

**Lansing School District  
Gardner Elementary School  
333 Dahlia Drive  
Lansing, MI 48911**

**Chiller Replacement  
LSD Project # SO-1858  
Matrix Project # 260150.00**

**Project Manual**

May 18, 2026

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**PROJECT IDENTIFICATION**

|                  |                                                                                   |
|------------------|-----------------------------------------------------------------------------------|
| <b>PROJECT:</b>  | <b>LANSING GARDNER CHILLER REPLACEMENT</b><br>333 Dahlia Dr<br>Lansing, MI 48911  |
| <b>OWNER:</b>    | <b>LANSING SCHOOL DISTRICT</b><br>519 W Kalamazoo St<br>Lansing, MI 48933         |
| <b>ENGINEER:</b> | <b>MATRIX CONSULTING ENGINEERS, INC.</b><br>544 Cherbourg Dr<br>Lansing, MI 48917 |

**END OF SECTION**



Lansing School District  
Gardner Elementary School Chiller Replacement  
LSD Project No. SO-1858

Project No. 260150.00  
May 2026  
Bid Documents

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## Invitation to Bid

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### **Lansing School District Gardner Elementary School Chiller Replacement Lansing, MI**

**LSD Project # SO-1858  
Matrix Project #260150.00**

- DESCRIPTION:** The project includes the direct replacement of an existing water-cooled rotary-screw chiller, the replacement of five (5) pumps associated with the chilled water system, and the replacement of all existing condenser water piping throughout the building.
- OWNER:** Lansing School District  
519 W Kalamazoo St  
Lansing, MI 48933  
Contact: Caleb Thelen  
Email: [caleb.thelen@lansingschools.net](mailto:caleb.thelen@lansingschools.net)
- ENGINEER:** Matrix Consulting Engineers, Inc.  
544 Cherboung Dr  
Lansing, MI 48917  
Contact: Nick Frechen  
Phone: (517) 487-2511  
Email: [nfrechen@matrixceinc.com](mailto:nfrechen@matrixceinc.com)
- DOCUMENTS:** Bid documents will be available upon request.
- PRE-BID MEETING:** A pre-bid meeting will be held at 3:30 pm on May 26, at 333 Dahlia Dr, Lansing, MI 48911.
- BID DUE DATE:** Delivered paper copies of signed proposals will be received until 2:00 PM, June 4, 2026 at 519 W Kalamazoo St, Lansing, MI 48933. Bids will be opened publicly at 2:00 pm. Bids received after this date and time will not be accepted or considered. Faxed bids will not be accepted.
- BONDS:** 5% Bid Bonds, 100% Performance, 100% Labor and Materials
- POST-BID INTERVIEW:** Post bid interviews will be scheduled as needed as soon as bids have been received and reviewed.

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## SECTION 002113 – INSTRUCTIONS TO BIDDERS

### PART 1 – GENERAL

#### 1.1 PRE-BID MEETING

- A. It is highly recommended that the prime bidder attend the pre-bid meeting. See Invitation for bids for pre-bid meeting information.
  - 1. The Engineer will present an overview of the project requirements at the pre-bid meeting and discuss procedures for arranging site visits.
  - 2. After the pre-bid meeting, bidders shall make all additional inquiries in writing to the Engineer. If it is necessary upon review of the inquiries, an Addendum will be issued to all bidders.

#### 1.2 EXAMINATION OF SITE

- A. It is the bidder's responsibility to become familiar with the existing conditions and the materials and labor required to complete the project. No additional compensation will be allowed to complete the work due to the bidder's failure to fulfill this requirement.
- B. Contact owner for instructions on arranging site visits.
- C. Submittal of a bid implies that the bidder is conversant with all of the site conditions under which the work must be performed.

#### 1.3 ADDENDA

- A. The bidder may, during the bidding period, be advised by Addendum of changes to the Specifications and Drawings. Such changes are included in the work and become part of the Contract Documents.
- B. List each Addendum by number in the space provided on the Bid Form.

#### 1.4 BID FORM

- A. Submit the bid on the form provided with all items of the form properly completed.
  - 1. Submitted bids shall be based only on the materials and constructions described in this Project Manual.
  - 2. The bid shall include the premiums and all other related charges for the indicated Performance and Payment Bonds and extra premiums or costs for the insurance coverage required in the Contract.

3. The Contractor shall obtain and pay the fees for all permits, licenses, and code inspections that may be required by the work of this Contract.
  4. Erasures or other changes must be initialed by the person signing the Bid Form.
- B. Requirements for signing bids:
1. Bids which are signed for a corporation shall have the correct corporate name thereof and signature of the president or other authorized officer of the corporation.
  2. Bids which are signed for a partnership shall be signed by all partners or by an attorney in fact. If signing attorney in fact, attach a power of attorney to the bid evidencing authority to sign the bid, executed by the partners.
  3. Bids which are not signed by the individual making them should have attached thereto a power of attorney evidencing authority to sign the bid in the name of the person for whom it is signed.

#### 1.5 BID INQUIRIES

- A. All bid inquiries should be, in writing, directed to Matrix Consulting Engineers, Inc., attention Nick Frechen, at [nfrechen@matrixceinc.com](mailto:nfrechen@matrixceinc.com)
- B. Bid inquiries received after May 28, 2026 at 2:00 PM will not be answered, unless the bid opening is postponed by addenda, or the work is rebid following post-bid addenda.

#### 1.6 BID TRANSMITTAL

- A. Submit Bid Form and all required attachments via email as directed in the invitation to bid. Submit the bid before the bid opening date and time indicated in the Invitation for Bid. Bids received after the bid closing date and time will be returned to the Bidder. Delays in bid submittal resulting from electronic complications will not be considered. Bidders may withdraw their bids, by written notice, at any time prior to the indicated date and time scheduled for receipt of bids. However, no bidder may withdraw a bid for a period of 90 calendar days after the bid opening.

#### 1.7 BID OPENING

- A. Bids will be opened and read publicly at 519 W Kalamazoo St, Lansing, MI 48933 at 2:00 PM on June 4, 2026.
- B. Right to Reject: The Owner reserves the right to reject any or all bids, either whole or in part; to award contract to other than the low bidder; to waive any irregularities and/or informalities; and, in general, to make awards in any manner deemed to be in the best interests of the Owner.

## 1.8 CONTRACT AWARD

- A. The Owner reserves the right to determine which bid is best suited for its use, to accept any or all parts of a bid, and assign all or part of the contract to one or more qualified bidders. In awarding the contract, the Owner will consider the past performance of the Contractor; conformity of the bid to the Bidding Requirements; bid price(s); and availability of funds.
- B. Within three (3) days after receiving the Form of Agreement, sign and submit the Agreement (by hand delivery of overnight mail) to the Architect.
- C. Within seven (7) days after receiving the executed form of Agreement (signed by all parties to the Agreement), submit the following to the Consultant:
  - 1. Performance Bond: A Surety Bond in the full amount of the Contract, with the Owner indicated as "Obligee," ensuring faithful performance of all provisions of the Contract. The Surety Company shall be authorized to do business in the State of Michigan and shall be approved by the Owner.
  - 2. Payment Bond: A Surety Bond in the full amount of the Contract, with the Owner indicated as "Obligee," ensuring the payment of all labor and material costs. The Surety Company shall be authorized to do business in the Jurisdiction where the project is located and shall be approved by the Owner.
  - 3. Insurance Certificates. Refer to insurance requirements provided by owner attached after this section.
- D. If the Contractor refuses or fails to submit the bonds and insurance certificates within seven (7) days after receiving the executed Form of Agreement, the Owner may consider the Contract to have abandoned all rights and interests in the Contract award. Consequently, the bid bond may be declared forfeited to the Owner as liquidated damages, and the work may be awarded to another.

END OF INSTRUCTIONS TO BIDDERS

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## Bid Proposal Form

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### **Lansing School District Gardner Elementary School Chilled Replacement Lansing, MI**

**LSD Project #SO-1858  
Project #260150.00**

Proposals are due no later than 2:00 PM on June 4, 2026.  
Bids received after this date and time will not be accepted or considered.

*Please mail or drop off your proposal to: Lansing School District, Attn: Purchasing Dept, 519 W Kalamazoo St, Lansing, MI 48933. All proposals should include one original and two copies in a sealed envelope and clearly marked as SO-1858 Gardner Elementary Chiller Replacement.*

Name of Bidder: \_\_\_\_\_

Address: \_\_\_\_\_

Phone No.: \_\_\_\_\_

E-mail: \_\_\_\_\_

Date: \_\_\_\_\_

#### BASE PROPOSAL

We the undersigned, propose to furnish all labor, materials, and facilities for the completion of the General Construction Contract (including Site, Architectural, Structural, Mechanical and Electrical Work), for the above named project in accordance with drawings and specifications prepared by Matrix Consulting Engineers Inc., dated **May 18, 2026** and all addenda (if applicable), for the sum of:

\_\_\_\_\_ dollars

(\$ \_\_\_\_\_) and hereby agree to enter into a contract for the work if this proposal is accepted in writing.



ADDENDA

We acknowledge the receipt of the following addenda to drawings and specifications:

|                    |               |            |
|--------------------|---------------|------------|
| Addendum No. _____ | Initial _____ | Date _____ |
| Addendum No. _____ | Initial _____ | Date _____ |
| Addendum No. _____ | Initial _____ | Date _____ |

TIME OF COMPLETION

Work is to commence within ten (10) consecutive calendar days after notice of Award of Contract. The work shall be substantially complete on or before October 1, 2026.

BASE BID COST BREAKDOWN

Provide a cost breakdown for each of the subcontractor proposals being provided in the base bid.

| <u>Trade</u>   | <u>Contractor Providing Proposal</u> | <u>Cost</u> |
|----------------|--------------------------------------|-------------|
| General Trades | _____                                | \$ _____    |
| Mechanical     | _____                                | \$ _____    |
| Electrical     | _____                                | \$ _____    |
| Controls       | _____                                | \$ _____    |

FEE FOR HANDLING ADDITIONAL WORK

For handling additional work performed upon instructions of the Owner by subcontractors of the undersigned, add to the subcontractor's prices for the additional work a fee of \_\_\_\_\_%, which shall include all of the undersigned's charges.

For additional work performed upon instructions of the Owner other than that of subcontractors of the undersigned, add to the actual cost of all labor and materials, including insurance and taxes (less all discounts) a fee of \_\_\_\_\_%, which shall include all charges for overhead and profit.

VOLUNTARY SUBSTITUTIONS

If awarded a contract for the work bid upon above, on the basis of the amount of our proposal, we agree to furnish materials and equipment specifically mentioned in the specifications.

If any of the following voluntary substitutions for materials or equipment are approved, we further agree to make the corresponding deduction from our proposal.

| <u>Name of Manufacturer</u> | <u>Amount of Deduction</u> |
|-----------------------------|----------------------------|
| _____                       | \$ _____                   |
| _____                       | \$ _____                   |
| _____                       | \$ _____                   |
| _____                       | \$ _____                   |

PERSONNEL ASSIGNMENT FOR THIS PROJECT:

Project Superintendent: \_\_\_\_\_  
Project Engineer: \_\_\_\_\_

SUBCONTRACTOR ASSIGNMENT FOR THIS PROJECT:

General Trades: \_\_\_\_\_  
Mechanical: \_\_\_\_\_  
Electrical: \_\_\_\_\_  
Controls: \_\_\_\_\_

SIGNATURES

*When the bidder is an individual:*

\_\_\_\_\_  
Bidder

\_\_\_\_\_  
Witness

*When the bidder is a partnership:*

\_\_\_\_\_  
Bidder

\_\_\_\_\_  
Bidder

\_\_\_\_\_  
Bidder

\_\_\_\_\_  
Bidder

\_\_\_\_\_  
Witness

*When the bidder is a corporation:*

\_\_\_\_\_  
President

\_\_\_\_\_  
Secretary

\_\_\_\_\_ is a corporation organized and existing under the laws of  
\_\_\_\_\_ and has (has not) been granted a certificate of authority to do business in the  
State of \_\_\_\_\_.

## SECTION 004373 – PROPOSED SCHEDULE OF VALUES FORMS

### 1.1 POST-BID SUPPLEMENT

- A. A completed Proposed Schedule of Values form is required to be provided, upon request from Architect after bid has been submitted.

### 1.2 PROPOSED SCHEDULE OF VALUES FORM

- A. Proposed Schedule of Values Form: Provide a breakdown of the bid amount, including alternates, in enough detail to facilitate continued evaluation of the bid. Coordinate with the Project Manual table of contents. Provide multiple line items for principal material and subcontract amounts in excess of five percent of the Contract Sum.
- B. Arrange schedule of values consistent with format of AIA Document G703.
  - 1. Copies of AIA standard forms may be obtained from the American Institute of Architects; <http://www.aia.org/contractdocs/purchase/index.htm>; [docspurchases@aia.org](mailto:docspurchases@aia.org); (800) 942-7732.

END OF SECTION 004373

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## SECTION 006000 - FORMS

### 1.1 FORM OF AGREEMENT AND GENERAL CONDITIONS

- A. The following form of Owner/Contractor Agreement and form of General Conditions shall be used for the Project:
  - 1. AIA Document A101, "Standard Form of Agreement between Owner and Contractor, Stipulated Sum."
    - a. The General Conditions for the Project are AIA Document A201, "General Conditions of the Contract for Construction."

### 1.2 ADMINISTRATIVE FORMS

- A. Administrative Forms: Additional administrative forms are specified in Division 01 General Requirements.
- B. Copies of AIA standard forms may be obtained from the American Institute of Architects; <http://www.aia.org/contractdocs/purchase/index.htm>; [docspurchases@aia.org](mailto:docspurchases@aia.org); (800) 942-7732.
- C. Preconstruction Forms
  - 1. Form of Performance Bond and Labor and Material Bond: AIA Document A312, "Performance Bond and Payment Bond."
  - 2. Form of Certificate of Insurance: AIA Document G715, "Supplemental Attachment for ACORD Certificate of Insurance 25-S."
- D. Information and Modification Forms:
  - 1. Form of Request for Proposal: AIA Document G709, "Work Changes Proposal Request."
  - 2. Change Order Form: AIA Document G701, "Change Order."
  - 3. Form of Architect's Memorandum for Minor Changes in the Work: AIA Document G707, "Architect's Supplemental Instructions."
  - 4. Form of Change Directive: AIA Document G714, "Construction Change Directive."
- E. Payment Forms:
  - 1. Schedule of Values Form: AIA Document G703, "Continuation Sheet."
  - 2. Payment Application: AIA Document G702/703, "Application and Certificate for Payment and Continuation Sheet."
  - 3. Form of Contractor's Affidavit: AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
  - 4. Form of Affidavit of Release of Liens: AIA Document G706A, "Contractor's Affidavit of Payment of Release of Liens."
  - 5. Form of Consent of Surety: AIA Document G707, "Consent of Surety to Final Payment."

END OF SECTION 006000

Lansing School District  
Gardner Elementary School Chiller Replacement  
LSD Project No. SO-1858

Project No. 260150.00  
May 2026  
Bid Documents

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## SECTION 012100 - ALLOWANCES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes administrative and procedural requirements governing allowances.
- B. Types of allowances include the following:
  - 1. General Allowance.

#### 1.3 DEFINITIONS

- A. Allowance: A quantity of work or dollar amount included in the Contract, established in lieu of additional requirements, used to defer selection of actual materials and equipment to a later date when direction will be provided to Contractor. If necessary, additional requirements will be issued by Change Order.

#### 1.4 SELECTION AND PURCHASE

- A. At the earliest practical date after award of the Contract, advise Architect of the date when final selection, or purchase and delivery, of each product or system described by an allowance must be completed by the Owner to avoid delaying the Work.
- B. At Architect's request, obtain proposals for each allowance for use in making final selections. Include recommendations that are relevant to performing the Work.
- C. Purchase products and systems selected by Architect from the designated supplier.

#### 1.5 ACTION SUBMITTALS

- A. Submit proposals for purchase of products or systems included in allowances in the form specified for Change Orders.



## 1.6 INFORMATIONAL SUBMITTALS

- A. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.
- B. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.
- C. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

## 1.7 ALLOWANCES

- A. Use the allowance only as directed by Architect for Owner's purposes and only by Change Orders that indicate amounts to be charged to the allowance.
- B. Contractor's overhead, profit, and related costs for products and equipment ordered by Owner under the allowance are included in the allowance and are not part of the Contract Sum. These costs include delivery, installation, taxes, insurance, equipment rental, and similar costs.
- C. Change Orders authorizing use of funds from the allowance will include Contractor's related costs and reasonable overhead and profit.
- D. At Project closeout, credit unused amounts remaining in the allowance to Owner by Change Order.

## PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

### 3.2 PREPARATION

- A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

### 3.3 SCHEDULE OF ALLOWANCES

- A. Allowance No. 1: General Allowance: Include an allowance of 10% of the Bid Price for use according to Owner's written instructions.

1. This allowance includes material cost; receiving, handling, and installation; and Contractor overhead and profit.

END OF SECTION 012100

## SECTION 013000 - SUBMITTALS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes: This Section includes, but not necessarily limited to, the submittal of Shop Drawings. Samples and other information as indicated on the Drawings, as specified herein, and as necessary for the proper and complete performance of the Work.
- B. Related Sections:
  - 1. Documents affecting work of this Section include, but are not necessarily limited to:
    - a. General Conditions, Supplementary Conditions and Sections in Division 1 of these Specifications.
    - b. Individual submittals required: Pertinent Sections of these Specifications.

