineer's-approved site representative. Failure to perform pressure testing with a witness will result in re-testing and demonstration.
- c. Testing results shall be recorded, including the following information: Date, Time, Location, Test Duration, Test Results, and Witness Signature
- d. Results of all tests shall be supplied to the Engineer upon completion of the testing.
- e. Pressure testing shall be performed with a 0 to 100 psi pressure gauge.
- f. Remove all gauges, controls, caps, and accessories that are not designed to withstand test pressures during testing. Replace after all testing is complete.
- g. Perform pressure testing so that piping is not exposed to direct sunlight or ambient air temperature that could influence the testing results.
- h. Geothermal piping is to be protected from freezing conditions before, during, and after pressure testing. If fluid in piping freezes notify Engineer within one (1) working day. Frozen pipe is to be replaced at Contractor's expense. System shall then be tested as per standard pressure testing procedures described above.
- i. Testing medium, pressures, duration, and acceptance criteria:
 - 1) The pressure test shall be hydrostatic. Air pressure testing is not permitted.
 - 2) Pre-test pressure = 100 psi for at least 30 minutes to allow pipe to expand to full volume.
 - 3) Test pressure = 90 psi for at least 4 hours
 - 4) Allowable pressure loss = 4 psi maximum
 - 5) Note: Pressure may need to be "topped off" to compensate for piping expansion under pressure. A new testing duration will begin upon topping the piping section off with additional water.

2. Vertical Loop Pressure and Flow Testing:

- a. Every vertical bore loop piping installation shall be filled with water, flow tested, and pressure tested after grouting is finished.
- b. Flow testing shall be performed at a minimum 2 ft/sec:

Nominal Pipe Diameter, SDR 11	Flow Rate at 2 ft/sec
¾-inch	4 gpm
1-inch	6 gpm
1¼-inch	9 gpm
1½-inch	12 gpm

- c. Leaks or failed flow tests in vertical loop piping require the vertical loop to be redrilled and replaced with a new piped borehole.

3. Circuit Pressure Testing:

- a. Prior to backfilling, each circuit shall be filled with water and pressure tested.
- b. Repair leaks found by cutting the damaged section and replacing it with new pipe and fittings. System shall then be retested.

4. System Pressure Testing:

- a. Following backfilling, the entire exterior system shall be filled with water and pressure tested.
- b. A failed system pressure test will require that all leaks are located and corrected. Repair leaks found by cutting the damaged section and replacing it with new pipe and fittings. System shall then be retested.

3.12 WATER FLOW TESTING, ADJUSTING, AND BALANCING (TAB)

- A. The Contractor shall coordinate with the balancing contractor and controls contractor to perform circuit balancing on the geothermal heat exchanger. Reference 230593 for requirements.

3.13 REPORT SAMPLE FORMS

- A. See attached sample reports at end of Section. Engineer will provide blank copies of reports for use by the Contractor for the project upon request.
 - 1. Bore Log Data Sheet
 - 2. Pressure Testing Report
 - 3. Flushing Report

END OF SECTION

SAMPLE BORE LOG DATA SHEET

Project: Baileys Harbor Geothermal Conversion

Location: 2392 County Road F, Baileys Harbor, WI 54202

Engineer: HGA

Contractor:

BORE REFERENCE NUMBER	DATE DRILLED	BORE DEPTH (FT)	# UNITS GROUT	SURVEYED GPS COORDINATES		PRESSURE TEST RESULTS		
				LATITUDE (DD° MM.xxx' N)	LONGITUDE (DD° MM.xxx' W)	DATE TESTED	INIITAL PRESSURE (PSI)	FINAL PRESSURE (PSI)

SAMPLE PRESSURE TESTING REPORT

Project: Baileys Harbor Geothermal Conversion

Location: 2392 County Road F, Baileys Harbor, WI 54202

Engineer: HGA

Contractor:

CIRCUIT NUMBER / PIPE SECTION	INITIAL PRESSURE (PSI)	FINAL PRESSURE (PSI)	DURATION (HRS)	CONTRACTOR SIGNATURE	WITNESS SIGNATURE	DATE PASSED

SAMPLE FLUSHING REPORT

Project: Baileys Harbor Geothermal Conversion

Location: 2392 County Road F, Baileys Harbor, WI 54202

Engineer: HGA

Contractor:

CIRCUIT NUMBER / PIPE SECTION	REQUIRED FLOW RATE* (GPM)	ACHIEVED FLOW RATE (GPM)	CONTRACTOR SIGNATURE	WITNESS SIGNATURE	DATE COMPLETED

* Contact Engineer for the required flow rate. Will be based on a velocity of 4 ft/sec on the most controlling pipe section.