### PART 2 - PRODUCTS

#### 2.1 SUBMITTALS REQUIRING ENGINEER'S REVIEW AND RETURN

- A. Drawings:
  - 1. Scale required: Unless otherwise specifically directed by ENGINEER, make all drawings accurately to a scale sufficiently large to indicate all pertinent features of the item and its method of connection to the Work.
  - 2. Type and number of prints required:
    - a. Submit one electronic copy.
- B. Manufacturer's literature and product data:
  - 1. General: Where content of submitted literature from Manufacturers includes data not pertinent to this submittal, clearly indicate which portion of the contents is being submitted for ENGINEER's review.
  - 2. Number of copies required:
    - a. Submit one electronic copy.
- C. Calculations:
  - 1. Performance type design calculations: Shall be prepared and sealed by a Professional Engineer licensed in the state where the project is being constructed.
  - 2. Number of copies required: Submit one electronic copy.

D. Samples:

1. General:

a. Samples:

- 1) Illustrate materials, equipment and workmanship.
- 2) Establish standards by which completed work is judged.

2. Accuracy of Sample: Unless otherwise specifically directed by ENGINEER, all Samples shall be of the precise articles proposed to be furnished.
3. Number of Samples required: Submit all Samples in the quantity which is required to be returned plus 1.

E. Colors and patterns: Unless the precise color and pattern is specifically described in the Contract Documents, whenever a choice of color or pattern is available in a specified Product, submit accurate color charts and pattern charts to ENGINEER for review and selection.

F. Closeout Manuals :

1. General:

- a. Where manuals are required to be submitted covering items included in this Work, prepare all such manuals in durable plastic binders approximately 8 ½ inches x 11 inches in size and with at least the following:

- 1) Identification on, or readable through, the front cover stating general nature of the manual.
- 2) Neatly typewritten index near the front of the manual.
- 3) Complete instructions regarding operation and maintenance of all equipment involved.
- 4) Complete nomenclature of all replaceable parts, their part numbers, current costs and name and address of nearest vendor of parts.
- 5) Copies of all guarantees and warranties issued.
- 6) Copies of the reviewed drawings.
- 7) Copies of all data concerning all changes made during construction.

2. Extraneous Data: Where contents of the manuals include Manufacturer's catalog pages. Clearly indicate the precise items included in this installation and delete or otherwise clearly indicate all Manufacturer's data with which this installation is not concerned.

3. Number of copies required: Unless otherwise specifically directed by ENGINEER or stipulated in the pertinent Section of these Specifications. Submit one electronic copy of the manual to ENGINEER. After review, contractor shall deliver one hard copy binder and one electronic copy of binder to ENGINEER for owner's records.

## 2.2 SUBMITTALS NOT REQUIRING ENGINEER'S RETURN

### A. General:

1. Including, but not necessarily limited to:
  - a. Test Reports.
  - b. Certifications and affidavits.
  - c. Installation instructions.

## PART 3 - EXECUTION

### 3.1 SCHEDULE OF SUBMITTALS

#### A. Preparation and submittal of a schedule of submittals:

1. Prepare and submit a schedule of submittals as required by Section 00700: General Conditions.
2. The schedule of submittals shall include the following:
  - a. Shop Drawings.
  - b. Manufacturer's literature and product data.
  - c. Samples.
  - d. Colors and patterns.
  - e. Manuals.
  - f. Other submittals required by the Contract Documents.
3. Allow at least 15 full working days for ENGINEER's review following ENGINEER's receipt of the submittal unless ENGINEER has agreed to a shorter period for specific submittals.
4. Schedule submittals, except operation and maintenance manuals, far enough in advance of scheduled dates for installation to provide all required time for reviews for securing necessary approvals for possible revision and resubmittal, and for placing orders and securing delivery.
5. Schedule submittal of operation and maintenance manuals at least 60 days prior to system Substantial Completion unless otherwise specified.

#### B. Make all submittals in accordance with the schedule of submittals.

#### C. Be responsible for costs of delays caused by tardiness of submittals.

### 3.2 COORDINATION OF SUBMITTALS

#### A. General:

1. Prior to submittals for ENGINEER's review. Use all means necessary to fully

coordinate all material including the following procedures.

- a. Determine and verify all field dimensions and conditions, catalog numbers and similar data.
- b. Coordinate as required with all trades and all public involved.
- c. Secure all necessary approvals from public agencies and others; signify by stamp or other means that all required approvals have been obtained.
- d. Clearly indicate all deviations from the Contract Documents.

B. Grouping of submittals:

1. Unless otherwise specifically permitted by ENGINEER, make all submittals in groups containing all associated items.
2. ENGINEER may reject partial submittals as not complying with the provisions of the Contract Documents.

3.3 IDENTIFICATION OF SUBMITTALS

A. General:

1. Consecutively number all submittals.
2. Accompany each submittal with a letter of transmittal showing the following:
  - a. Project title and number.
  - b. OWNER.
  - c. Subcontractor.
  - d. Date of submittal.
  - e. Specification Section or Drawing number to which the submittal pertains.
  - f. Brief description of the material submitted.
  - g. Submittal identification number.
3. Mark each submittal with:
  - a. Company name of the originator of the submittal.
  - b. Deviations from Contract Documents.
  - c. CONTRACTOR's approval of the submittal.
  - d. Submittal identification number adjacent to CONTRACTOR's approval.

B. Resubmittal:

1. When material is resubmitted for any reason, transmit under a new letter of transmittal with a suffix added to the original submittal identification number.
2. Indicate that this is a resubmittal and refer to the previous submittal.

C. Submittal Log:

1. Maintain an accurate submittal log for the duration of the construction period showing the status of all submittals of all types.
2. Make the log available to ENGINEER for review upon request.

### 3.4 RETURN OF SUBMITTALS

#### A. Submittals requiring ENGINEER review and return:

1. With status. "Rejected. Resubmit":
  - a. Drawings: ENGINEER will retain 1 copy and return the rejected copies to CONTRACTOR.
  - b. Manufacturer's literature and product data: ENGINEER will retain 1 copy and return remaining copies to CONTRACTOR.
  - c. Other submittals: ENGINEER will notify CONTRACTOR of rejection.
2. With status: "Reviewed. No Exceptions Taken" and "Reviewed w/Corrections Noted":
  - a. Drawings: ENGINEER will retain 4 copies and return the remaining copies to CONTRACTOR.
  - b. Manufacturer's literature and product data: ENGINEER will retain 4 copies and return the remaining copies to CONTRACTOR.
  - c. Samples: ENGINEER will retain 1 Sample and return the remaining Samples to CONTRACTOR.
  - d. Colors: ENGINEER will retain color charts and pattern charts and will indicate color and pattern choices to CONTRACTOR.

#### B. Submittals not requiring ENGINEER return: No copies will be returned.

### 3.5 RESUBMISSION REQUIREMENTS

#### A. Drawings:

1. Revise initial drawings as required and resubmit as specified for initial submittal.
2. Indicate on drawings all changes which have been made other than those requested by ENGINEER.
3. If the same drawings are submitted with additional data and revisions, clearly identify the added data and revisions on the drawings.

#### B. Other submittals: Submit as required for initial submittal.

### 3.6 RE-REVIEW COST

- #### A.
- Should ENGINEER be required to review a submittal more than twice because of failure of the submittal to meet the requirements of the Contract Documents, ENGINEER will record ENGINEER's expenses for performing all additional reviews. The OWNER will compensate ENGINEER for these additional services and deduct the amount paid from payments to CONTRACTOR.

END OF SECTION 013000

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## SECTION 013516 - ALTERATION PROJECT PROCEDURES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes special procedures for alteration work.

#### 1.2 DEFINITIONS

- A. Alteration Work: This term includes remodeling, renovation, repair, and maintenance work performed within existing spaces or on existing surfaces as part of the Project.
- B. Consolidate: To strengthen loose or deteriorated materials in place.
- C. Design Reference Sample: A sample that represents the Engineer's prebid selection of work to be matched; it may be existing work or work specially produced for the Project.
- D. 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.
- E. Match: To blend with adjacent construction and manifest no apparent difference in material type, species, cut, form, detail, color, grain, texture, or finish; as approved by Architect.
- F. Refinish: To remove existing finishes to base material and apply new finish to match original, or as otherwise indicated.
- G. Repair: To correct damage and defects, retaining existing materials, features, and finishes. This includes patching, piecing-in, splicing, consolidating, or otherwise reinforcing or upgrading materials.
- H. Replace: To remove, duplicate, and reinstall entire item with new material. The original item is the pattern for creating duplicates unless otherwise indicated.
- I. Replicate: To reproduce in exact detail, materials, and finish unless otherwise indicated.
- J. Reproduce: To fabricate a new item, accurate in detail to the original, and from either the same or a similar material as the original, unless otherwise indicated.
- K. Retain: To keep an element or detail secure and intact.
- L. Strip: To remove existing finish down to base material unless otherwise indicated.

### 1.3 QUALITY ASSURANCE

- A. Fire-Prevention Plan: Prepare a written plan for preventing fires during the Work, including placement of fire extinguishers, fire blankets, rag buckets, and other fire-control devices during each phase or process. Coordinate plan with Owner's fire-protection equipment and requirements. Include fire-watch personnel's training, duties, and authority to enforce fire safety.
- B. Safety and Health Standard: Comply with ANSI/ASSP A10.6.

### PART 2 - PRODUCTS - (Not Used)

### PART 3 - EXECUTION

#### 3.1 PROTECTION

- A. Temporary Protection of Materials to Remain:
  - 1. Protect existing materials with temporary protections and construction. Do not remove existing materials unless otherwise indicated.
  - 2. Do not attach temporary protection to existing surfaces except as indicated as part of the alteration work program.
- B. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.
- C. Utility and Communications Services:
  - 1. Notify Owner, Architect, authorities having jurisdiction, and entities owning or controlling wires, conduits, pipes, and other services affected by alteration work before commencing operations.
  - 2. Disconnect and cap pipes and services as required by authorities having jurisdiction, as required for alteration work.
  - 3. Maintain existing services unless otherwise indicated; keep in service, and protect against damage during operations. Provide temporary services during interruptions to existing utilities.

#### 3.2 PROTECTION FROM FIRE

- A. General: Follow fire-prevention plan and the following:
  - 1. Comply with NFPA 241 requirements unless otherwise indicated.
  - 2. Remove and keep area free of combustibles, including rubbish, paper, waste, and chemicals, unless necessary for the immediate work.

- a. If combustible material cannot be removed, provide fire blankets to cover such materials.
- B. Heat-Generating Equipment and Combustible Materials: Comply with the following procedures while performing work with heat-generating equipment or combustible materials, including welding, torch-cutting, soldering, brazing, removing paint with heat, or other operations where open flames or implements using high heat or combustible solvents and chemicals are anticipated:
  1. Obtain Owner's approval for operations involving use of open-flame or welding or other high-heat equipment. Notify Owner at least 72 hours before each occurrence, indicating location of such work.
  2. As far as practicable, restrict heat-generating equipment to shop areas or outside the building.
  3. Do not perform work with heat-generating equipment in or near rooms or in areas where flammable liquids or explosive vapors are present or thought to be present. Use a combustible gas indicator test to ensure that the area is safe.
  4. Use fireproof baffles to prevent flames, sparks, hot gases, or other high-temperature material from reaching surrounding combustible material.
  5. Prevent the spread of sparks and particles of hot metal through open windows, doors, holes, and cracks in floors, walls, ceilings, roofs, and other openings.
  6. Fire Watch: Before working with heat-generating equipment or combustible materials, station personnel to serve as a fire watch at each location where such work is performed. Fire-watch personnel shall have the authority to enforce fire safety. Station fire watch according to NFPA 51B, NFPA 241, and as follows:
    - a. Train each fire watch in the proper operation of fire-control equipment and alarms.
    - b. Prohibit fire-watch personnel from other work that would be a distraction from fire-watch duties.
    - c. Cease work with heat-generating equipment whenever fire-watch personnel are not present.
    - d. Have fire-watch personnel perform final fire-safety inspection each day beginning no sooner than 30 minutes after conclusion of work in each area to detect hidden or smoldering fires and to ensure that proper fire prevention is maintained.
    - e. Maintain fire-watch personnel at each area of Project site until two hours after conclusion of daily work.
- C. Fire-Control Devices: Provide and maintain fire extinguishers, fire blankets, and rag buckets for disposal of rags with combustible liquids. Maintain each as suitable for the type of fire risk in each work area. Ensure that nearby personnel and the fire-watch personnel are trained in fire-extinguisher and blanket use.

### 3.3 GENERAL ALTERATION WORK

- A. Record existing work before each procedure (preconstruction), and record progress during the work. Use digital preconstruction documentation photographs or video recordings.
- B. Perform surveys of Project site as the Work progresses to detect hazards resulting from alterations.

- C. Notify Architect of visible changes in the integrity of material or components whether from environmental causes including biological attack, UV degradation, freezing, or thawing or from structural defects including cracks, movement, or distortion.

- 1. Do not proceed with the work in question until directed by Architect.

END OF SECTION 013516

LANSING SCHOOL DISTRICT  
PURCHASING DEPARTMENT  
519 W. KALAMAZOO ST., ROOM 200  
LANSING MI 48933  
(517) 755-3030  
FAX (517) 755-3019

**SUPPLIER/VENDOR APPLICATION**  
(Please type or print)

PURFR016 – 7/7/08 – Version 5

MARK ONE:

- ☐ New Application  
☐ Update

Date: \_\_\_\_\_

W-9 form attached? ☐ YES ☐ NO

DUN & BRADSTREET RATING (if available)

|                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                 |                     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|---------------------|
| <b>NAME OF COMPANY</b>                                                                                                                                                                                                                                                                                                                                                   | <b>FEDERAL ID NUMBER (OR) SOCIAL SECURITY NUMBER</b><br><small>Submit copy of W-9 form with application</small> |                     |
| <b>ADDRESS TO WHICH BIDDING FORMS AND PURCHASE ORDERS ARE TO BE MAILED – STREET NO., CITY, STATE, ZIP CODE</b>                                                                                                                                                                                                                                                           |                                                                                                                 |                     |
| <b>ADDRESS TO WHICH PAYMENTS ARE TO BE MAILED – STREET NO., CITY, STATE, ZIP CODE</b>                                                                                                                                                                                                                                                                                    |                                                                                                                 |                     |
| <b>PARENT COMPANY AND ADDITIONAL OFFICE LOCATIONS IN MICHIGAN (May attach separate sheet)</b>                                                                                                                                                                                                                                                                            |                                                                                                                 |                     |
| <b>E-MAIL ADDRESS:</b><br><small>For Purchase orders to be emailed</small>                                                                                                                                                                                                                                                                                               |                                                                                                                 |                     |
| <b>WEB SITE:</b>                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                 |                     |
| <b>TYPE OF ORGANIZATION</b><br><input type="checkbox"/> Individual <input type="checkbox"/> Partnership <input type="checkbox"/> Corporation                                                                                                                                                                                                                             | <b>TELEPHONE #:</b> _____<br><b>FACSIMILIE #:</b> _____                                                         |                     |
| <b>PERSONS TO CONTACT AND THOSE AUTHORIZED TO SIGN BIDS AND CONTRACTS IN YOUR NAME (if agent, so specify)</b>                                                                                                                                                                                                                                                            |                                                                                                                 |                     |
| Name                                                                                                                                                                                                                                                                                                                                                                     | Official Capacity                                                                                               | Telephone No.       |
|                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                 |                     |
|                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                 |                     |
| PLEASE LIST ON THE REVERSE SIDE CLASSES OF EQUIPMENT, SUPPLIES, MATERIALS, AND/OR SERVICES ON WHICH YOU DESIRE TO BID.<br><input type="checkbox"/> Do you require a hard copy of verbal orders? Yes ____ No ____      Do you accept Procurement Cards? Yes ____ No ____<br><input type="checkbox"/> Electronic Disk Catalog <input type="checkbox"/> Electronic Ordering |                                                                                                                 |                     |
| <b>Please complete the following:</b><br>STANDARD PAYMENT TERMS: _____ PROMPT PAY DISCOUNT: _____ STANDARD DELIVERY TIME: _____                                                                                                                                                                                                                                          |                                                                                                                 |                     |
| <b>PLEASE COMPLETE BELOW</b>                                                                                                                                                                                                                                                                                                                                             |                                                                                                                 |                     |
| Please list percentage and circle category that applies:                                                                                                                                                                                                                                                                                                                 |                                                                                                                 |                     |
| MINORITY OWNED: ____% Native-American Asian-Pacific American African-American Hispanic-American Asian-Indian American                                                                                                                                                                                                                                                    |                                                                                                                 |                     |
| WOMEN OWNED: ____% White Native-American Asian-Pacific American African-American Hispanic-American Asian-Indian American                                                                                                                                                                                                                                                 |                                                                                                                 |                     |
| DISABLED: ____%      SMALL BUSINESS: Yes ____ No ____<br>Business located within LANSING SCHOOL District Yes ____ No ____                                                                                                                                                                                                                                                |                                                                                                                 |                     |
| Are you certified? If so, list agencies                                                                                                                                                                                                                                                                                                                                  |                                                                                                                 | Certificate Number: |
| _____                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                 | _____               |
| _____                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                 | _____               |
| _____                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                 | _____               |
| <b>SIGNATURE OF PERSON AUTHORIZED TO SIGN THIS APPLICATION</b><br>_____                                                                                                                                                                                                                                                                                                  |                                                                                                                 |                     |
| <b>NAME AND TITLE OF PERSON SIGNING (Please type or print)</b><br>_____                                                                                                                                                                                                                                                                                                  |                                                                                                                 |                     |

## COMMODITY LIST

Please place a checkmark (✓) by the appropriate code and provide a detailed description of the commodities and/or services offered. If the complete NAICS Code is known please include this number in the description area.  
Website URL address for NAICS is: <http://www.census.gov/epcd/www/naics.html>

| NAICS CODE                                                                    | DESCRIPTION |
|-------------------------------------------------------------------------------|-------------|
| ____11 – Agriculture, Forestry, Fishing and Hunting                           |             |
| ____21 – Mining                                                               |             |
| ____22 – Utilities                                                            |             |
| ____23 – Construction                                                         |             |
| ____31-33 – Manufacturing                                                     |             |
| ____42 – Wholesale Trade                                                      |             |
| ____44-45 – Retail Trade                                                      |             |
| ____48-49 – Transportation and Warehousing                                    |             |
| ____51 – Information                                                          |             |
| ____52 – Finance and Insurance                                                |             |
| ____53 – Real Estate and Rental and Leasing                                   |             |
| ____54 – Professional, Scientific and Technical Services                      |             |
| ____55 – Management of Companies and Enterprises                              |             |
| ____56 – Administrative & Support, Waste Management<br>& Remediation Services |             |
| ____61 – Educational Services                                                 |             |
| ____62 – Health Care and Social Assistance                                    |             |
| ____71 – Arts, Entertainment and Recreation                                   |             |
| ____72 – Accommodation and Foodservices                                       |             |
| ____81 – Other Services (except Public Administration)                        |             |
| ____92 – Public Administration                                                |             |
| ____99 – Unclassified Establishments                                          |             |

CATEGORY (Check below the category which applies to the applicant)

- ☐ (A) Manufacturer or Producer ☐ (B) Wholesaler ☐ (C) Retailer ☐ (D) Mfg'r Agent ☐ (E) Distributor  
☐ (F) Service Establishment



Committed to Quality

**STATEMENT OF NO BID**

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NOTE: IF YOU DO NOT INTEND TO BID, PLEASE RETURN THIS FORM ONLY TO:

Lansing School District  
519 W KALAMAZOO ST  
LANSING, MI 48933

BID NO: # \_\_\_\_\_

PHONE: 517-755-3030  
FAX: 517-755-3019

We, the undersigned, have declined to bid on the above noted bid for the following reasons:

\_\_\_\_\_ Insufficient time to respond to the invitation to Bid.