SECTION 238146.13 WATER-TO-AIR HEAT PUMPS

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. Concealed horizontal units, 6 tons and smaller.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, furnished specialties, and accessories for each model.
- B. 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. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports
- B. Startup reports.
- C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For water-to-air heat pumps to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. ASHRAE Compliance:
 - 1. ASHRAE 15.
 - 2. Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- C. Comply with NFPA 70.
- D. Comply with safety requirements in UL 484 for assembly of free-delivery, water-source heat pumps.
- E. Comply with safety requirements in UL 1995 for duct-system connections.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of water-source heat pumps that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, refrigeration components.
 - 2. Warranty Period: Four years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONCEALED WATER-SOURCE HEAT PUMPS, 6 TONS AND SMALLER

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carrier Corporation; a unit of United Technologies Corp. (www.carrier.com)
 - 2. ClimateMaster, Incorporated. (www.climatemaster.com)
 - 3. FHP Manufacturing Incorporated. (www.fhp-mfg.com)
 - 4. Hydro-Temp Corporation, Incorporated. (www.hydro-temp.com)
 - 5. Mammoth Incorporated. (www.mammoth-inc.com)
 - 6. McQuay International. (www.mcquay.com)
 - 7. Trane Incorporated. (www.trane.com)
 - 8. WaterFurnace International, Incorporated (www.waterfurnace.com)
- B. Description: Packaged water-source heat pump with temperature controls; factory assembled, tested, and rated according to ASHRAE/ARI/ISO-13256-1.
 - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
- C. Cabinet and Chassis: Heavy-gauge galvanized-steel casing with corrosion resistant powder coating and the following features:
 - 1. Access panel for access and maintenance of internal components.
 - 2. Knockouts for electrical and piping connections.
 - 3. Flanged duct connections.
 - 4. Cabinet Insulation: Cleanable aluminum foil coated glass-fiber liner, minimum 1/2 inch thick, complying with UL 181, ASTM C 1071, and ASTM G 21.
 - 5. Units field convertible for various discharge configurations.
 - 6. Condensate Drainage: High-density polyethylene plastic or stainless-steel drain pan with condensate drain piping projecting through unit cabinet and complying with ASHRAE 62.1.
 - 7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
 - 8. Sound Attenuation Package: Provide one or more of the following:
 - a. Minimum 0.598-inch- thick compressor enclosure and front panel. Minimum 0.0937-inch-thick foam gasket around the compressor and perimeter of end panel.
 - b. Sound attenuating blanket over compressor.
 - c. Hot-gas muffler.
- D. Fan: Direct driven, centrifugal, with multispeed motor resiliently mounted in fan inlet and with inlet rings to allow wheel removal from one side without removing housing.
 - 1. Motor: Multispeed, permanently lubricated, ECM2.3 motor.
- E. Water Circuit:
 - 1. Refrigerant-to-Water Heat Exchangers:
 - a. Coaxial heat exchangers with copper water tube with enhanced heat-transfer surfaces inside a steel shell; both shell and tube are leak tested to 450 psig on refrigerant side and 400 psig on water side. Factory mount heat exchanger in unit on resilient rubber vibration isolators.
- F. Refrigerant-to-Air Coils: Copper tubes with aluminum fins, leak tested to 450 psig.
- G. Condensate Pump: Condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir under coil assembly.
- H. Refrigerant Circuit Components:
 - 1. Sealed Refrigerant Circuit: Charge with R-454B refrigerant.
 - 2. Charging Connections: Service fittings on suction and liquid for charging and testing on each circuit.