\_\_\_\_\_ Request for Proposal is unclear.

\_\_\_\_\_ Do not offer this product or service.

\_\_\_\_\_ Our schedule will not permit us to perform.

\_\_\_\_\_ Unable to meet the specifications

\_\_\_\_\_ Specifications are unclear (Please explain below)

\_\_\_\_\_ Remove us from your Bidder Mailing List

\_\_\_\_\_ Other ( Please specify below)

REMARKS:

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Company Name: \_\_\_\_\_

Signature: \_\_\_\_\_

Date: \_\_\_\_\_ Telephone: \_\_\_\_\_ Fax: \_\_\_\_\_

**AFFIDAVIT OF BIDDER**

The undersigned, the owner or authorized officer of \_\_\_\_\_(the “Bidder), pursuant to the familial disclosure requirement provided in the \_\_\_\_\_(the “School District”) advertisement for construction bids, hereby represent and warrant, except as provided below, that no familial relationships exist between the owner(s) or any employee of \_\_\_\_\_and any member of the Board of Education of the School District or the Superintendent of the School District.

List any Familial Relationships:

**BIDDER:**

\_\_\_\_\_

By: \_\_\_\_\_

Its: \_\_\_\_\_

STATE OF MICHIGAN                    )  
                                                  )ss.  
COUNTY OF \_\_\_\_\_ )

This instrument was acknowledged before me on the \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_, by  
\_\_\_\_\_.

\_\_\_\_\_

, Notary Public

\_\_\_\_\_ County, Michigan

My Commission Expires: \_\_\_\_\_

Acting in the County of: \_\_\_\_\_





|              |                                                    |
|--------------|----------------------------------------------------|
| Book         | Policy Manual                                      |
| Section      | 3000 Professional Staff                            |
| Title        | NONDISCRIMINATION AND EQUAL EMPLOYMENT OPPORTUNITY |
| Code         | po3122                                             |
| Status       | Active                                             |
| Adopted      | November 1, 2016                                   |
| Last Revised | June 22, 2023                                      |

### 3122 - **NONDISCRIMINATION AND EQUAL EMPLOYMENT OPPORTUNITY**

The Board of Education does not discriminate on the basis of race, color, national origin, sex (including sexual orientation and gender identity), disability, age, religion, height, weight, marital or family status, military status, ancestry, genetic information, or any other legally protected category, (collectively, "Protected Classes"), in its programs and activities, including employment opportunities.

#### **Definitions:**

Words used in this policy shall have those meanings defined herein; words not defined herein shall be construed according to their plain and ordinary meanings.

Race is inclusive of traits historically associated with race, including, but not limited to, hair texture and protective hairstyles. For purposes of this definition, "protective hairstyles" includes, but is not limited to, such hairstyles as braids, locks, and twists.

**Complainant** is the individual who alleges, or is alleged, to have been subjected to unlawful discrimination/retaliation, regardless of whether the person files a formal complaint or is pursuing an informal resolution to the alleged discrimination/retaliation.

**Respondent** is the individual who has been alleged to have engaged in unlawful discrimination/retaliation, regardless of whether the Reporting Party files a formal complaint or is seeking an informal resolution to the alleged discrimination/retaliation.

**School District community** means students and Board employees (i.e., administrators, and professional and classified staff), as well as Board members, agents, volunteers, contractors, or other persons subject to the control and supervision of the Board.

**Third Parties** include, but are not limited to, guests and/or visitors on School District property (e.g., visiting speakers, participants on opposing athletic teams, parents), vendors doing business with, or seeking to do business with, the Board, and other individuals who come in contact with members of the School District community at school-related events/activities (whether on or off District property).

**Day(s):** Unless expressly stated otherwise, the term "day" or "days" as used in this policy means a business day(s) (i.e., a day(s) that the Board office is open for normal operating hours, Monday - Friday, excluding State-recognized holidays).

For purposes of this policy, "military status" refers to a person's status in the uniformed services, which includes the performance of duty, on a voluntary basis, or involuntary basis, in a uniformed service including active duty, active duty for training, initial active duty for training, inactive duty for training, full-time National Guard duty. It also includes the period of time for which a person is absent from employment for the purpose of an examination to determine the fitness of the person to perform any such duty as listed above.

### **District Compliance Officers**

The Board designates the following individuals to serve as the District's "Compliance Officers" (also known as "Civil Rights Coordinators") (hereinafter referred to as the "COs").

Darin Walter  
 Title IX - Public Safety  
 517-755-2037  
 519 W Kalamazoo  
 Lansing, MI 48933  
 darin.walter@lansingschools.net

Erin Miracle  
 Human Resources Manager  
 517-755-2010  
 519 W Kalamazoo  
 Lansing, MI 48933  
 Erin.miracle@lansingschools.net

The names, titles, and contact information of these individuals will be published annually on the School District's website and in the staff handbooks, and in the School District Annual Report to the public

The COs are responsible for coordinating the District's efforts to comply with applicable Federal and State laws and regulations, including the District's duty to address in a prompt and equitable manner any inquiries or complaints regarding discrimination/retaliation or denial of equal access. The COs shall also verify that proper notice of nondiscrimination for Title II of the Americans with Disabilities Act (as amended), Title VI and Title VII of the Civil Rights Act of 1964, Section 504 of the Rehabilitation Act of 1973 (as amended), and the Age Discrimination in Employment Act of 1975 is provided to staff members and the general public. A copy of each of the Acts and regulations on which this notice is available upon request from the CO.

### **Reports and Complaints of Unlawful Discrimination and Retaliation**

Employees are required to report incidents of unlawful discrimination and/or retaliation to an administrator, supervisor, or other District-level official so that the Board may address the conduct. Any administrator, supervisor, or other District-level official who receives such a report shall file it with the CO within two (2) days.

Employees who believe they have been unlawfully discriminated/retaliated against are entitled to utilize the complaint process set forth below. Initiating a complaint, whether formally or informally, will not adversely affect the Complainant's employment. While there are no time limits for initiating complaints under this policy, individuals should make every effort to file a complaint as soon as possible after the conduct occurs while the facts are known and potential witnesses are available.

The COs will be available during regular school/work hours to discuss concerns related to unlawful discrimination/retaliation. COs shall accept reports of unlawful discrimination/retaliation directly from any member of the School District community or a Third Party, or received reports that are initially filed with another Board employee. Upon receipt of a report of alleged discrimination/retaliation, the CO will contact the Complainant and begin either an informal or formal complaint process (depending on the Complainant's request and the nature of the alleged discrimination/retaliation), or the CO will designate a specific individual to conduct such a process. The CO will provide a copy of this policy to the Complainant and the Respondent. In the case of a formal complaint, the CO will prepare recommendations for the Superintendent or oversee the preparation of such recommendations by a designee. All members of the School District community must report incidents of discrimination/retaliation that are reported to them to the CO within two (2) business days of learning of the incident/conduct.

Any Board employee who directly observes unlawful discrimination/retaliation is obligated, in accordance with this policy, to report such observations to one of the COs within two (2) business days. Additionally, any Board employee who observes an act of unlawful discrimination/retaliation is expected to intervene to stop the misconduct, unless circumstances make such an intervention dangerous, in which case the staff member should immediately notify other Board employees and/or local law enforcement officials, as necessary, to stop the misconduct. Thereafter, the CO or designee must contact the Complainant within two (2) business days to advise of the Board's intent to investigate the alleged wrongdoing.

### **Investigation and Complaint Procedure (See Form 3122 F2)**

Except for sex discrimination and/or Sexual Harassment that is covered by Policy 2266 - Nondiscrimination on the Basis of Sex in Education Programs or Activities, any employee who alleges to have been subjected to unlawful discrimination or retaliation may seek resolution of the complaint through the procedures described below. The formal complaint procedures

involve an investigation of the individual's claims of discrimination/retaliation and a process for rendering a decision regarding whether the charges are substantiated.

Due to the sensitivity surrounding complaints of unlawful discrimination or retaliation, timelines are flexible for initiating the complaint process; however, individuals are encouraged to file a complaint within thirty (30) days after the conduct occurs. Once the formal complaint process is begun, the investigation will be completed in a timely manner (ordinarily, within fifteen (15) business days of the complaint being received).

The procedures set forth below are not intended to interfere with the rights of any individual to pursue a complaint of unlawful discrimination or retaliation with the United States Department of Education Office for Civil Rights or Equal Employment Opportunity Commission ("EEOC").

### **Informal Complaint Procedure**

The goal of the informal complaint procedure is to promptly stop inappropriate behavior and facilitate resolution through an informal means, if possible. The informal complaint procedure is provided as a less formal option for an employee who alleges unlawful discrimination or retaliation. This informal procedure is not required as a precursor to the filing of a formal complaint. The informal process is only available in those circumstances where the Complainant and the Respondent mutually agree to participate in it.

The Complainant may proceed immediately to the formal complaint process and individuals who participate in the informal procedure may request that the informal process be terminated at any time to move to the formal complaint process.

All complaints involving a District employee or any other adult member of the School District community and a student will be formally investigated.

As an initial course of action, if a Complainant feels comfortable and safe doing so, the individual should tell or otherwise inform the Respondent that the allegedly discriminatory/retaliatory conduct that it is inappropriate and must stop. The Complainant should address the alleged misconduct as soon after it occurs as possible. The COs are available to support and counsel the Complainant when taking this initial step or to intervene on behalf of the individual if requested to do so. A Complainant who is uncomfortable or unwilling to directly approach the Respondent about the inappropriate conduct may file an informal or a formal complaint. In addition, with regard to certain types of unlawful discrimination (e.g., sex discrimination), the CO may advise against the use of the informal complaint process.

A Complainant who alleges unlawful discrimination/retaliation may make an informal complaint, either orally or in writing: 1) to a building administrator; 2) directly to one of the COs; and/or 3) to the Superintendent or other District-level employee.

All informal complaints must be reported to one of the COs who will either facilitate an informal resolution as described below or appoint another individual to facilitate an informal resolution.

The School District's informal complaint procedure is designed to provide the Complainant with a range of options aimed at bringing about a prompt resolution of their concerns. Depending upon the nature of the complaint and the wishes of the Complainant, informal resolution may involve, but not be limited to, one or more of the following:

- A. Advising the Complainant about how to communicate concerns to the Respondent.
- B. Distributing a copy of Policy 3122 – Nondiscrimination and Equal Employment Opportunity to the individuals in the school building or office where the Respondent works.
- C. If both parties agree, the CO may arrange and facilitate a meeting or mediation between the Complainant and the Respondent to work out a mutual resolution.

While there are no set time limits within which an informal complaint must be resolved, the CO or designee is directed to attempt to resolve all informal complaints within fifteen (15) business days of receiving the informal complaint. If the Complainant is dissatisfied with the informal complaint process, the Complainant may proceed to file a formal complaint and, as stated above, either party may request that the informal process be terminated at any time to move to the formal complaint process.

### **Formal Complaint Procedure**

If a complaint is not resolved through the informal complaint process, if one of the parties requested that the informal complaint process be terminated to move to the formal complaint process, or if the Complainant, from the outset, elects to file a formal complaint, or the Compliance Officer(s) determines the allegations are not appropriate for resolution through the informal process, the formal complaint process shall be implemented.

A Complainant may file a formal complaint, either orally or in writing, with a principal, the CO, Superintendent, or other District official. Due to the sensitivity surrounding complaints of unlawful discrimination and retaliation, timelines are flexible for initiating the complaint process; however, individuals should make every effort to file a formal complaint within thirty (30) days after the conduct occurs. If a Complainant informs a principal, Superintendent, or other District official, either orally or in writing, about any complaint of discrimination/retaliation, that employee must report such information to the CO/designee within two (2) business days.

Throughout the course of the process, the CO should keep the parties reasonably informed of the status of the investigation and the decision-making process.

All formal complaints must include the following information to the extent known: the identity of the Respondent; a detailed description of the facts upon which the complaint is based (i.e., when, where, and what occurred); a list of potential witnesses; and the resolution sought by the Complainant.

If the Complainant is unwilling or unable to provide a written statement including the information set forth above, the CO shall ask for such details in an oral interview. Thereafter, the CO will prepare a written summary of the oral interview, and the Complainant will be asked to verify the accuracy of the reported charge by signing the document.

Upon receiving a formal complaint, the CO will consider whether any action should be taken in the investigatory phase to protect the Complainant from further discrimination or retaliation, including, but not limited to, a change of work assignment or schedule for the Complainant and/or the Respondent. In making such a determination, the CO should consult the Complainant to assess whether the individual agrees with the proposed action. If the Complainant is unwilling to consent to the proposed change, the CO may still take whatever actions deemed appropriate in consultation with the Superintendent.

Within two (2) business days of receiving the complaint, the CO or designee will initiate a formal investigation to determine whether the Complainant has been subjected to unlawful discrimination/retaliation.

Simultaneously, the CO will inform the Respondent that a formal complaint has been received. The Respondent will be informed about the nature of the allegations and provided with a copy of any relevant policies and/or administrative guidelines, including Policy 3122 - Nondiscrimination and Equal Employment Opportunity. The Respondent must also be informed of the opportunity to submit a written response to the formal complaint within five (5) days.

Although certain cases may require additional time, the CO or a designee will attempt to complete an investigation into the allegations of discrimination/retaliation within fifteen (15) business days of receiving the formal complaint. The investigation will include:

- A. interviews with the Complainant;
- B. interviews with the Respondent;
- C. interviews with any other witnesses who may reasonably be expected to have any information relevant to the allegations;
- D. consideration of any documentation or other information presented by the Complainant, Respondent, or any other witness that is reasonably believed to be relevant to the allegations.

At the conclusion of the investigation, the CO/designee shall prepare and deliver a written report to the Superintendent that summarizes the evidence gathered during the investigation and provides recommendations based on the evidence and the definition of unlawful discrimination/retaliation as provided in Board policy and State and Federal law as to whether the Respondent has engaged in unlawful harassment/retaliation of the Complainant. The CO's recommendations must be based upon the totality of the circumstances. In determining if discrimination or retaliation occurred, a preponderance of evidence standard will be used. The CO may consult with the Board's legal counsel before finalizing the report to the Superintendent.

Absent extenuating circumstances, within five (5) business days of receiving the report of the CO or the designee, the Superintendent must either issue a written decision regarding whether the charges have been substantiated or request further investigation. A copy of the Superintendent's final decision will be delivered to both the Complainant and the Respondent.

If the Superintendent requests additional investigation, the Superintendent must specify the additional information that is to be gathered, and such additional investigation must be completed within five (5) business days. At the conclusion of the additional investigation, the Superintendent must issue a final written decision as described above.

If the Superintendent determines the Respondent engaged in unlawful discrimination/retaliation toward the Complainant, the Superintendent must identify what corrective action will be taken to stop, remedy, and prevent the recurrence of the discrimination/retaliation. The corrective action should be reasonable, timely, age-appropriate, effective, and tailored to the



specific situation.

The Board reserves the right to investigate and resolve a complaint or report of unlawful discrimination/retaliation regardless of whether the employee alleging the unlawful discrimination/retaliation pursues the complaint. The Board also reserves the right to have the formal complaint investigation conducted by an external person in accordance with this policy or in such other manner as deemed appropriate by the Board or its designee.