3. Reversing Valve: Four-way, solenoid-activated valve designed to be fail-safe in heating position with replaceable magnetic coil.
4. Compressor: Hermetic scroll, high efficiency variable speed compressor installed on vibration isolators and housed in an acoustically treated enclosure with factory-installed safeties as follows:
 - a. Antirecycle timer.
 - b. High-pressure cutout.
 - c. Low-pressure cutout or loss of charge switch.
 - d. Internal thermal-overload protection.
 - e. Freezestat to stop compressor if water-loop temperature in refrigerant-to-water heat exchanger falls below 35 degrees F.
 - f. Water-coil, low-temperature switch.
 - g. Air-coil, low-temperature switch.
5. Refrigerant Piping Materials: ASTM B 743 copper tube with wrought-copper fittings and brazed joints.
6. Pipe Insulation: Refrigerant minimum 3/8-inch- thick, flexible elastomeric insulation on piping exposed to airflow through the unit. Maximum 25/50 flame-spread/smoke-developed indexes according to ASTM E 84.
7. Refrigerant Metering Device: Dual-port, thermal-expansion valve to allow specified operation with entering-water temperatures from 25 to 125 degrees F.
8. Refrigerant Detection Device: In accordance with UL 60335-2-40.
- I. Filters: Disposable, pleated type, 2 inches thick and with a minimum efficiency reporting value of MERV 11 according to ASHRAE 52.2.
- J. Controls:
 1. Basic Unit Control Modes and Devices:
 - a. Cooling mode.
 - b. Heating mode.
 - c. Dehumidification mode.
 - d. Unit shutdown on high or low refrigerant pressures.
 - e. Unit shutdown on low water temperature.
 - f. Low- and high-voltage protection.
 - g. Overcurrent protection for compressor and fan motor.
 - h. Random time delay, three to ten seconds, start on power-up.
 - i. Time delay override for servicing.
 - j. Control voltage transformer.
 - k. Water-coil freeze protection (selectable for water or antifreeze).
 - l. Air-coil freeze protection (check filter switch).
 - m. Option to reset unit at thermostat or disconnect.
 - n. Fault type shall be retained in memory if reset at thermostat.
 - o. Automatic intelligent reset. Unit shall automatically reset five minutes after trip if the fault has cleared. Should a fault reoccur three times sequentially, lockout requiring manual reset occurs.
 - p. Ability to defeat time delays for servicing.
 - q. Light-emitting diodes (LED) to indicate high pressure, low pressure, low voltage, and high voltage.
 - r. The low-pressure switch SHALL NOT be monitored for the first 90 seconds after a compressor start command to prevent nuisance safety trips.
 - s. Remote fault-type indication at thermostat.
 - t. Selectable 24-V dc or pilot duty dry contact alarm output.
 - u. 24-V dc output to cycle a motorized water valve with compressor contactor.
 - v. Service test mode for troubleshooting and service.
 - w. Unit-performance sentinel warns when the heat pump is running inefficiently.
 2. Thermostat:
 - a. Wall-Mounted Thermostat:
 - 1) Color Touchscreen Display
 - 2) Heat-cool-off switch.

- 3) Seven day, programmable.
 - 4) Automatic changeover.
 - 5) Exposed temperature set point.
 - 6) Exposed temperature indication.
 - 7) Deg F indication.
 - b. Duct-mounted temperature sensor
 - c. Unoccupied period override push button.
 - d. Digital display to indicate fault condition at heat pump.
 - e. Data entry and access port.
 - 1) Input data include room temperature and humidity set points for occupied and unoccupied periods.
 - 2) Output data include room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.
2. Terminal Controller:
- a. Scheduled operation for occupied and unoccupied periods on **seven**-day clock with minimum of four programmable periods per day.
 - b. Two -hour unoccupied override period.
 - c. Remote-control panel to contain programmable timer and digital display for fault condition.
 - d. Compressor-disable relay to stop compressor operation for demand limiting or switch to unoccupied operation.
 - e. Automatic restart after five minutes if fault clears. Lockout after three attempts to restart following fault. Indicate fault for service technician.
 - f. Backup for volatile memory.
- K. Vibration Isolators: Neoprene isolation mounts installed on unit hanger rods.
- L. Electrical Connection: Single electrical connection.
- M. Capacities and Characteristics:
1. Refer to Water-To-Air Heat Pump Schedule.