The right of a person to a prompt and equitable resolution of the complaint shall not be impaired by the person's pursuit of other remedies such as the filing of a complaint with the Office for Civil Rights, the filing of charges with local law enforcement, or the filing of a civil action in court. Use of this internal complaint process is not a prerequisite to the pursuit of other remedies.

### **Privacy/Confidentiality**

The District will employ all reasonable efforts to protect the rights of the Complainant, the Respondent(s), and the witnesses as much as possible, consistent with the Board's legal obligations to investigate, to take appropriate action, and to conform with any discovery or disclosure obligations. All records generated under the terms of this policy shall be maintained as confidential to the extent permitted by law. Confidentiality, however, cannot be guaranteed. Additionally, the Respondent must be provided with the Complainant's identity.

During the course of a formal investigation, the CO or designee will instruct each person who is interviewed about the importance of maintaining confidentiality. Any individual who is interviewed as part of an investigation is expected not to disclose to third parties any information that is learned or provided during the course of the investigation.

### **Sanctions and Monitoring**

The Board shall vigorously enforce its prohibitions against unlawful discrimination/retaliation by taking appropriate action reasonably calculated to stop and prevent further misconduct. While observing the principles of due process, a violation of this policy may result in disciplinary action up to and including the discharge of an employee. All disciplinary action will be taken in accordance with applicable State law and the terms of the relevant collective bargaining agreement(s). When imposing discipline, the Superintendent shall consider the totality of the circumstances involved in the matter. In those cases where unlawful discrimination/retaliation is not substantiated, the Board may consider whether the alleged conduct nevertheless warrants discipline in accordance with other Board policies, consistent with the terms of the relevant collective bargaining agreement(s).

Where the Board becomes aware that a prior remedial action has been taken against an employee, all subsequent sanctions imposed by the Board and/or Superintendent shall be reasonably calculated to end such conduct, prevent its recurrence, and remedy its effect.

### **Retaliation**

Retaliation against a person who makes a report or files a complaint alleging unlawful harassment/retaliation or participates as a witness in an investigation is prohibited. Neither the Board nor any other person may intimidate, threaten, coerce or interfere with any individual because the person opposed any act or practice made unlawful by any Federal or State civil rights law, or because that individual made a report, formal complaint, testified, assisted or participated or refused to participate in any manner in an investigation, proceeding, or hearing under those laws and/or this policy, or because that individual exercised, enjoyed, aided or encouraged any other person in the exercise or enjoyment of any right granted or protected by those laws and/or this policy.

Retaliation against a person for making a report of discrimination, filing a formal complaint, or participating in an investigation or meeting is a serious violation of this policy that can result in the imposition of disciplinary sanctions/consequences and/or other appropriate remedies.

Formal complaints alleging retaliation may be filed according to the internal complaint process set forth above.

The exercise of rights protected under the First Amendment of the United States Constitution does not constitute retaliation prohibited under this policy.

### **Education and Training**

In support of this policy, the Board promotes preventative educational measures to create greater awareness of unlawful discriminatory practices. The Superintendent shall provide appropriate information to all members of the School District community related to the implementation of this policy and shall provide training for District students and staff where appropriate. All training, as well as all information provided regarding the Board's policy and discrimination in general, will be age and content appropriate.

## Retention of Investigatory Records and Materials

The Compliance Officer(s) is responsible for overseeing the retention of all records that must be maintained pursuant to this policy. All individuals charged with conducting investigations under this policy shall retain all documents, electronically stored information ("ESI"), and electronic media (as defined in Policy 8315) created and/or received as part of an investigation, which may include but not be limited to:

- A. all written reports/allegations/complaints/grievances/statements/responses pertaining to an alleged violation of this policy;
- B. any narratives that memorialize oral reports/allegations/complaints/grievances/statements/responses pertaining to an alleged violation of this policy;
- C. any documentation that memorializes the actions taken by District personnel or individuals contracted or appointed by the Board to fulfill its responsibilities related to the investigation and/or the District's response to the alleged violation of this policy;
- D. written witness statements;
- E. narratives, notes from, or audio, video, or digital recordings of witness interviews/statements;
- F. e-mails, texts, or social media posts that directly relate to or constitute evidence pertaining to an alleged violation of this policy (i.e., not after-the-fact commentary about or media coverage of the incident);
- G. notes or summaries prepared contemporaneously by the investigator in whatever form made (e.g., handwritten, keyed into a computer or tablet, etc.), but not including transitory notes whose content is otherwise memorialized in other documents;
- H. written disciplinary sanctions issued to students or employees and other documentation that memorializes oral disciplinary sanctions issued to students or employees for violations of this policy;
- I. dated written determinations/reports (including summaries of relevant exculpatory and inculpatory evidence) and other documentation that memorializes oral notifications to the parties concerning the outcome of the investigation, including any consequences imposed as a result of a violation of this policy;
- J. documentation of any supportive measures offered and/or provided to the Complainant and/or Respondent, including no-contact orders issued to both parties, the dates the no-contact orders were issued, and the dates the parties acknowledged receipt of the no-contact orders;
- K. documentation of all actions taken, both individual and systemic, to stop the discrimination or harassment, prevent its recurrence, eliminate any hostile environment, and remedy its discriminatory effects;
- L. copies of the Board policy and/or procedures/guidelines used by the District to conduct the investigation, and any documents used by the District at the time of the alleged violation to communicate the Board's expectations to students and staff with respect to the subject of this policy (e.g., Student Codes of Conduct and/or Employee Handbooks);
- M. copies of any documentation that memorializes any formal or informal resolutions to the alleged discrimination or harassment.

The documents, ESI, and electronic media (as defined in Policy 8315) retained may include public records and records exempt from disclosure under Federal (e.g., FERPA, ADA) and/or State law – e.g., student records and confidential medical records.

The documents, ESI, and electronic media (as defined in Policy 8315) created or received as part of an investigation shall be retained in accordance with Policy 8310, Policy 8315, Policy 8320, and Policy 8330 for not less than three (3) years, but longer if required by the District's records retention schedule.

Revised 10/19/17

Revised 11/15/18

T.C. 3/8/21

Revised 12/02/21

T.C. 6/22/23

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Legal

M.C.L. 37.2101 et seq., 37.1101 et seq.

20 U.S.C. Section 1681, Title IX of Education Amendment Act

20 U.S.C. Section 1701 et seq., Equal Educational Opportunities Act of 1974

20 U.S.C. Section 7905, Boy Scouts of America Equal Access Act

29 C.F.R. Part 1635

29 U.S.C. 701 et seq., Rehabilitation Act of 1973 as amended

34 C.F.R. Part 110 (7/27/93)

42 U.S.C. 2000e et seq., Civil Rights Act of 1964

42 U.S.C. 2000ff et seq., The Genetic Information Nondiscrimination Act

42 U.S.C. 6101 et seq., Age Discrimination Act of 1975

42 U.S.C. 12101 et seq., The Americans with Disabilities Act of 1990, as amended

Fourteenth Amendment, U.S. Constitution

# **NON-DISCRIMINATION IN EMPLOYMENT CERTIFICATION**

## **Lansing School District Certificate of Intent to Comply with “NON-DISCRIMINATION IN EMPLOYMENT” POLICY**

I have read Lansing School District’s Policy #3122, including paragraph #13 and hereby state my intent to comply with the terms and conditions contained therein. Further I agree to furnish the Michigan Civil Rights Commission with such data and records concerning employment as may be requested by that agency in determining compliance with the policy.

Print or type name of Contact Person:

Signed: \_\_\_\_\_

\_\_\_\_\_

Title: \_\_\_\_\_

Company: \_\_\_\_\_

Date: \_\_\_\_\_



# AFFIDAVIT OF BIDDER - NON-COLLUSION

**Lansing School District**  
**AFFIDAVIT OF BIDDER**  
**SWORN STATEMENT**  
**“Non-Collusion”**

DATE: \_\_\_\_\_

The Bidder, by its officers and agents or representatives, present at the time of filing this bid, being duly sworn, on their oaths, say that neither they nor any of them, have in any way, directly or indirectly, entered into any arrangement or agreement with any other Bidder, whereby such affiant or affiants or either of them has paid or is to pay to such other Bidder any sum of money, or has given, or is to give, to such other Bidder anything of value whatever, or such affiant or affiants or either of them has not, directly or indirectly, entered into any arrangement or agreement with any other Bidder or Bidders, which tends to or does lessen or destroy free competition in the letting of the Contract sought for by the attached bids; that no inducement of any form or character other than that which appears upon the face of the bid, will be suggested, offered, paid or delivered to any person whomsoever to influence the acceptance of the said bid or awarding of the Contract, nor has this Bidder any agreement or understanding of any kind whatsoever, with any person whomsoever to pay, deliver to, or share with any other person in any way or manner, any of the proceeds of the Contract sought by this bid.

IN TESTIMONY WHEREOF, the Bidder (an authorized individual) has agrees to the above:

\_\_\_\_\_  
(Company Name)

By: \_\_\_\_\_  
(Authorized Signer)

\_\_\_\_\_  
Print or type Name and Title of Signer

Address: \_\_\_\_\_

Notary Public: \_\_\_\_\_

Subscribed and sworn to before me on this \_\_\_\_\_ day of \_\_\_\_\_, 2016

County of: \_\_\_\_\_ My Commission expires: \_\_\_\_\_

Telephone number: \_\_\_\_\_

## IRAN ECONOMIC SANCTIONS ACT CERTIFICATE

In accordance with the Iran Economic Sanctions Act, Michigan 2012 PA 517, effective April 1, 2013, (MCL 129.311, *et seq.*), (the "Act"), the undersigned certifies in support of its bid or proposal that it is not an Iran linked business as such is defined in the Act.

**Contractor:** \_\_\_\_\_

**By:** \_\_\_\_\_

**Dated:** \_\_\_\_\_

**Name:** \_\_\_\_\_

**Title:** \_\_\_\_\_

Act No. 517  
Public Acts of 2012  
Approved by the Governor  
December 28, 2012  
Filed with the Secretary of State  
December 28, 2012  
EFFECTIVE DATE: April 1, 2013

**STATE OF MICHIGAN  
96TH LEGISLATURE  
REGULAR SESSION OF 2012**

Introduced by Senators Kahn, Marleau, Brandenburg, Anderson, Green and Booher

# **ENROLLED SENATE BILL No. 1024**

AN ACT to prohibit persons who have certain economic relationships with Iran from submitting bids on requests for proposals with this state, political subdivisions of this state, and other public entities; to require bidders for certain public contracts to submit certification of eligibility with the bid; to require reports; and to provide for sanctions for false certification.

*The People of the State of Michigan enact:*

Sec. 1. This act shall be known and may be cited as the "Iran economic sanctions act".

Sec. 2. As used in this act:

- (a) "Energy sector of Iran" means activities to develop petroleum or natural gas resources or nuclear power in Iran.
- (b) "Investment" means 1 or more of the following:
  - (i) A commitment or contribution of funds or property.
  - (ii) A loan or other extension of credit.
  - (iii) The entry into or renewal of a contract for goods or services.
- (c) "Investment activity" means 1 or more of the following:
  - (i) A person who has an investment of \$20,000,000.00 or more in the energy sector of Iran.
  - (ii) A financial institution that extends \$20,000,000.00 or more in credit to another person, for 45 days or more, if that person will use the credit for investment in the energy sector of Iran.
- (d) "Iran" means any agency or instrumentality of Iran.
- (e) "Iran linked business" means either of the following:
  - (i) A person engaging in investment activities in the energy sector of Iran, including a person that provides oil or liquefied natural gas tankers or products used to construct or maintain pipelines used to transport oil or liquefied natural gas for the energy sector of Iran.
  - (ii) A financial institution that extends credit to another person, if that person will use the credit to engage in investment activities in the energy sector of Iran.
- (f) "Person" means any of the following:
  - (i) An individual, corporation, company, limited liability company, business association, partnership, society, trust, or any other nongovernmental entity, organization, or group.
  - (ii) Any governmental entity or instrumentality of a government, including a multilateral development institution, as defined in section 1701(c)(3) of the international financial institutional act, 22 USC 262r(c)(3).

(iii) Any successor, subunit, parent company, or subsidiary of, or company under common ownership or control with, any entity described in subparagraph (i) or (ii).

(g) "Public entity" means this state or an agency or authority of this state, school district, community college district, intermediate school district, city, village, township, county, public authority, or public airport authority.

Sec. 3. (1) Beginning April 1, 2013, an Iran linked business is not eligible to submit a bid on a request for proposal with a public entity.

(2) Beginning April 1, 2013, a public entity shall require a person that submits a bid on a request for proposal with the public entity to certify that it is not an Iran linked business.

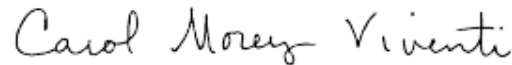
Sec. 4. If a public entity determines, using credible information available to the public, that a person has submitted a false certification under section 3(2), the public entity shall provide the person with written notice of its determination and of the intent not to enter into or renew a contract with the person. The notice shall include information on how to contest the determination and specify that the person may become eligible for a future contract with the public entity if the person ceases the activities that cause it to be an Iran linked business. The person shall have 90 days following receipt of the notice to respond in writing and to demonstrate that the determination of false certification was made in error. If a person does not make that demonstration within 90 days after receipt of the notice, the public entity may terminate any existing contract and shall report the name of the person to the attorney general together with information supporting the determination.

Sec. 5. The attorney general may bring a civil action against any person reported under section 4. If a civil action results in a finding that the person submitted a false certification, the person is responsible for a civil penalty of not more than \$250,000.00 or 2 times the amount of the contract or proposed contract for which the false certification was made, whichever is greater, the cost of the public entity's investigation, and reasonable attorney fees, in addition to the fine. A person who submitted a false certification shall be ineligible to bid on a request for proposal for 3 years from the date the public entity determines that the person has submitted the false certification.

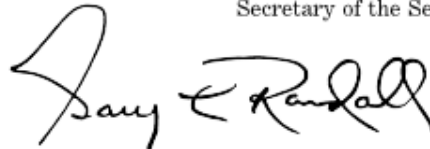
Sec. 6. The provisions of this act are effective only if Iran is a state sponsor of terror as defined under section 2 of the divestment from terror act, 2008 PA 234, MCL 129.292.

Enacting section 1. This act takes effect April 1, 2013.

This act is ordered to take immediate effect.



Secretary of the Senate



Clerk of the House of Representatives

## **LEGAL STATUS OF BIDDER**

### **CERTIFICATION REGARDING DEBARMENT, SUSPENSION, AND OTHER RESPONSIBILITY MATTERS.**

The Vendor and/or Bidder certifies to the best of its knowledge and belief that it and its principals: Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency; Have not within a three-year period preceding this agreement been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or local) transaction or contract under a public transaction; violation of federal or state antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property; Are not presently indicted for or otherwise criminally or civilly charged by a government entity (Federal, State, or local) with commission of any of the offenses enumerated above in this certification; and Have not within a three-year period preceding this agreement had one or more public transactions (Federal, State, or local) terminated for cause or default; is not now or has been, within a three-year period preceding this date, been listed on the Excluded Parties List System website (EPLS).

***Vendor/contractor will notify the Lansing School District Purchasing Office immediately upon becoming suspended or debarred if there is any current or ongoing contract or agreement in place between the district and the vendor/contractor.***

Firm Name:

---

Address:

---

Phone &

E-mail:

---

### **Name, title and signature of individual duly authorized to execute contracts:**

The Owner, Principal, or Corporate Office of the responding firm is also attesting that all the information provided within this response is true.

Name:

---

Title:

---

Signature:

---

**A Corporation organized and existing under the laws of the  
State of \_\_\_\_\_**

# General Conditions and Instructions to Bidders

1. Proposals shall be submitted on forms furnished by the owner. The proposal shall be in accordance with the specifications listed, which are available at the Lansing School District Purchasing Office.

Any variance from the specifications shall be fully explained in writing by the bidder and all prices quoted shall be on a unit price basis.

## 2. MAILING OF PROPOSALS:

Proposals shall be mailed in an opaque, sealed envelope and shall be clearly marked describing the project upon which the bid is made.

3. No oral, telegraphic facsimile, or electronic mail proposals or modifications will be considered.

## 4 WITHDRAWAL OF BIDS:

Any bidder may withdraw their bid at any time prior to the scheduled time of opening the bids upon the presentation of proper identification. After the opening of the bids, no proposal shall be withdrawn for a period of ninety (90) days.

## 5. PROPOSAL FORMS AND SIGNATURES:

Proposals shall be made on the proper forms provided by the owner. All spaces shall be properly filled in with ink or typewriter. The signatures shall be in longhand in ink by an authorized representative.

## 6. BRANDS:

The naming of a manufacturer, brand or model number shall not be considered as excluding other brands or models. Specifically, similar products with comparable construction, material and workmanship shall be considered as equal. However, the Board of Education of the Lansing School District shall evaluate the merits of all bids submitted and reserves the right to accept or reject any or all bids.

It is the intent of the attached specifications to define the minimum quality of equipment acceptable. The product lines of nationally recognized manufacturers who regularly advertise, promote and distribute catalog products to the school market are required.

## 7. SAMPLES:

Samples shall be submitted upon request at the expense of each bidder. These samples will be retained as control items until the completion of the delivery and installation.

## 8. AGENDA:

Any modifications of contract documents will be issued in the form of an addendum.

All addenda issued during the bidding time shall become part of the specifications. A copy of the addendum shall be sent to all bidders. No verbal statements by the owner shall be considered as authoritative. No request for explanations can be processed within four (4) days immediately prior to the bid opening date.

## 9. VARIATIONS FROM MATERIALS SPECIFIED:

All variations from the specified material or equipment shall be fully explained and included with the bid. Manufacturer numbers shall be used in all cases.

## 10. ROYALTIES AND PATENTS:

The contract shall pay for all royalties and patents, and shall defend all suits for claims or infringements on patent rights and save the owner harmless from loss on account thereof.

## 11. CLEAN-UP:

The contractor shall at all times, keep the premises free from accumulations of waste materials or same caused by the work; and upon completing the work, shall remove all work related rubbish from and about the building and shall leave the work broom clean, or it equivalent. In the case of dispute, the owner may remove the rubbish and charge the cost to the contractor, as the owner shall determine.

## 12. FEDERAL, STATE AND MUNICIPAL TAXES:

Each proposal submitted shall include, and the contractor shall pay, all taxes which are levied by the Federal, State and Municipal Governments, on labor, and for materials entering into the work. The owner reserves the right to require evidence of payment of such taxes prior to final payment. The school district is exempt from Federal Excise Tax.

# General Conditions and Instructions to Bidders

## 13. QUALIFICATIONS OF BIDDERS:

The owner may request any or all bidders to submit any of the following information before the award of the contracts.

- A. A bidder's performance record
- B. The address and description of bidder's equipment, plant or permanent place of business.
- C. An itemized list of the bidder's equipment, plant and personnel.
- D. A bidder's financial statement.
- E. A description of any project which the bidder has completed.
- F. Such additional information as will satisfy the owner that the bidder is adequately prepared to fulfill the contract.
- G. Description of work which will be done simultaneously with the owner's project.

## 14. NOTICE OF AWARD:

The contracts shall be deemed as having been awarded when the formal notice of acceptance of their proposal has been duly served upon the intended awardees (normally by purchase order) by some officer or agent of the owner duly authorized to give such notice.

## 15. GUARANTEE:

Each contract shall furnish the owner a written guarantee running for one (1) year, or longer as required herein, after the final payment covering all work in the contract. Any defects in workmanship or materials for which a claim is submitted within this period shall be corrected.

## 16. DOCUMENTS:

The Proposals submitted shall be based upon the specifications contained herein.

## 17. RIGHTS OF ACCEPTANCE OR REJECTION:

The Board of Education of the Lansing School District reserves the right to reject any or all bids in whole or in part and to accept the bid or portion of bid that, in their opinion, best serves the interest of the School District.

18. Contractors and subcontractors are required not to discriminate against any employee or applicant for employment, to be employed in the performance of this contract, with respect to hire, tenure, terms, conditions or privileges of employment because of race, color, religion, national origin, or ancestry or also because of age or sex, except based on a bona fide occupational qualification. Breach of this covenant of purchasing agreement as provided in the Michigan Fair Employment Practices Act and may be processed there under. See Policy 6320.

# policy

**BOARD OF EDUCATION  
LANSING SCHOOL DISTRICT**

FINANCES  
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## PURCHASING

Procurement of all supplies, materials, equipment, and services paid for from District funds shall be made in accordance with all applicable Federal and State statutes, Board policies, and administrative procedures. Standards of conduct covering conflicts of interest and governing the actions of its employees engaged in the selection, award, and administration of contracts are established in Policy 1130, Policy 3110, and Policy 4110 – Conflict of Interest.

All procurement transactions shall be conducted in a manner that encourages full and open competition and in accordance with good administrative practice and sound business judgement.

Each year the State of Michigan informs the School of the legal amount for purchases which require a formal bidding process of a single item.

It is the policy of the Board that the Superintendent adhere to the following:

- A. Seek informal price quotations on purchases in excess of \$3,000.
- B. When the purchase of, and contract for, single items of supplies, materials, or equipment is less than the amount allowed by State statute, but exceeds \$10,000 the Superintendent shall whenever possible, require three (3) competitive price quotations.

Purchases in a single transaction that are in excess of the dollar amount permitted by State statute shall require competitive bids and, whenever possible, have at least three (3) such bids for substantiation of purchase and shall require approval of the Board prior to purchase.



# policy

**BOARD OF EDUCATION  
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## **Competitive Bids**

Competitive bids are not required for items purchased through the cooperative bulk purchasing program operated by the Michigan Department of Management and Budget pursuant to M.C.L. 18.1263.

Competitive bids are not required for food purchases, unless food purchased in a single transaction costs \$100,000 or more.

When food purchased in a single transaction exceeds \$100,000, the Superintendent shall, whenever possible, require three (3) competitive price quotations.

Bids shall be sealed and shall be opened by the Director of Purchasing in the presence of at least one (1) witness. All orders or contracts should be awarded to the lowest responsible bidder; however, consideration can be given to:

- A. the quality of the item(s) to be supplied;
- B. its conformity with specifications;
- C. suitability to the requirements of the school;
- D. delivery terms;
- E. past performance of vendor.

In addition to the factors above, the Board may consider and provide a preference to bidders

- A. which use a Michigan-based business as the primary contractor.
- B. which use one (1) or more Michigan-based business as subcontractors.

# policy

## **BOARD OF EDUCATION LANSING SCHOOL DISTRICT**

FINANCES  
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For purposes of this preference a Michigan-based business means a business that would qualify for a Michigan preference for procurement contracts under M.C.L. 18.1268, which requires that the businesses certify that since inception or during the last twelve (12) months it has done one of the following:

- A. have filed a Michigan business tax return showing an allocation of income tax base to Michigan
- B. have filed a Michigan income tax return showing income generated in or attributed to Michigan
- C. withheld Michigan income tax from compensation paid to the bidder's owners and remitted the tax to the Michigan Department of Treasury

This preference shall not apply to any procurement or project using Federal funds, nor shall it be used if it would violate any Federal law or requirements.

The Board reserves the right to reject any and all bids.

Contracts may be awarded by the Superintendent without Board approval for any single item or group of identical items costing less than the dollar amount permitted by State Statute. All other contracts require Board approval prior to purchase.

### **Bid Protest**

A bidder who wishes to file a bid protest must file such notice and follow procedures prescribed by the Request For Proposals (RFP) or the individual bid specifications package, for resolution. Bid protests must be filed in writing with the Office of the Superintendent within seventy-two (72) hours of the opening of the bids in protest.

Within five (5) days of receipt of a protest, the Superintendent shall review the protest as submitted and render a decision regarding the merits of the protest and any impact on the acceptance and rejection of bids submitted. Notice of the filing of a bid protest shall be communicated to the Board and shall be so noted in any subsequent recommendation for the acceptance of bids and awarding of contracts.

Failure to file a notice of intent to protest, or failure to file a formal written protest within the time prescribed, shall constitute a waiver of proceedings.

# policy

## **BOARD OF EDUCATION LANSING SCHOOL DISTRICT**

FINANCES  
6320/page 4 of 5

### General Provisions

The Superintendent is authorized to purchase all items within budget allocations.

The Board should be advised, for prior approval, of all purchases of equipment, materials, and services when the purchase

- A. was not contemplated during the budgeting process.
- B. exceeds the previously Board approved amount by ten percent (10%).

The Superintendent is authorized to make emergency purchases, without prior approval, of those goods and/or services needed to keep the school in operation. Such purchases shall be brought to the Board's attention at the next regular meeting.

In order to promote efficiency and economy in the operation of the school, the Board requires that the Superintendent periodically estimate requirements for standard items or classes of items and make quantity purchases on a bid basis to procure the lowest cost consistent with good quality.

Whenever storage facilities or other conditions make it impractical to receive total delivery at any one time, the total quantity to be shipped but with staggered delivery dates, shall be made a part of the bid specifications.

Before placing a purchase order, the Superintendent shall check as to whether the proposed purchase is subject to bid, whether sufficient funds exist in the budget, and whether the material might be available elsewhere in the school. All purchase orders shall be numbered consecutively.

# policy

**BOARD OF EDUCATION  
LANSING SCHOOL DISTRICT**

FINANCES  
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The Superintendent shall determine the amount of purchase which shall be allowed without a properly signed purchase order. Employees may be held personally responsible for anything purchased without a properly signed purchase order or authorization.

The Board may acquire office equipment as defined in law by lease, by installment payments, by entering into lease-purchase agreements, or by lease with an option to purchase, provided the contract sets forth the terms of such a purchase.

## Procurement – Federal Grants

The Superintendent shall maintain a procurement and contract administration system in accordance with the USDOE requirements (34 CFR 80.36) for the administration and management of Federal grants and federally-funded programs. The District shall maintain a compliance system that requires contractors to perform in accordance with the terms, conditions, and specifications of their contracts or purchase orders. Except as otherwise noted, procurement transactions shall conform to the provisions of this policy and administrative guidelines (AG 6320).

M.C.L. 380.1267, 380.1274 et seq.

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# policy

**BOARD OF EDUCATION  
LANSING SCHOOL DISTRICT**

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## NEW SCHOOL CONSTRUCTION, RENOVATION

Before beginning construction of a new school building, or an addition, repair or renovation of an existing school building, except emergency repairs, the Board of Education, shall obtain competitive bids on all the material and labor required for the complete construction of a proposed new building or addition to or repair or renovation of an existing school building which exceeds the State statutory limit.

This policy does not apply to buildings, renovations, or repairs costing less than the statutory limit or to repair work normally performed by District employees.

The Board shall advertise for the bids required under subsection:

- A. By placing an advertisement for bids at least once in a newspaper of general circulation in the area where the building or addition is to be constructed or where the repair or renovation of an existing building is to take place and by posting an advertisement for bids for at least two (2) weeks on the Department of Management and Budget website on a page on the website maintained for this purpose or on a website maintained by a school organization and designated by the Department of Management and Budget for this purpose.
- B. By submitting the request for bids for placement on the Michigan Department of Management and Budget's website for school organizations, including a link to the District's website.
- C. The advertisement for bids shall do all of the following:
  - 1. specify the date and time by which all bids must be received by the Board at a designated location;
  - 2. state that the Board will not consider or accept a bid received after the date and time specified for bid submission;
  - 3. identify the time, date, and place of a public meeting at which the Board or its designee will open and read aloud each bid received by the Board by the date and time specified in advertisement;

# policy

**BOARD OF EDUCATION  
LANSING SCHOOL DISTRICT**

FINANCES  
6321/page 2 of 3

4. state that the bid shall be accompanied by a sworn and notarized statement disclosing any familial relationship that exists between the owner or any employee of the bidder and any member of the Board or the Superintendent of the District. A Board shall not accept a bid that does not include this sworn and notarized disclosure statement.
- D. The Board shall require each bidder for a contract under this policy, to file with the Board security in an amount not less than 1/20 of the amount of the bid conditioned to secure the District from loss or damage by reason of the withdrawal of the bid or by the failure of the bidder to enter a contract for performance, if the bid is accepted by the Board.
- E. The Board shall not open, consider, or accept a bid that the Board receives after the date and time specified for bid submission in the advertisement for bids as described in subsection C of this policy.
- F. At a public meeting identified in the advertisement for bids described in subsection C of this policy, the Board or its designee shall open and read aloud each bid that the Board received at or before the time and date for bid submission specified in the advertisement for bids. The Board may reject any or all bids, and if all bids are rejected, shall readvertise in the manner required by this policy.

The Board may consider and provide a preference to bidders:

1. which use a Michigan-based business as the primary contractor.
2. which use one (1) or more Michigan-based business(es) as subcontractors.

# policy

**BOARD OF EDUCATION  
LANSING SCHOOL DISTRICT**

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6321/page 3 of 3

For purposes of this preference a Michigan-based business means a business that would qualify for a Michigan preference for procurement contracts under M.C.L. 18.1268, which requires that the businesses certify that since inception or during the last twelve (12) months it has done one of the following:

1. have filed a Michigan business tax return showing an allocation of income tax base to Michigan
2. have filed a Michigan income tax return showing income generated in or attributed to Michigan
3. withheld Michigan income tax from compensation paid to the bidder's owners and remitted the tax to the Michigan Department of Treasury

This preference shall not apply to any procurement or project using Federal funds, nor shall it be used if it would violate any Federal law or requirements.

- G. The competitive bid threshold amount specified in this policy (\$20,959 for 2009) is adjusted each year by multiplying the amount for the immediately preceding year by the percentage by which the average consumer price index for all items for the twelve (12) months ending August 31<sup>st</sup> of the year in which the adjustment is made differs from that index's average for the twelve (12) months ending on August 31<sup>st</sup> of the immediately preceding year and adding that product to the maximum amount that applied in the immediately preceding year, rounding to the nearest whole dollar. The current exempt amount must be confirmed with the Michigan Department of Education prior to issuing contracts for construction, renovation, or repair which exceed the amount listed in this policy.

M.C.L. 380.1267

**NEW POLICY - VOL. 30, NO. 2**

**PROCUREMENT – FEDERAL GRANTS/FUNDS**

Procurement of all supplies, materials, equipment, and services paid for from Federal funds or District matching funds shall be made in accordance with all applicable Federal, State, and local statutes and/or regulations, the terms and conditions of the Federal grant, Board of Education policies, and administrative procedures.

The Superintendent shall maintain a procurement and contract administration system in accordance with the USDOE requirements (2 CFR 200.317-.326) for the administration and management of Federal grants and Federally-funded programs. The District shall maintain a contract administration system that requires contractors to perform in accordance with the terms, conditions, and specifications of their contracts or purchase orders. Except as otherwise noted, procurement transactions shall conform to the provisions of the District's documented general purchasing Policy 6320 and AG 6320.

All District employees, officers, and agents who have purchasing authority shall abide by the standards of conduct covering conflicts of interest and governing the actions of its employees, officers, and agents engaged in the selection, award, and administration of contracts as established in Policy 1130, Policy 3110 and Policy 4110 – Conflict of Interest.

The District will avoid acquisition of unnecessary or duplicative items. Additionally, consideration shall be given to consolidating or breaking out procurements to obtain a more economical purchase. And, where appropriate, an analysis shall be made of lease versus purchase alternatives, and any other appropriate analysis to determine the most economical approach. These considerations are given as part of the process to determine the allowability of each purchase made with Federal funds.

To foster greater economy and efficiency, the District may enter into State and local intergovernmental agreements where appropriate for procurement or use of common or shared goods and services.

**Competition**

All procurement transactions shall be conducted in a manner that encourages full and open competition and that is in accordance with good administrative practice and sound business judgement. In order to promote objective contractor



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performance and eliminate unfair competitive advantage, the District shall exclude any contractor that has developed or drafted specifications, requirements, statements of work, or invitations for bids or requests for proposals from competition for such procurements.

Some of the situations considered to be restrictive of competition include, but are not limited to, the following:

- A. unreasonable requirements on firms in order for them to qualify to do business;
- B. unnecessary experience and excessive bonding requirements;
- C. noncompetitive contracts to consultants that are on retainer contracts;
- D. organizational conflicts of interest;
- E. specification of only a “brand name” product instead of allowing for an “*or equal*” product to be offered and describing the performance or other relevant requirements of the procurement; and
- F. any arbitrary action in the procurement process.

Further, the District does not use statutorily or administratively imposed State, local, or tribal geographical preferences in the evaluation of bids or proposals, unless (1) an applicable Federal statute expressly mandates or encourages a geographic preference; or (2) the District is contracting for architectural and engineering services, in which case geographic location may be a selection criterion provided its application leaves an appropriate number of qualified firms, given the nature and size of the project, to compete for the contract.

To the extent that the District uses a pre-qualified list of persons, firms or products to acquire goods and services, the pre-qualified list includes enough qualified sources as to ensure maximum open and free competition. The District allows vendors to apply for consideration to be placed on the list annually.

Solicitation Language

The District shall require that all solicitations incorporate a clear and accurate description of the technical requirements for the material, product, or service to be procured. Such description shall not, in competitive procurements, contain features which unduly restrict competition. The description may include a statement of the qualitative nature of the material, product or service to be procured and, when necessary, shall set forth those minimum essential characteristics and standards to which it shall conform if it is to satisfy its intended use. Detailed product specifications should be avoided if at all possible.

When it is impractical or uneconomical to make a clear and accurate description of the technical requirements, a “brand name or equivalent” description may be used as a means to define the performance or other salient requirements of procurement. The specific features of the named brand which shall be met by offers shall be clearly stated; and identify all requirements which the offerors shall fulfill and all other factors to be used in evaluating bids or proposals.

The Board will not approve any expenditure for an unauthorized purchase or contract.

Procurement Methods

The District shall utilize the following methods of procurement:

Micro-purchases

Procurement by micropurchase is the acquisition of supplies or services, the aggregate dollar amount of which does not exceed \$3000. To the extent practicable, the District shall distribute micro-purchases equitably among qualified suppliers. Micro-purchases may be made without soliciting competitive quotations if Superintendent considers the price to be reasonable. The District maintains evidence of this reasonableness in the records of all purchases made by this method.

Small Purchases

Small purchase procedures provide for relatively simple and informal procurement methods for securing services, supplies, and other property that does not exceed the competitive bid threshold established annually by the State. Small purchase procedures require that price or rate quotations shall be obtained from an adequate number of qualified sources.

### Sealed Bids

Sealed, competitive bids shall be obtained when the purchase of, and contract for, single items of supplies, materials, or equipment which amounts to the amount allowed by Michigan statute and when the Board determines to build, repair, enlarge, improve, or demolish a school building/facility the cost of which will exceed the amount allowed by Michigan statute.

In order for sealed bidding to be feasible, the following conditions shall be present:

1. a complete, adequate, and realistic specification or purchase description is available;
2. two (2) or more responsible bidders are willing and able to compete effectively for the business; and
3. the procurement lends itself to a firm fixed price contract and the selection of the successful bidder can be made principally on the basis of price.