2.2 HOSE KITS

- A. General: Hose kits shall be designed for minimum 400-psig working pressure and operating temperatures from 20 to 211 deg F. Tag hose kits to equipment designations.
- B. Hose: Length 24 inches braided stainless steel, complete with adapters. Minimum diameter, equal to water-source, heat-pump connection size.
- C. Strainer: Y-type with blowdown valve in supply connection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping and electric installations for water-source heat pumps to verify actual locations of piping connections and electrical conduits before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Mount Floor Mounted Equipment in compliance with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

- B. Suspend heat pumps from structure with all-thread hanger rods spring hangers with vertical-limit stop. Hanger rods and attachments to structure are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- C. Install wall-mounting thermostats, humidistats, and switch controls in electrical outlet boxes at heights to match lighting controls or as required in Section 230900 "Instrumentation and Control for HVAC."

3.3 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
 - 1. Connect supply and return hydronic piping to heat pump with hose kits.
 - 2. Install a tee and manual air vent on the water outlet; extend the vent pipe up with a manual air vent above the unit.
 - 3. Install a strainer on the water inlet
 - 4. Install shut-off valves on the inlet and outlet. The shut-off valves will isolate the heat pump, hose kits, strainer, and air vent.
- B. Condensate Drainage Connections: Provide adequate connections for condensate drain. Route condensate drain from unit to hub drain located in per plans. Hub drain provided by Div. 22 contractor.
 - 1. Connect heat-pump condensate drain pan to indirect waste connection with condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.
- C. Duct installation requirements are specified in other Sections. Drawings indicate general arrangement of ducts. Specific connection requirements are as follows:
 - 1. Connect supply and return ducts to water-source heat pumps with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
- D. Install electrical devices furnished by manufacturer but not specified to be factory mounted.
- E. Install piping adjacent to machine to allow service and maintenance.
- F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections:
 - 1. After installing water-source heat pumps and after electrical circuitry has been energized, test units for compliance with requirements.
 - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Heat pumps will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 START UP SERVICE

- A. Complete installation and startup checks according to manufacturer's written instructions and do the following:
 - 1. Inspect for visible damage to unit casing.
 - 2. Inspect for visible damage to compressor, coils, and fans.
 - 3. Inspect internal insulation.

4. Verify that labels are clearly visible.
5. Verify that clearances have been provided for servicing.
6. Verify that controls are connected and operable.
7. Verify that filters are installed.
8. Adjust vibration isolators.
9. Verify bearing lubrication on fan.
10. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
11. Start unit according to manufacturer's written instructions.
12. Complete startup sheets and attach copy with Contractor's startup report.
13. Inspect and record performance of interlocks and protective devices; verify sequences.
14. Operate unit for an initial period as recommended or required by manufacturer.
15. Verify thermostat and humidistat calibration.

3.6 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.7 CLEANING

- A. Replace filters used during construction prior to air balance or Substantial Completion.
- B. After completing installation of exposed, factory-finished, water-source heat pumps, inspect exposed finishes and repair damaged finishes.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water-source heat pumps.

END OF SECTION

SECTION 238236 FINNED-TUBE RADIATION HEATERS

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 **electric** radiation heaters.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include enclosure joints, corner pieces, access doors, and other accessories.
 - 4. Include diagrams for power, signal, and control wiring.
- C. Color Samples for Initial Selection: For finned-tube radiation heaters with factory-applied color finishes.
- D. Color Samples for Verification: For each type of exposed finish.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Structural members, including wall construction, to which finned-tube radiation heaters will be attached.
 - 2. Method of attaching finned-tube radiation heaters to building structure.
 - 3. Penetrations of fire-rated wall and floor assemblies.
- B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 ELECTRIC BASEBOARD RADIATION HEATERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Berko; Marley Engineered Products.
 - 2. Chromalox.
 - 3. Indeeco.
 - 4. Markel Products Company; TPI Corporation.
 - 5. Marley Engineered Products.
 - 6. Ouellet Canada Inc.
 - 7. Qmark; Marley Engineered Products.
- B. Description: Factory-packaged units constructed according to UL 499, UL 1030, and UL 2021.
 - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- C. Heating Elements: Nickel-chromium-wire heating element enclosed in metallic sheath mechanically bonded to fins, with high-temperature cutout and sensor running the full length of the element. Element supports shall eliminate thermal expansion noise.
- D. Enclosures: Minimum **0.0329-inch**-thick steel, removable front cover.
 - 1. Full-length damper.
 - 2. End panel.
 - 3. Inside and outside corners.
 - 4. Joiner pieces to snap together.
 - 5. Finish: Baked-enamel finish in manufacturer's **standard** color as selected by Architect.
 - 6. Element Brackets: Primed and painted steel to support front panel and element.
- E. Unit Controls: Integral line-voltage thermostat or Remote line-voltage thermostat refer to Mechanical drawings and schedules.
- F. Accessories:
 - 1. Straight-blade-type receptacles complying with DSCC W-C-596G/GEN, NEMA WD 1, NEMA WD 6, and UL 498; in color selected by Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive finned-tube radiation heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for **electrical** connections to verify actual locations before installation of finned-tube radiation heaters.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BASEBOARD RADIATION HEATER INSTALLATION