When sealed bids are used, the following requirements apply:

1. Bids shall be solicited in accordance with the provisions of State law and Policy 6320. Bids shall be solicited from an adequate number of qualified suppliers, providing sufficient response time prior to the date set for the opening of bids. The invitation to bid shall be publicly advertised.
2. The invitation for bids will include product/contract specifications and pertinent attachments and shall define the items and/or services required in order for the bidder to properly respond.
3. All bids will be opened at the time and place prescribed in the invitation for bids; bids will be opened publicly.

4. A firm fixed price contract award will be made in writing to the lowest responsive and responsible bidder. Where specified in bidding documents, factors such as discounts, transportation cost, and life cycle costs shall be considered in determining which bid is lowest. Payment discounts may only be used to determine the low bid when prior experience indicates that such discounts are usually taken.
5. The Board reserves the right to reject any or all bids for sound documented reason.

#### Competitive Proposals

Procurement by competitive proposal, normally conducted with more than one source submitting an offer, is generally used when conditions are not appropriate for the use of sealed bids or in the case of a recognized exception to the sealed bid method.

If this method is used, the following requirements apply:

1. Requests for proposals shall be publicized and identify all evaluation factors and their relative importance. Any response to the publicized requests for proposals shall be considered to the maximum extent practical.
2. Proposals shall be solicited from an adequate number of sources.
3. The District shall use its written method for conducting technical evaluations of the proposals received and for selecting recipients.

4. Contracts shall be awarded to the responsible firm whose proposal is most advantageous to the program, with price and other factors considered.

The District may use competitive proposal procedures for qualifications-based procurement of architectural/engineering (A/E) professional services whereby competitors' qualifications are evaluated and the most qualified competitor is selected, subject to negotiation of fair and reasonable compensation. The method, where price is not used as a selection factor, can only be used in procurement of A/E professional services. It cannot be used to purchase other types of services though A/E that firms are a potential source to perform the proposed effort.

#### Noncompetitive Proposals

Procurement by noncompetitive proposals allows for solicitation of a proposal from only one source and may be used only when one or more of the following circumstances apply:

1. the item is available only from a single source
2. the public exigency or emergency for the requirement will not permit a delay resulting from competitive solicitation
3. the Federal awarding agency or pass-through entity expressly authorizes noncompetitive proposals in response to a written request from the District
4. after solicitation of a number of sources, competition is determined to be inadequate

Contract/Price Analysis

The District shall perform a cost or price analysis in connection with every procurement action in excess of \$150,000, including contract modifications. A cost analysis generally means evaluating the separate cost elements that make up the total price, while a price analysis means evaluating the total price, without looking at the individual cost elements.

The method and degree of analysis is dependent on the facts surrounding the particular procurement situation; however, the District shall come to an independent estimate prior to receiving bids or proposals.

When performing a cost analysis, the District shall negotiate profit as a separate element of the price. To establish a fair and reasonable profit, consideration is given to the complexity of the work to be performed, the risk borne by the contractor, the contractor's investment, the amount of subcontracting, the quality of its record of past performance, and industry profit rates in the surrounding geographical area for similar work.

Time and Materials Contracts

The District uses a time and materials type contract only (1) after a determination that no other contract is suitable; and (2) if the contract includes a ceiling price that the contractor exceeds at its own risk. Time and materials type contract means a contract whose cost to the District is the sum of the actual costs of materials, and direct labor hours charged at fixed hourly rates that reflect wages, general and administrative expenses, and profit.

Since this formula generates an open-ended contract price, a time-and-materials contract provides no positive profit incentive to the contractor for cost control or labor efficiency. Therefore, the District sets a ceiling price for each contract that the contractor exceeds at its own risk. Further, the District shall assert a high degree of oversight in order to obtain reasonable assurance that the contractor is using efficient methods and effective cost controls.

Suspension and Debarment

The District will award contracts only to responsible contractors possessing the ability to perform successfully under the terms and conditions of the proposed procurement. All purchasing decisions shall be made in the best interests of the District and shall seek to obtain the maximum value for each dollar expended. When making a purchasing decision, the District shall consider such factors as (1) contractor integrity; (2) compliance with public policy; (3) record of past performance; and (4) financial and technical resources.

The Superintendent shall have the authority to suspend or debar a person/corporation, for cause, from consideration or award of further contracts. The District is subject to and shall abide by the nonprocurement debarment and suspension regulations implementing Executive Orders 12549 and 12689, 2 CFR Part 180.

Suspension is an action taken by the District that immediately prohibits a person from participating in covered transactions and transactions covered under the Federal Acquisition Regulation (48 CFR chapter 1) for a temporary period, pending completion of an agency investigation and any judicial or administrative proceedings that may ensue. A person so excluded is suspended. (2 CFR Part 180 Subpart G)

Debarment is an action taken by the Superintendent to exclude a person from participating in covered transactions and transactions covered under the Federal Acquisition Regulation (48 CFR chapter 1). A person so excluded is debarred. (2 CFR Part 180 Subpart H)

The District shall not subcontract with or award subgrants to any person or company who is debarred or suspended. For contracts over \$25,000, the District shall confirm that the vendor is not debarred or suspended by either checking the Federal government's System for Award Management, which maintains a list of such debarred or suspended vendors at [www.sam.gov](http://www.sam.gov); collecting a certification from the vendor; or adding a clause or condition to the covered transaction with that vendor. (2 CFR Part 180 Subpart C)



Bid Protest

The District maintains the following protest procedures to handle and resolve disputes relating to procurements and, in all instances, discloses information regarding the protest to the awarding agency.

A bidder who wishes to file a bid protest shall file such notice and follow procedures prescribed by the Request For Proposals (RFPs) or the individual bid specifications package, for resolution. Bid protests shall be filed in writing with the Superintendent within seventy-two (72) hours of the opening of the bids in protest.

Within five (5) days of receipt of a protest, the Superintendent shall review the protest as submitted and render a decision regarding the merits of the protest and any impact on the acceptance and rejection of bids submitted. Notice of the filing of a bid protest shall be communicated to the Board and shall be so noted in any subsequent recommendation for the acceptance of bids and awarding of contracts.

Failure to file a notice of intent to protest, or failure to file a formal written protest within the time prescribed, shall constitute a waiver of proceedings.

Maintenance of Procurement Records

The District maintains records sufficient to detail the history of all procurements. These records will include, but are not necessarily limited to the following: rationale for the method of procurement, selection of contract type, contractor selection or rejection, and the basis for the contract price (including a cost or price analysis).

Applicable laws and regulations:  
2 C.F.R. 200.317 - .326

# policy

**BOARD OF EDUCATION  
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## PREVAILING WAGE COORDINATOR

It is the purpose of this policy to comply with State and Federal regulations concerning prevailing wage rate.

The Michigan Department of Consumer and Industry Services; Wage and Hour Division will determine the prevailing wage rate in the locality where the work is to be performed.

The Superintendent shall designate a Prevailing Wage Coordinator for this District.

The Prevailing Wage Coordinator will submit to the Superintendent, for Board of Education approval, procedures for monitoring compliance with prevailing wage laws. S/He will request the Michigan Department of Consumer and Industry Services; Wage and Hour Division to establish the prevailing wage rate in this District for school construction or renovation projects. A schedule of those wages must be attached to the specifications for the work, and printed on any bidding blanks. A copy of the bidding blank must be filed with the Michigan Department of Consumer and Industry Services; Wage and Hour Division prior to the award of any contract. Thereafter, any contract which is awarded must include a provision that each laborer, workman, or mechanic employed by the contractor will be paid at a rate not less than the prevailing wage rate. On the first pay date, the contractors and subcontractors must provide each employee with written notification of his/her job classification and the prevailing wage rate for his/her job classification, unless the employee is covered by a collective bargaining agreement.

M.C.L. 408.551 et seq.

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# policy

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## COOPERATIVE PURCHASING

The Board of Education recognizes the advantages of centralized purchasing in that volume buying tends to maximize value for each dollar spent. The Board, therefore, encourages the administration to seek advantages in savings that may accrue to this District through joint agreements for the purchase of supplies, equipment, or services with the governing body(ies) of other governmental units.

The Board authorizes the Business Manager to negotiate such joint purchase agreements for services, supplies, and equipment which may be determined to be required from time to time by the Board and which the Board may otherwise lawfully purchase for itself, with governmental contracting units as may be appropriate in accordance with State law, the policies of this Board, and the dictates of sound purchasing procedures.

Cooperative or joint purchases require an agreement approved by the Board and the participating contracting body(ies) which shall specify the categories of equipment and supplies to be purchased; the manner of advertising for bids and of awarding contracts; the method of payment by each participating party and such other matters as may be deemed necessary to carry out the purposes of the agreement. Such agreements are subject to all legal bidding requirements.

M.C.L. 124.1 et seq.

# policy

**BOARD OF EDUCATION  
LANSING SCHOOL DISTRICT**

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## LOCAL PURCHASING

The Board of Education recognizes its position as a major purchaser in this community, and while it is the intention of the Board to purchase materials and supplies of quality at the lowest possible cost through widespread competition, if all other considerations are equal, the Board prefers to purchase within the District from established local merchants.

The Board authorizes the Superintendent to award purchases placed in accordance with law, this policy, and all policies of the Board otherwise applicable to local merchants when

- A. their quotation is competitive, within a percentage determined by the Board,
- B. freight charges are a factor,
- C. maintenance service may be required,
- D. promptness of delivery is a consideration,

provided that all statutes pertaining to public purchasing are duly observed.

# policy

**BOARD OF EDUCATION  
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## VENDOR RELATIONS

The Board of Education shall not enter a contract knowingly with any supplier of goods or services to this District under which any Board member or officer, employee, or agent of this School District has any pecuniary or beneficial interest, direct or indirect, unless the person has not solicited the contract or participated in the negotiations leading up to the contract. This prohibition shall not prevent any person from receiving royalties upon the sale of any textbook of which s/he is the author and which has been properly approved for use in the schools of this District.

For the purpose of this policy "beneficial interest" shall be determined in accordance with M.C.L. 15.321 et seq.

Board members and school personnel shall not accept any gifts or favors from vendors which might, in any way, influence their recommendations on the eventual purchase of equipment, supplies, or services.

All sales persons, regardless of product, shall clear with the Superintendent's Office before contacting any teachers, students, or other personnel of the School District. Purchasing personnel shall not show any favoritism to any vendor. Each order shall be placed in accordance with policies of the Board on the basis of quality, price, and delivery with past service a factor if all other considerations are equal.

M.C.L. 15.321 et seq.



*In order to maintain the public trust, your local school district Board of Education should consider and adopt a resolution containing at least some, if not all, of the factors listed below.*

*Each factor should be discussed thoroughly by school board members, the architects and construction managers involved in any school construction because of the potential impact they will have on a project.*

*Your construction manager and design professional will then include these factors in the construction bid documents so all bidders know that in addition to price these items will be considered when construction bids are reviewed.*



**EXPERIENCE.** Institutional building projects are expected to last 50-75 years. Therefore school board members should review the past experience of all construction professionals to ensure that they have pertinent experience on similar institutional projects. In so doing, the board members can evaluate whether local contractors should be considered for the project and only if they have the required experience should they be considered.



**REFERENCES.** School board members should investigate the references of their construction professionals from past clients doing similar institutional work. Construction professionals must supply pertinent references from their past clients, including information regarding performance and jobsite cooperation.







**FINANCIAL CONDITION.** A good financial rating means stability on the job and all through the project. Construction professionals must show they are financially prepared to perform the work they are bidding on. School boards must obtain information concerning a bidder's financial capability, any outstanding claims against them and bank references. A poor financial condition can affect the quality of materials, equipment and workers used on the project. It also can result in substantial project delays and unsafe schools.



**SAFETY & ACCIDENTS.** Construction professionals with a good safety and EMR record will be more productive. An employer has an obligation according to the Michigan Occupational Safety and Health Act (MIOSHA) to provide a place of employment free from recognized hazards likely to cause death or serious physical harm. Every employee has the right to a safe and healthy workplace. An employer must provide training in the recognition and avoidance of hazards and specific training called for in the MIOSHA standards.



**RESUME OF SUPERVISORY PERSONNEL.** Beyond a construction professional's experience with similar institutional projects, it is important for board members to evaluate the resumes of the supervisory personnel of all construction professionals on their project. All supervisory personnel should have pertinent experience and adequate education and training to complete your project.



**INSURANCE & SURETY BONDING.** Construction professionals must show proof of adequate and relevant insurance coverage for a particular project and must prove their compliance with workers' compensation statutes. School boards must set minimum standards for insurance coverage. Construction professionals that cannot provide proper coverage may be unable to fulfill project obligations. A measure of a construction professional's stability is shown in the ability to secure the required bonding.



**USE OF A TRAINED LOCAL WORKFORCE.** Employing local construction professionals and skilled craft workers on a project can be an attractive goal for school boards. Local craft workers, their friends and family, in all probability use those schools. However, it is necessary to determine if the construction professional has ready access to a qualified, experienced workforce to build your project.



**PREVAILING WAGE.** Use of prevailing wage requirements ensures that school boards secure the best qualified construction professionals to perform work on their projects. Construction professionals should compete for projects on the basis of their management practices, not by paying sub-standard wages. Utilization of prevailing wage will allow the construction professional to pay locally determined wages and benefits to attract qualified skilled craft workers.



**EMPLOYEE HEALTH INSURANCE & PENSION BENEFITS.** School districts can maintain and promote their community's health care and craft employees by requiring the construction professional to use prevailing wage, which includes health insurance and pension benefits. Construction professionals who provide such benefits to their craft personnel demonstrate a commitment to developing a stable workforce, which is a key component to a quality project and to the health of the community.



**WORKFORCE SOURCE & PROPER EMPLOYEE CLASSIFICATION.** School boards can ensure that their project will be built by qualified construction professionals by ensuring contractor access to a skilled workforce. School districts should examine carefully the source of building trades craft employees. School districts should ask prospective construction professionals to identify the source of the workforce they intend to use on the project. Construction professionals who staff the project with personnel hired from help-wanted ads or employment agencies might not have sufficient competence and ability to complete a quality project on schedule.



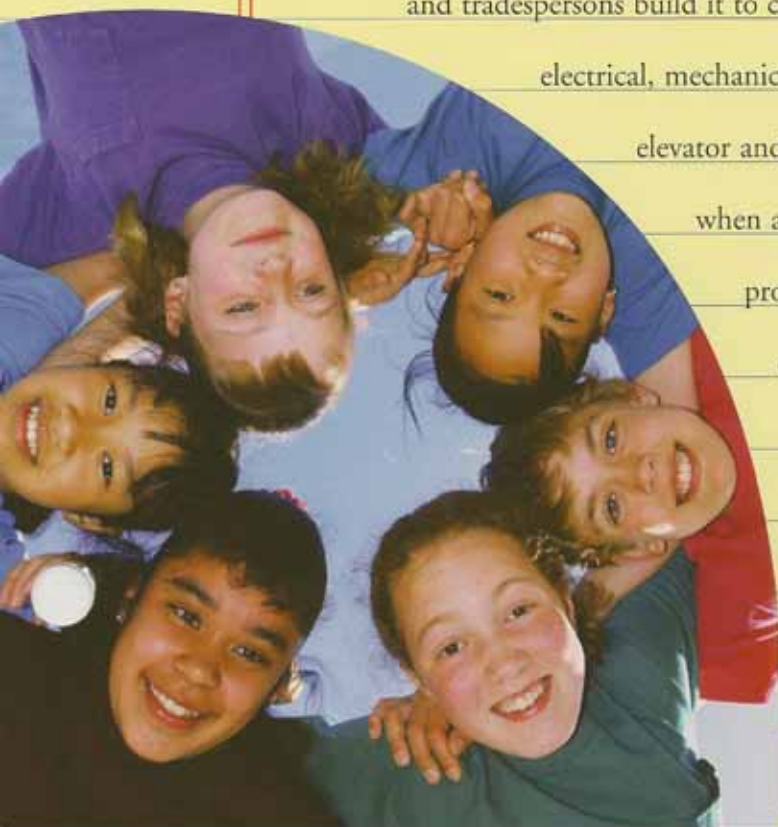


## **REGISTERED UNITED STATES DEPARTMENT OF LABOR, BUREAU OF**

**APPRENTICESHIP & TRAINING PROGRAMS.** School boards know the value of high quality training and education. Responsible contractors know that better training equals better buildings. Bureau of Apprenticeship and Training (BAT) approved training programs create more productive craft workers. A construction professional's ability to staff a school construction project with qualified trades' workers is the key to success. Contractors, who bid on school construction projects should maintain, participate in and contribute to bona fide apprentice training programs recognized by the U.S. D.O.L./B.A.T. Trained craft workers promote cost effectiveness, timeliness, safety and quality on school construction work. Companies who employ skilled and trained workers, educated in their trade, deliver exceptional work. Moreover, every registered U.S. D.O.L./B.A.T., program must meet twenty-two standards of apprenticeship regulated and audited by the U.S. D.O.L./B.A.T., as outlined in 29 CFR 29.5.



**LICENSING.** School boards get a better building when highly competent construction professionals and tradespersons build it to code. State law establishes licensing requirements for electrical, mechanical, plumbing, boiler and elevator contractors, and electrical, elevator and plumbing craft workers. Proper licensing and certification, when applicable, show school boards that construction professionals bidding the job have been tested and are competent to perform the work. All responsible construction professionals must provide documented proof of licensing and certification. This will allow school boards to contact licensing and certification agencies to verify the bidder's history and determine if any complaints or judgments have been filed against them.