- A. Install units level and plumb.
- B. Install enclosure continuously around corners, using outside and inside corner fittings.
- C. Join sections with splice plates and filler pieces to provide continuous enclosure.
- D. Install access doors for access to valves.
- E. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.

3.3 CONNECTIONS

- A. Ground electric finned-tube radiation heaters according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Units will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION

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SECTION 238239.13 CABINET UNIT HEATERS

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 cabinet unit heaters with centrifugal fans and electric-resistance heating coils.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. DDC / BAS: Direct digital control / Building Automation System
- C. PTFE: Polytetrafluoroethylene plastic.
- D. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include location and size of each field connection.
 - 4. Include details of anchorages and attachments to structure and to supported equipment.
 - 5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
 - 6. Wiring Diagrams: Power, signal, and control wiring.
- C. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Cabinet Unit-Heater Filters: Furnish one spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Airtherm; a Mestek company.
2. Carrier Corporation; a UTC company.
3. Chromalox, Incorporated
4. Dunham-Bush, Incorporated
5. Engineered Air.
6. Indeeco.
7. International Environmental Corporation.
8. Markel Products Company; TPI Corporation.
9. Marley Engineered Products.
10. McQuay International.
11. Ouellet Canada Incorporated
12. Rittling
13. Sigma Corporation
14. Sterling
15. Trane Incorporated
16. USA Coil & Air.

2.2 DESCRIPTION

- A. Factory-assembled and -tested unit complying with AHRI 440.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with UL 2021.

2.3 PERFORMANCE REQUIREMENTS

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

2.4 COIL SECTION INSULATION

- A. Insulation Materials: ASTM C 1071; surfaces exposed to airstream shall have aluminum-foil facing or erosion-resistant coating to prevent erosion of glass fibers.
 1. Thickness: 1/2 inch.
 2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F mean temperature.
 3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
 4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.
 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.5 CABINETS

- A. Material: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.
- B. Material: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect
 1. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch-thick sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
 2. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0528-inch-thick sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.

- 3.
4. Recessed Flanges: Steel, finished to match cabinet.
5. Control Access Door: Key operated.
6. Base: Minimum 0.0528-inch-thick steel, finished to match cabinet, 4 inches high with leveling bolts.
7. Extended Piping Compartment: 8-inch-wide piping end pocket.

2.6 FILTERS

- A. Minimum Arrestance: According to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 1. Pleated: 90 percent arrestance and MERV 7.

2.7 COILS

- A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, mounted in ceramic inserts in galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

2.8 CONTROLS

- A. Fan and Motor Board: Removable.
 1. Fan: Forward curved, high static, double width, centrifugal, directly connected to motor; thermoplastic or painted-steel wheels and aluminum, painted-steel, or galvanized-steel fan scrolls.
 2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
 3. Wiring Terminations: Connect motor to chassis wiring with plug connection.
- B. Control devices and operational sequences are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."
- C. Electrical Connection: Factory-wired motors and controls for a single field connection.

2.9 CAPACITIES AND CHARACTERISTICS

- A. Refer to the Cabinet Unit Heater Schedule on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install cabinet unit heaters to comply with NFPA 90A.
- B. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- B. Units will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Adjust initial temperature set points.