**COMPLIANCE WITH REGULATORY AGENCIES.** School boards get a higher quality building when local, state and federal regulations are followed. Compliance with the EPA, MIOSHA, OSHA and other agencies helps school boards evaluate the construction professional's willingness to follow rules. It also ensures that the bidding contractors are aware of the policies that affect them. Contractor adherence to wage and hour standards, record keeping guidelines, child labor regulations and other components of the Fair Labor Standards Act are good indicators of a stable workforce. Construction craft workers who are treated fairly and receive proper pay and benefits are more likely to produce high quality work which helps ensure a safe learning environment for Michigan children.



**CIVIL SUITS/ARBITRATION/HISTORY.** A school board will have their building projects completed without costly legal entanglements if they select a responsible contractor with a 'clean' legal history. School boards should contract with construction professionals that build according to contract – not in spite of the contract. School districts should carefully examine a contractor's litigation history and the final disposition of any arbitration claims brought against him/her. A contractor with an unusually high level of adverse claims might indicate that the school board should disqualify the contractor.



**Michigan Association for Responsible Contracting**

**phone: 1-866-YES-MARC • fax: 517-372-0402 • [www.miarc.org](http://www.miarc.org)**

# **AIA® Document A201® – 2007**

## **General Conditions of the Contract for Construction**

### **for the following PROJECT:**

*(Name and location or address)*

Lansing Gardner Elementary Chiller Replacement  
333 Dahlia Dr  
Lansing, 48911

### **THE OWNER:**

*(Name, legal status and address)*

Lansing School District  
519 W Kalamazoo St  
Lansing, MI 48933

### **THE ARCHITECT:**

*(Name, legal status and address)*

Matrix Consulting Engineers  
544 Cherbourg Drive  
Lansing, MI 48917

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### **ADDITIONS AND DELETIONS:**

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## **ARTICLE 1 GENERAL PROVISIONS**

### **§ 1.1 BASIC DEFINITIONS**

#### **§ 1.1.1 THE CONTRACT DOCUMENTS**

The Contract Documents are enumerated in the Agreement between the Owner and Contractor (hereinafter the Agreement) and consist of the Agreement, Conditions of the Contract (General, Supplementary and other Conditions), Drawings, Specifications, Addenda issued prior to execution of the Contract, other documents listed in the Agreement and Modifications issued after execution of the Contract. A Modification is (1) a written amendment to the Contract signed by both parties, (2) a Change Order, (3) a Construction Change Directive or (4) a written order for a minor change in the Work issued by the Architect. Unless specifically enumerated in the Agreement, the Contract Documents do not include the advertisement or invitation to bid, Instructions to Bidders, sample forms, other information furnished by the Owner in anticipation of receiving bids or proposals, the Contractor's bid or proposal, or portions of Addenda relating to bidding requirements.

#### **§ 1.1.2 THE CONTRACT**

The Contract Documents form the Contract for Construction. The Contract represents the entire and integrated agreement between the parties hereto and supersedes prior negotiations, representations or agreements, either written or oral. The Contract may be amended or modified only by a Modification. The Contract Documents shall not be construed to create a contractual relationship of any kind (1) between the Contractor and the Architect or the Architect's consultants, (2) between the Owner and a Subcontractor or a Sub-subcontractor, (3) between the Owner and the Architect or the Architect's consultants or (4) between any persons or entities other than the Owner and the Contractor. The Architect shall, however, be entitled to performance and enforcement of obligations under the Contract intended to facilitate performance of the Architect's duties.

#### **§ 1.1.3 THE WORK**

The term "Work" means the construction and services required by the Contract Documents, whether completed or partially completed, and includes all other labor, materials, equipment and services provided or to be provided by the Contractor to fulfill the Contractor's obligations. The Work may constitute the whole or a part of the Project.

#### **§ 1.1.4 THE PROJECT**

The Project is the total construction of which the Work performed under the Contract Documents may be the whole or a part and which may include construction by the Owner and by separate contractors.

#### **§ 1.1.5 THE DRAWINGS**

The Drawings are the graphic and pictorial portions of the Contract Documents showing the design, location and dimensions of the Work, generally including plans, elevations, sections, details, schedules and diagrams.

#### **§ 1.1.6 THE SPECIFICATIONS**

The Specifications are that portion of the Contract Documents consisting of the written requirements for materials, equipment, systems, standards and workmanship for the Work, and performance of related services.

#### **§ 1.1.7 INSTRUMENTS OF SERVICE**

Instruments of Service are representations, in any medium of expression now known or later developed, of the tangible and intangible creative work performed by the Architect and the Architect's consultants under their respective professional services agreements. Instruments of Service may include, without limitation, studies, surveys, models, sketches, drawings, specifications, and other similar materials.

#### **§ 1.1.8 INITIAL DECISION MAKER**

The Initial Decision Maker is the person identified in the Agreement to render initial decisions on Claims in accordance with Section 15.2 and certify termination of the Agreement under Section 14.2.2.

### **§ 1.2 CORRELATION AND INTENT OF THE CONTRACT DOCUMENTS**

**§ 1.2.1** The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work by the Contractor. The Contract Documents are complementary, and what is required by one shall be as binding as if required by all; performance by the Contractor shall be required only to the extent consistent with the Contract Documents and reasonably inferable from them as being necessary to produce the indicated results.

**§ 1.2.2** Organization of the Specifications into divisions, sections and articles, and arrangement of Drawings shall not control the Contractor in dividing the Work among Subcontractors or in establishing the extent of Work to be performed by any trade.

**§ 1.2.3** Unless otherwise stated in the Contract Documents, words that have well-known technical or construction industry meanings are used in the Contract Documents in accordance with such recognized meanings.

### **§ 1.3 CAPITALIZATION**

Terms capitalized in these General Conditions include those that are (1) specifically defined, (2) the titles of numbered articles or (3) the titles of other documents published by the American Institute of Architects.

### **§ 1.4 INTERPRETATION**

In the interest of brevity the Contract Documents frequently omit modifying words such as “all” and “any” and articles such as “the” and “an,” but the fact that a modifier or an article is absent from one statement and appears in another is not intended to affect the interpretation of either statement.

### **§ 1.5 OWNERSHIP AND USE OF DRAWINGS, SPECIFICATIONS AND OTHER INSTRUMENTS OF SERVICE**

**§ 1.5.1** The Architect and the Architect’s consultants shall be deemed the authors and owners of their respective Instruments of Service, including the Drawings and Specifications, and will retain all common law, statutory and other reserved rights, including copyrights. The Contractor, Subcontractors, Sub-subcontractors, and material or equipment suppliers shall not own or claim a copyright in the Instruments of Service. Submittal or distribution to meet official regulatory requirements or for other purposes in connection with this Project is not to be construed as publication in derogation of the Architect’s or Architect’s consultants’ reserved rights.

**§ 1.5.2** The Contractor, Subcontractors, Sub-subcontractors and material or equipment suppliers are authorized to use and reproduce the Instruments of Service provided to them solely and exclusively for execution of the Work. All copies made under this authorization shall bear the copyright notice, if any, shown on the Instruments of Service. The Contractor, Subcontractors, Sub-subcontractors, and material or equipment suppliers may not use the Instruments of Service on other projects or for additions to this Project outside the scope of the Work without the specific written consent of the Owner, Architect and the Architect’s consultants.

### **§ 1.6 TRANSMISSION OF DATA IN DIGITAL FORM**

If the parties intend to transmit Instruments of Service or any other information or documentation in digital form, they shall endeavor to establish necessary protocols governing such transmissions, unless otherwise already provided in the Agreement or the Contract Documents.

## **ARTICLE 2 OWNER**

### **§ 2.1 GENERAL**

**§ 2.1.1** The Owner is the person or entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The Owner shall designate in writing a representative who shall have express authority to bind the Owner with respect to all matters requiring the Owner’s approval or authorization. Except as otherwise provided in Section 4.2.1, the Architect does not have such authority. The term “Owner” means the Owner or the Owner’s authorized representative.

**§ 2.1.2** The Owner shall furnish to the Contractor within fifteen days after receipt of a written request, information necessary and relevant for the Contractor to evaluate, give notice of or enforce mechanic’s lien rights. Such information shall include a correct statement of the record legal title to the property on which the Project is located, usually referred to as the site, and the Owner’s interest therein.

### **§ 2.2 INFORMATION AND SERVICES REQUIRED OF THE OWNER**

**§ 2.2.1** Prior to commencement of the Work, the Contractor may request in writing that the Owner provide reasonable evidence that the Owner has made financial arrangements to fulfill the Owner’s obligations under the Contract. Thereafter, the Contractor may only request such evidence if (1) the Owner fails to make payments to the Contractor as the Contract Documents require; (2) a change in the Work materially changes the Contract Sum; or (3) the Contractor identifies in writing a reasonable concern regarding the Owner’s ability to make payment when due. The Owner shall furnish such evidence as a condition precedent to commencement or continuation of the Work or the portion of the Work affected by a material change. After the Owner furnishes the evidence, the Owner shall not materially vary such financial arrangements without prior notice to the Contractor.

**§ 2.2.2** Except for permits and fees that are the responsibility of the Contractor under the Contract Documents, including those required under Section 3.7.1, the Owner shall secure and pay for necessary approvals, easements, assessments and charges required for construction, use or occupancy of permanent structures or for permanent changes in existing facilities.

**§ 2.2.3** The Owner shall furnish surveys describing physical characteristics, legal limitations and utility locations for the site of the Project, and a legal description of the site. The Contractor shall be entitled to rely on the accuracy of information furnished by the Owner but shall exercise proper precautions relating to the safe performance of the Work.

**§ 2.2.4** The Owner shall furnish information or services required of the Owner by the Contract Documents with reasonable promptness. The Owner shall also furnish any other information or services under the Owner's control and relevant to the Contractor's performance of the Work with reasonable promptness after receiving the Contractor's written request for such information or services.

**§ 2.2.5** Unless otherwise provided in the Contract Documents, the Owner shall furnish to the Contractor one copy of the Contract Documents for purposes of making reproductions pursuant to Section 1.5.2.

### **§ 2.3 OWNER'S RIGHT TO STOP THE WORK**

If the Contractor fails to correct Work that is not in accordance with the requirements of the Contract Documents as required by Section 12.2 or repeatedly fails to carry out Work in accordance with the Contract Documents, the Owner may issue a written order to the Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, the right of the Owner to stop the Work shall not give rise to a duty on the part of the Owner to exercise this right for the benefit of the Contractor or any other person or entity, except to the extent required by Section 6.1.3.

### **§ 2.4 OWNER'S RIGHT TO CARRY OUT THE WORK**

If the Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents and fails within a ten-day period after receipt of written notice from the Owner to commence and continue correction of such default or neglect with diligence and promptness, the Owner may, without prejudice to other remedies the Owner may have, correct such deficiencies. In such case an appropriate Change Order shall be issued deducting from payments then or thereafter due the Contractor the reasonable cost of correcting such deficiencies, including Owner's expenses and compensation for the Architect's additional services made necessary by such default, neglect or failure. Such action by the Owner and amounts charged to the Contractor are both subject to prior approval of the Architect. If payments then or thereafter due the Contractor are not sufficient to cover such amounts, the Contractor shall pay the difference to the Owner.

## **ARTICLE 3 CONTRACTOR**

### **§ 3.1 GENERAL**

**§ 3.1.1** The Contractor is the person or entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The Contractor shall be lawfully licensed, if required in the jurisdiction where the Project is located. The Contractor shall designate in writing a representative who shall have express authority to bind the Contractor with respect to all matters under this Contract. The term "Contractor" means the Contractor or the Contractor's authorized representative.

**§ 3.1.2** The Contractor shall perform the Work in accordance with the Contract Documents.

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

### **§ 3.2 REVIEW OF CONTRACT DOCUMENTS AND FIELD CONDITIONS BY CONTRACTOR**

**§ 3.2.1** Execution of the Contract by the Contractor is a representation that the Contractor has visited the site, become generally familiar with local conditions under which the Work is to be performed and correlated personal observations with requirements of the Contract Documents.

**§ 3.2.2** Because the Contract Documents are complementary, the Contractor shall, before starting each portion of the Work, carefully study and compare the various Contract Documents relative to that portion of the Work, as well as the information furnished by the Owner pursuant to Section 2.2.3, shall take field measurements of any existing conditions related to that portion of the Work, and shall observe any conditions at the site affecting it. These obligations are for the purpose of facilitating coordination and construction by the Contractor and are not for the purpose of discovering errors, omissions, or inconsistencies in the Contract Documents; however, the Contractor shall promptly report to the Architect any errors, inconsistencies or omissions discovered by or made known to the Contractor as a request for information in such form as the Architect may require. It is recognized that the Contractor's review is made in the Contractor's capacity as a contractor and not as a licensed design professional, unless otherwise specifically provided in the Contract Documents.

**§ 3.2.3** The Contractor is not required to ascertain that the Contract Documents are in accordance with applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities, but the Contractor shall promptly report to the Architect any nonconformity discovered by or made known to the Contractor as a request for information in such form as the Architect may require.

**§ 3.2.4** If the Contractor believes that additional cost or time is involved because of clarifications or instructions the Architect issues in response to the Contractor's notices or requests for information pursuant to Sections 3.2.2 or 3.2.3, the Contractor shall make Claims as provided in Article 15. If the Contractor fails to perform the obligations of Sections 3.2.2 or 3.2.3, the Contractor shall pay such costs and damages to the Owner as would have been avoided if the Contractor had performed such obligations. If the Contractor performs those obligations, the Contractor shall not be liable to the Owner or Architect for damages resulting from errors, inconsistencies or omissions in the Contract Documents, for differences between field measurements or conditions and the Contract Documents, or for nonconformities of the Contract Documents to applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities.

### **§ 3.3 SUPERVISION AND CONSTRUCTION PROCEDURES**

**§ 3.3.1** The Contractor shall supervise and direct the Work, using the Contractor's best skill and attention. The Contractor shall be solely responsible for, and have control over, construction means, methods, techniques, sequences and procedures and for coordinating all portions of the Work under the Contract, unless the Contract Documents give other specific instructions concerning these matters. If the Contract Documents give specific instructions concerning construction means, methods, techniques, sequences or procedures, the Contractor shall evaluate the jobsite safety thereof and, except as stated below, shall be fully and solely responsible for the jobsite safety of such means, methods, techniques, sequences or procedures. If the Contractor determines that such means, methods, techniques, sequences or procedures may not be safe, the Contractor shall give timely written notice to the Owner and Architect and shall not proceed with that portion of the Work without further written instructions from the Architect. If the Contractor is then instructed to proceed with the required means, methods, techniques, sequences or procedures without acceptance of changes proposed by the Contractor, the Owner shall be solely responsible for any loss or damage arising solely from those Owner-required means, methods, techniques, sequences or procedures.

**§ 3.3.2** The Contractor shall be responsible to the Owner for acts and omissions of the Contractor's employees, Subcontractors and their agents and employees, and other persons or entities performing portions of the Work for, or on behalf of, the Contractor or any of its Subcontractors.

**§ 3.3.3** The Contractor shall be responsible for inspection of portions of Work already performed to determine that such portions are in proper condition to receive subsequent Work.

### **§ 3.4 LABOR AND MATERIALS**

**§ 3.4.1** Unless otherwise provided in the Contract Documents, the Contractor shall provide and pay for labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation, and other facilities and services necessary for proper execution and completion of the Work, whether temporary or permanent and whether or not incorporated or to be incorporated in the Work.

**§ 3.4.2** Except in the case of minor changes in the Work authorized by the Architect in accordance with Sections 3.12.8 or 7.4, the Contractor may make substitutions only with the consent of the Owner, after evaluation by the Architect and in accordance with a Change Order or Construction Change Directive.

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

### **§ 3.5 WARRANTY**

The Contractor warrants to the Owner and Architect that materials and equipment furnished under the Contract will be of good quality and new unless the Contract Documents require or permit otherwise. The Contractor further warrants that the Work will conform to the requirements of the Contract Documents and will be free from defects, except for those inherent in the quality of the Work the Contract Documents require or permit. Work, materials, or equipment not conforming to these requirements may be considered defective. The Contractor's warranty excludes remedy for damage or defect caused by abuse, alterations to the Work not executed by the Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear and normal usage. If required by the Architect, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment.

### **§ 3.6 TAXES**

The Contractor shall pay sales, consumer, use and similar taxes for the Work provided by the Contractor that are legally enacted when bids are received or negotiations concluded, whether or not yet effective or merely scheduled to go into effect.

### **§ 3.7 PERMITS, FEES, NOTICES AND COMPLIANCE WITH LAWS**

**§ 3.7.1** Unless otherwise provided in the Contract Documents, the Contractor shall secure and pay for the building permit as well as for other permits, fees, licenses, and inspections by government agencies necessary for proper execution and completion of the Work that are customarily secured after execution of the Contract and legally required at the time bids are received or negotiations concluded.

**§ 3.7.2** The Contractor shall comply with and give notices required by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities applicable to performance of the Work.

**§ 3.7.3** If the Contractor performs Work knowing it to be contrary to applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities, the Contractor shall assume appropriate responsibility for such Work and shall bear the costs attributable to correction.

**§ 3.7.4 Concealed or Unknown Conditions.** If the Contractor encounters conditions at the site that are (1) subsurface or otherwise concealed physical conditions that differ materially from those indicated in the Contract Documents or (2) unknown physical conditions of an unusual nature, that differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents, the Contractor shall promptly provide notice to the Owner and the Architect before conditions are disturbed and in no event later than 21 days after first observance of the conditions. The Architect will promptly investigate such conditions and, if the Architect determines that they differ materially and cause an increase or decrease in the Contractor's cost of, or time required for, performance of any part of the Work, will recommend an equitable adjustment in the Contract Sum or Contract Time, or both. If the Architect determines that the conditions at the site are not materially different from those indicated in the Contract Documents and that no change in the terms of the Contract is justified, the Architect shall promptly notify the Owner and Contractor in writing, stating the reasons. If either party disputes the Architect's determination or recommendation, that party may proceed as provided in Article 15.