END OF SECTION

SECTION 260500 COMMON WORK RESULTS FOR ELECTRICAL

1.1 SUMMARY

A. General

1. Scope: Project shall be provided with a complete electrical installation, including lighting, power, and low voltage systems in the building as defined in the drawings and specifications.
2. Codes: Electrical work shall comply with the 2017 National Electrical Code and all state and local codes that apply. Secure and pay for all permits, licenses and inspection fees, and coordinate all work with local inspection authorities.
3. Quality Assurance: All materials shall be new and free from defects, bearing certification for use as required by Underwriter's Laboratory, National Electrical Manufacturer's Association, National Fire Protection Association, American Society for Testing and Material, American National Standards Institute, and other standards that apply. Material shall be assembled in a manner consistent with the highest standards of construction practice. Work such as carpentry, painting, or welding related to the electrical construction shall be performed by persons skilled in the related trade.
4. Testing and Adjustment: All electrical power systems shall be tested for insulation integrity and wiring continuity prior to energization. All grounding systems shall be tested for earth path resistance and continuity. After energization, phase rotation and voltage at distribution equipment and motors shall be verified, and all loads shall be balanced on the distribution system to within 5% of each other.
5. Cutting, Patching and Excavation: Electrical Contractor shall be responsible for all cutting, patching, and excavation required by the work. All work shall be accomplished in a manner complying with the requirements of General Specifications. Do not cut or drill structural members without Structural Engineer approval.
6. Rubbish Removal and Storage: Electrical Contractor shall remove all rubbish associated with the work at the end of the project and as required to prevent hazard. Electrical Contractor shall be responsible for obtaining and securing a space for material storage and staging. This space shall not interfere with construction nor shall it constitute a hazard.
7. Cleaning, Painting and Labeling: All fixtures and equipment shall be cleaned free from construction dust, paint and foreign matter both externally and internally. All equipment shall be primed and painted or galvanized in a factory finish, or in the field if so specified, using methods to assure maximum durability. Provide a typewritten index in all panelboards and an engraved plastic laminate label identifying all distribution equipment, distribution panelboards, and major equipment disconnects and control devices. Using permanent marker, label each system junction box on the face of the cover in exposed construction and at the interior in finished construction.
8. Shop drawings, Submittals, and Owner's Manual: Shop drawings shall be submitted for approval on all devices and plates, distribution equipment, control equipment, light fixtures and lamps, specified utilization equipment and systems. Alternates to specified equipment may be proposed if submitted for approval ten days prior to bid date and time. No equipment shall be considered approved until such approval is made by Addendum. The Electrical Contractor shall maintain a set of accurate as-built drawings. Two copies of Owner's manuals shall be assembled with operating and maintenance manuals for all building equipment and systems, copies of all shop drawings, specialized utilization procedures and as-built drawings. Manuals shall be submitted for approval.
9. The drawings are diagrammatic. Field verify equipment, light fixture and device locations. Coordinate electrical work with the other trades.
10. Warranty: Work shall be guaranteed free from defects for a period of one year from date of final acceptance, unless noted otherwise.

- B. Outages: Outages shall be requested in writing, scheduled with the Owner, and coordinated with the electric utility where applicable. All work shall be done to minimize down time and inconvenience.

- C. Underground Installations: Provide all excavation, backfilling, fill material, and compacting of trenches for installation of electrical work. Provide all necessary pumping and drains. Restore site surfaces such as streets, sidewalks, curbs, paved areas and lawns, to original condition. Install underground marking tapes and pitch conduits for draining.
- D. Remodeling: Provide removal and remodel work necessary for the installation of new electrical work. De-energize circuit conductors for removal and remove back to energizing panelboard or nearest energizing source unless noted otherwise. Exposed raceway systems shall be removed and concealed raceways may be abandoned. Existing equipment and circuits that remain in a remodeled area shall be energized. Turn over to the Owner equipment, devices, and lighting fixtures he wants to keep and dispose of all other equipment off of the site. Check ballasts for PCBs and dispose of properly. Fluorescent lamps shall be recycled. Include costs for recycling lamps and ballast disposal.
- E. Abandoned Circuits and Equipment: Remove all wire back to its source wherever existing circuits are abandoned. Remove abandoned raceways and boxes unless concealed in concrete masonry construction, or if in a wall that is remaining and can be patched without removing box. Remove all abandoned electrical equipment.
- F. Record drawings shall meet all "As-built" and "Record Drawings" requirements for Milwaukee County. Coordinate all requirements with Milwaukee County staff prior to completion.
 - 1. Drawings:
 - a. Record of Project Progress: Maintain drawings available at the job site for inspection. Keep an accurate, legible and continuously updated record of installed locations and all project revisions other than revised drawings issued by the Architect, including source and date of authorization. Utilize only contract drawing symbols for recording the work. Drawing notations to be sufficiently clear in the representation of the work, for utilization by a CADD operator (drafts person) who is not necessarily familiar with the installed work.
 - b. Record of Installation: At the conclusion of the work, deliver one (1) set of updated drawings to the Owner's Representative for review. Following the review, Contractor shall have incorporated by a competent CADD operator all of the installed data represented on the project progress drawings.
 - c. Include in Record Drawings the Following:
 - 1) Revisions, including sketches, bulletins, change orders, written addenda and directives, clarifications and responses generated by requests for information (RFIs), regardless of source of the revision.
 - 2) Location and configuration of equipment with related housekeeping pads.
 - 3) Physical routing of ductbank work, raceways, exposed and above ceilings with locations of fire dampers, combination fire/smoke dampers, smoke detectors, power supplies, etc., plainly marked and identified.
 - 4) Location of room controllers, switches, devices, and sensors.
 - 5) Physical routing of raceways, underground, exposed and above ceiling with locations of accessories, pull points, access points plainly marked and identified.
 - 6) Location of raceways below building and on exterior, accessories, manholes, appurtenances and stub outs dimensioned from buildings and permanent structures, both horizontally and vertically.
 - 7) Location of wall and ceiling access panels.

1.2 260519 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

- A. Branch circuit conductors shall be THW-2 or THWN-2/THHN stranded copper. Minimum wire size is #12. 75 degree C ampacities shall be used for sizing conductors and conduit fill shall conform to NEC table 4. All conductors shall be in raceways with color coded insulation and each voltage system shall be separately identified.
- B. A maximum of three phase conductors is allowed in a single home run conduit. Provide a dedicated neutral for each phase conductor in multi-wire branch circuits unless noted otherwise. Install pull and junction boxes as required to aid in the installation of cables and conductors.
- C. VFD Output Circuits: Type XHHW-2 in metal conduit.

1.3 260526 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

- A. Provide grounding and bonding of the service entrance complete with grounding bushing on each conduit entering the service equipment. Provide grounding of all equipment comprising a permanent bonding together of all metallic, non-current carrying parts of the electrical system like raceways, boxes, panels, cabinets, equipment enclosures, housings, motor frames, cable trays, ducts, and lighting fixtures. Scrape light fixture finish to assure a good ground. Provide grounding conductors in all nonmetallic conduit systems, flexible conduit lengths, and surface raceways.

1.4 260529 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

- A. Equipment Support: Provide support of all electrical work through the use of threaded hanger rods, clamps, structural framing, fastening devices, and backboards. Provide vibration isolation in all supporting hardware for vibrating electrical equipment installed by this Contractor. Provide 4" high concrete pads for floor mounted equipment.

1.5 260533 RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

- A. Conduits: Rigid steel, rigid aluminum, PVC coated rigid steel, IMC, EMT, Flexible steel and Liquid-tight, and PVC conduits will be used where customary with approved fittings. Provide complete raceway systems including outlet boxes, pull boxes, and fittings. Conceal conduits in finished spaces. Group conduits on racks leaving 25% conduit space and suspend from the structure. Size conduits, boxes, and bends per the NEC where not specified on plan. Provide expansion fittings, conduit seals, drain tees, conduit hubs, fire/smoke barriers where required. Metal conduits shall have continuous grounding integrity and PVC conduits shall be complete with a properly sized circuit grounding conductor. MC or AC cable is allowed for branch circuit wiring. Home runs shall be in conduit, minimum size $\frac{3}{4}$ ", from last device box to panel.
 - 1. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - a. Rigid and Intermediate Steel Conduit: Threaded rigid steel conduit fittings.
 - b. PVC Externally Coated, Rigid Steel Conduits: Fittings listed for use with this type of conduit.
 - c. EMT: Setscrew, steel fittings.
 - d. Flexible Conduit: Fittings listed for use with flexible conduit.
- B. Wireways: Wireways shall be used where shown on the plans. Wireways shall be galvanized steel, painted grey, with hinge cover and all flanges, elbows, connections and partitions necessary for a complete system. Wireways shall be deburred, complete with a grounding conductor, NEMA 1 inside and NEMA 3R outside.
- C. Pull & Junction Boxes: Indoor boxes shall be NEMA 1, constructed of a single piece code gauge steel, with folded and welded corners, complete with flat removable screw down cover. Outdoor boxes utilizing rigid metal conduit shall be cast iron with cast iron gasketed cover held down with stainless steel screws. Outdoor boxes utilizing PVC conduit shall be plastic with screw down gasketed cover. Size all boxes per NEC article 314. Boxes are not shown on plan. Provide boxes to comply with code and to provide ease of conductor installation.
- D. Outlet Boxes and Fittings: Interior outlet boxes shall be galvanized steel, non-gangable, with knockouts and covers or extension rings as required. [Non-metallic boxes may only be used in conjunction with cable systems permitted under section 260519.] Exterior surface outlet boxes shall be cast iron alloy with threaded hubs and screw down gasketed WP covers.

1.6 260553 IDENTIFICATION FOR ELECTRICAL SYSTEMS

- A. Identification: Provide engraved nameplates, wire and cable markers, embossed tape, and device plate cover engraving where required or specified on the drawings. Provide engraved nameplates on electrical distribution and control equipment and the loads they serve, main power and special system cabinets, motor control centers, motor starters and variable frequency drives, capacitors, and disconnects.

1.7 262726 WIRING DEVICES

- A. Switches shall be specification grade, 20 amp, 277 volt, quiet toggle. Provide single pole, double pole, 3-way, 4-way, or SPDT as required. Similar to Hubbell 1221 series.
- B. Receptacles shall be specification grade, duplex or single outlet, voltage, and NEMA configuration as required or shown on the drawings. Provide GFI where shown on the drawings. GFI receptacles shall have test and reset buttons and meet UL 2003 standards. Specification grade shall be similar to Hubbell 5362 series.
- C. Provide GFCI receptacles for all outdoor receptacle devices. Include a low profile expandable weatherproof while in use cover.
- D. Devices connected to normal power shall be white.
- E. Interior device plate covers shall be thermoplastic nylon and galvanized steel in unfinished areas; exterior device plates shall be cast aluminum WP in-use type cover.
- F. Dimmers complete with calibrated linear vertical slide control, separate push on-push off illuminated switch, square law dimming, concealed fins, and preset feature with high adjust trim. Install dimmers where shown on the drawings. Group dimmers so that finished installation appears ganged without breaking off any cooling fins. Provide LED lamp dimmer switches for LED drivers.
- G. Occupancy Sensors: Dual-technology, self-adaptive. Wall switch shall have a 180deg. field of view, ceiling mount shall have a 360deg. field of view. Provide power packs and accessories as required. Rooms indicated with occupancy sensor symbols shall be provided with devices to provide full coverage of area indicated, regardless of quantity of devices indicated. Provide submittals to include product data and manufacturer approved plans indicating full coverage. Approved manufacturer is Wattstopper or approved equal.

1.8 262816 ENCLOSED SWITCHES AND CIRCUIT BREAKERS

- A. Disconnect Switches shall be heavy duty, horsepower rated, 250 volt or 600 volt, 2-pole, solid neutral, or 3-pole fused or un-fused and as required. Switch shall be quick-make quick-break with interlock and lockable enclosure door for opening. Provide NEMA 1 enclosure indoors, NEMA 3R outdoors, and NEMA 4X in interior wet locations. Fusible switches shall use current limiting fuses with rejection type fuse clips. Provide sizes shown on the drawings.
- B. Circuit Breaker Disconnects: Provide molded case disconnect switches, 250 volt or 600 volt, 2-pole or 3-pole without thermal overload protection, with silver alloy contacts, common trip and trip indicator. Circuit breaker AIC rating shall coordinate with the circuit.
- C. Enclosures:
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R

1.9 262923 VARIABLE-FREQUENCY MOTOR CONTROLLERS

- A. Furnished under Division 23.

End of section