**§ 3.7.5** If, in the course of the Work, the Contractor encounters human remains or recognizes the existence of burial markers, archaeological sites or wetlands not indicated in the Contract Documents, the Contractor shall immediately suspend any operations that would affect them and shall notify the Owner and Architect. Upon receipt of such notice, the Owner shall promptly take any action necessary to obtain governmental authorization required to resume the operations. The Contractor shall continue to suspend such operations until otherwise instructed by the Owner but shall continue with all other operations that do not affect those remains or features. Requests for adjustments in the Contract Sum and Contract Time arising from the existence of such remains or features may be made as provided in Article 15.

### **§ 3.8 ALLOWANCES**

**§ 3.8.1** The Contractor shall include in the Contract Sum all allowances stated in the Contract Documents. Items covered by allowances shall be supplied for such amounts and by such persons or entities as the Owner may direct,



but the Contractor shall not be required to employ persons or entities to whom the Contractor has reasonable objection.

**§ 3.8.2** Unless otherwise provided in the Contract Documents,

- .1 Allowances shall cover the cost to the Contractor of materials and equipment delivered at the site and all required taxes, less applicable trade discounts;
- .2 Contractor's costs for unloading and handling at the site, labor, installation costs, overhead, profit and other expenses contemplated for stated allowance amounts shall be included in the Contract Sum but not in the allowances; and
- .3 Whenever costs are more than or less than allowances, the Contract Sum shall be adjusted accordingly by Change Order. The amount of the Change Order shall reflect (1) the difference between actual costs and the allowances under Section 3.8.2.1 and (2) changes in Contractor's costs under Section 3.8.2.2.

**§ 3.8.3** Materials and equipment under an allowance shall be selected by the Owner with reasonable promptness.

**§ 3.9 SUPERINTENDENT**

**§ 3.9.1** The Contractor shall employ a competent superintendent and necessary assistants who shall be in attendance at the Project site during performance of the Work. The superintendent shall represent the Contractor, and communications given to the superintendent shall be as binding as if given to the Contractor.

**§ 3.9.2** The Contractor, as soon as practicable after award of the Contract, shall furnish in writing to the Owner through the Architect the name and qualifications of a proposed superintendent. The Architect may reply within 14 days to the Contractor in writing stating (1) whether the Owner or the Architect has reasonable objection to the proposed superintendent or (2) that the Architect requires additional time to review. Failure of the Architect to reply within the 14 day period shall constitute notice of no reasonable objection.

**§ 3.9.3** The Contractor shall not employ a proposed superintendent to whom the Owner or Architect has made reasonable and timely objection. The Contractor shall not change the superintendent without the Owner's consent, which shall not unreasonably be withheld or delayed.

**§ 3.10 CONTRACTOR'S CONSTRUCTION SCHEDULES**

**§ 3.10.1** The Contractor, promptly after being awarded the Contract, shall prepare and submit for the Owner's and Architect's information a Contractor's construction schedule for the Work. The schedule shall not exceed time limits current under the Contract Documents, shall be revised at appropriate intervals as required by the conditions of the Work and Project, shall be related to the entire Project to the extent required by the Contract Documents, and shall provide for expeditious and practicable execution of the Work.

**§ 3.10.2** The Contractor shall prepare a submittal schedule, promptly after being awarded the Contract and thereafter as necessary to maintain a current submittal schedule, and shall submit the schedule(s) for the Architect's approval. The Architect's approval shall not unreasonably be delayed or withheld. The submittal schedule shall (1) be coordinated with the Contractor's construction schedule, and (2) allow the Architect reasonable time to review submittals. If the Contractor fails to submit a submittal schedule, the Contractor shall not be entitled to any increase in Contract Sum or extension of Contract Time based on the time required for review of submittals.

**§ 3.10.3** The Contractor shall perform the Work in general accordance with the most recent schedules submitted to the Owner and Architect.

**§ 3.11 DOCUMENTS AND SAMPLES AT THE SITE**

The Contractor shall maintain at the site for the Owner one copy of the Drawings, Specifications, Addenda, Change Orders and other Modifications, in good order and marked currently to indicate field changes and selections made during construction, and one copy of approved Shop Drawings, Product Data, Samples and similar required submittals. These shall be available to the Architect and shall be delivered to the Architect for submittal to the Owner upon completion of the Work as a record of the Work as constructed.

### **§ 3.12 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES**

**§ 3.12.1** Shop Drawings are drawings, diagrams, schedules and other data specially prepared for the Work by the Contractor or a Subcontractor, Sub-subcontractor, manufacturer, supplier or distributor to illustrate some portion of the Work.

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

**§ 3.12.3** Samples are physical examples that illustrate materials, equipment or workmanship and establish standards by which the Work will be judged.

**§ 3.12.4** Shop Drawings, Product Data, Samples and similar submittals are not Contract Documents. Their purpose is to demonstrate the way by which the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents for those portions of the Work for which the Contract Documents require submittals. Review by the Architect is subject to the limitations of Section 4.2.7. Informational submittals upon which the Architect is not expected to take responsive action may be so identified in the Contract Documents. Submittals that are not required by the Contract Documents may be returned by the Architect without action.

**§ 3.12.5** The Contractor shall review for compliance with the Contract Documents, approve and submit to the Architect Shop Drawings, Product Data, Samples and similar submittals required by the Contract Documents in accordance with the submittal schedule approved by the Architect or, in the absence of an approved submittal schedule, with reasonable promptness and in such sequence as to cause no delay in the Work or in the activities of the Owner or of separate contractors.

**§ 3.12.6** By submitting Shop Drawings, Product Data, Samples and similar submittals, the Contractor represents to the Owner and Architect that the Contractor has (1) reviewed and approved them, (2) determined and verified materials, field measurements and field construction criteria related thereto, or will do so and (3) checked and coordinated the information contained within such submittals with the requirements of the Work and of the Contract Documents.

**§ 3.12.7** The Contractor shall perform no portion of the Work for which the Contract Documents require submittal and review of Shop Drawings, Product Data, Samples or similar submittals until the respective submittal has been approved by the Architect.

**§ 3.12.8** The Work shall be in accordance with approved submittals except that the Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by the Architect's approval of Shop Drawings, Product Data, Samples or similar submittals unless the Contractor has specifically informed the Architect in writing of such deviation at the time of submittal and (1) the Architect has given written approval to the specific deviation as a minor change in the Work, or (2) a Change Order or Construction Change Directive has been issued authorizing the deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples or similar submittals by the Architect's approval thereof.

**§ 3.12.9** The Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, Product Data, Samples or similar submittals, to revisions other than those requested by the Architect on previous submittals. In the absence of such written notice, the Architect's approval of a resubmission shall not apply to such revisions.

**§ 3.12.10** The Contractor shall not be required to provide professional services that constitute the practice of architecture or engineering unless such services are specifically required by the Contract Documents for a portion of the Work or unless the Contractor needs to provide such services in order to carry out the Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. The Contractor shall not be required to provide professional services in violation of applicable law. If professional design services or certifications by a design professional related to systems, materials or equipment are specifically required of the Contractor by the Contract Documents, the Owner and the Architect will specify all performance and design criteria that such services must satisfy. The Contractor shall cause such services or certifications to be provided by a properly licensed design professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to the Architect. The Owner and the Architect shall be entitled

to rely upon the adequacy, accuracy and completeness of the services, certifications and approvals performed or provided by such design professionals, provided the Owner and Architect have specified to the Contractor all performance and design criteria that such services must satisfy. Pursuant to this Section 3.12.10, the Architect will review, approve or take other appropriate action on submittals only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Contractor shall not be responsible for the adequacy of the performance and design criteria specified in the Contract Documents.

### **§ 3.13 USE OF SITE**

The Contractor shall confine operations at the site to areas permitted by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities and the Contract Documents and shall not unreasonably encumber the site with materials or equipment.

### **§ 3.14 CUTTING AND PATCHING**

**§ 3.14.1** The Contractor shall be responsible for cutting, fitting or patching required to complete the Work or to make its parts fit together properly. All areas requiring cutting, fitting and patching shall be restored to the condition existing prior to the cutting, fitting and patching, unless otherwise required by the Contract Documents.

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

### **§ 3.15 CLEANING UP**

**§ 3.15.1** The Contractor shall keep the premises and surrounding area free from accumulation of waste materials or rubbish caused by operations under the Contract. At completion of the Work, the Contractor shall remove waste materials, rubbish, the Contractor's tools, construction equipment, machinery and surplus materials from and about the Project.

**§ 3.15.2** If the Contractor fails to clean up as provided in the Contract Documents, the Owner may do so and Owner shall be entitled to reimbursement from the Contractor.

### **§ 3.16 ACCESS TO WORK**

The Contractor shall provide the Owner and Architect access to the Work in preparation and progress wherever located.

### **§ 3.17 ROYALTIES, PATENTS AND COPYRIGHTS**

The Contractor shall pay all royalties and license fees. The Contractor shall defend suits or claims for infringement of copyrights and patent rights and shall hold the Owner and Architect harmless from loss on account thereof, but shall not be responsible for such defense or loss when a particular design, process or product of a particular manufacturer or manufacturers is required by the Contract Documents, or where the copyright violations are contained in Drawings, Specifications or other documents prepared by the Owner or Architect. However, if the Contractor has reason to believe that the required design, process or product is an infringement of a copyright or a patent, the Contractor shall be responsible for such loss unless such information is promptly furnished to the Architect.

### **§ 3.18 INDEMNIFICATION**

**§ 3.18.1** To the fullest extent permitted by law the Contractor shall indemnify and hold harmless the Owner, Architect, Architect's consultants, and agents and employees of any of them from and against claims, damages, losses and expenses, including but not limited to attorneys' fees, arising out of or resulting from performance of the Work, provided that such claim, damage, loss or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), but only to the extent caused by the negligent acts or omissions of the Contractor, a Subcontractor, anyone directly or indirectly employed by them or anyone for whose acts they may be liable, regardless of whether or not such claim, damage, loss or expense is caused in part by a party indemnified hereunder. Such obligation shall not be construed to negate, abridge, or reduce other rights or obligations of indemnity that would otherwise exist as to a party or person described in this Section

3.18.

**§ 3.18.2** In claims against any person or entity indemnified under this Section 3.18 by an employee of the Contractor, a Subcontractor, anyone directly or indirectly employed by them or anyone for whose acts they may be liable, the indemnification obligation under Section 3.18.1 shall not be limited by a limitation on amount or type of damages, compensation or benefits payable by or for the Contractor or a Subcontractor under workers' compensation acts, disability benefit acts or other employee benefit acts.

## **ARTICLE 4 ARCHITECT**

### **§ 4.1 GENERAL**

**§ 4.1.1** The Owner shall retain an architect lawfully licensed to practice architecture or an entity lawfully practicing architecture in the jurisdiction where the Project is located. That person or entity is identified as the Architect in the Agreement and is referred to throughout the Contract Documents as if singular in number.

**§ 4.1.2** Duties, responsibilities and limitations of authority of the Architect as set forth in the Contract Documents shall not be restricted, modified or extended without written consent of the Owner, Contractor and Architect. Consent shall not be unreasonably withheld.

**§ 4.1.3** If the employment of the Architect is terminated, the Owner shall employ a successor architect as to whom the Contractor has no reasonable objection and whose status under the Contract Documents shall be that of the Architect.

### **§ 4.2 ADMINISTRATION OF THE CONTRACT**

**§ 4.2.1** The Architect will provide administration of the Contract as described in the Contract Documents and will be an Owner's representative during construction until the date the Architect issues the final Certificate for Payment. The Architect will have authority to act on behalf of the Owner only to the extent provided in the Contract Documents.

**§ 4.2.2** The Architect will visit the site at intervals appropriate to the stage of construction, or as otherwise agreed with the Owner, to become generally familiar with the progress and quality of the portion of the Work completed, and to determine in general if the Work observed is being performed in a manner indicating that the Work, when fully completed, will be in accordance with the Contract Documents. However, the Architect will not be required to make exhaustive or continuous on-site inspections to check the quality or quantity of the Work. The Architect will not have control over, charge of, or responsibility for, the construction means, methods, techniques, sequences or procedures, or for the safety precautions and programs in connection with the Work, since these are solely the Contractor's rights and responsibilities under the Contract Documents, except as provided in Section 3.3.1.

**§ 4.2.3** On the basis of the site visits, the Architect will keep the Owner reasonably informed about the progress and quality of the portion of the Work completed, and report to the Owner (1) known deviations from the Contract Documents and from the most recent construction schedule submitted by the Contractor, and (2) defects and deficiencies observed in the Work. The Architect will not be responsible for the Contractor's failure to perform the Work in accordance with the requirements of the Contract Documents. The Architect will not have control over or charge of and will not be responsible for acts or omissions of the Contractor, Subcontractors, or their agents or employees, or any other persons or entities performing portions of the Work.

### **§ 4.2.4 COMMUNICATIONS FACILITATING CONTRACT ADMINISTRATION**

Except as otherwise provided in the Contract Documents or when direct communications have been specially authorized, the Owner and Contractor shall endeavor to communicate with each other through the Architect about matters arising out of or relating to the Contract. Communications by and with the Architect's consultants shall be through the Architect. Communications by and with Subcontractors and material suppliers shall be through the Contractor. Communications by and with separate contractors shall be through the Owner.

**§ 4.2.5** Based on the Architect's evaluations of the Contractor's Applications for Payment, the Architect will review and certify the amounts due the Contractor and will issue Certificates for Payment in such amounts.

**§ 4.2.6** The Architect has authority to reject Work that does not conform to the Contract Documents. Whenever the Architect considers it necessary or advisable, the Architect will have authority to require inspection or testing of the Work in accordance with Sections 13.5.2 and 13.5.3, whether or not such Work is fabricated, installed or completed.

However, neither this authority of the Architect nor a decision made in good faith either to exercise or not to exercise such authority shall give rise to a duty or responsibility of the Architect to the Contractor, Subcontractors, material and equipment suppliers, their agents or employees, or other persons or entities performing portions of the Work.

**§ 4.2.7** The Architect will review and approve, or take other appropriate action upon, the Contractor's submittals such as Shop Drawings, Product Data and Samples, but only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Architect's action will be taken in accordance with the submittal schedule approved by the Architect or, in the absence of an approved submittal schedule, with reasonable promptness while allowing sufficient time in the Architect's professional judgment to permit adequate review. Review of such submittals is not conducted for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of the Contractor as required by the Contract Documents. The Architect's review of the Contractor's submittals shall not relieve the Contractor of the obligations under Sections 3.3, 3.5 and 3.12. The Architect's review shall not constitute approval of safety precautions or, unless otherwise specifically stated by the Architect, of any construction means, methods, techniques, sequences or procedures. The Architect's approval of a specific item shall not indicate approval of an assembly of which the item is a component.

**§ 4.2.8** The Architect will prepare Change Orders and Construction Change Directives, and may authorize minor changes in the Work as provided in Section 7.4. The Architect will investigate and make determinations and recommendations regarding concealed and unknown conditions as provided in Section 3.7.4.

**§ 4.2.9** The Architect will conduct inspections to determine the date or dates of Substantial Completion and the date of final completion; issue Certificates of Substantial Completion pursuant to Section 9.8; receive and forward to the Owner, for the Owner's review and records, written warranties and related documents required by the Contract and assembled by the Contractor pursuant to Section 9.10; and issue a final Certificate for Payment pursuant to Section 9.10.

**§ 4.2.10** If the Owner and Architect agree, the Architect will provide one or more project representatives to assist in carrying out the Architect's responsibilities at the site. The duties, responsibilities and limitations of authority of such project representatives shall be as set forth in an exhibit to be incorporated in the Contract Documents.

**§ 4.2.11** The Architect will interpret and decide matters concerning performance under, and requirements of, the Contract Documents on written request of either the Owner or Contractor. The Architect's response to such requests will be made in writing within any time limits agreed upon or otherwise with reasonable promptness.

**§ 4.2.12** Interpretations and decisions of the Architect will be consistent with the intent of, and reasonably inferable from, the Contract Documents and will be in writing or in the form of drawings. When making such interpretations and decisions, the Architect will endeavor to secure faithful performance by both Owner and Contractor, will not show partiality to either and will not be liable for results of interpretations or decisions rendered in good faith.

**§ 4.2.13** The Architect's decisions on matters relating to aesthetic effect will be final if consistent with the intent expressed in the Contract Documents.

**§ 4.2.14** The Architect will review and respond to requests for information about the Contract Documents. The Architect's response to such requests will be made in writing within any time limits agreed upon or otherwise with reasonable promptness. If appropriate, the Architect will prepare and issue supplemental Drawings and Specifications in response to the requests for information.

## **ARTICLE 5 SUBCONTRACTORS**

### **§ 5.1 DEFINITIONS**

**§ 5.1.1** A Subcontractor is a person or entity who has a direct contract with the Contractor to perform a portion of the Work at the site. The term "Subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Subcontractor or an authorized representative of the Subcontractor. The term "Subcontractor" does not include a separate contractor or subcontractors of a separate contractor.

**§ 5.1.2** A Sub-subcontractor is a person or entity who has a direct or indirect contract with a Subcontractor to perform a portion of the Work at the site. The term “Sub-subcontractor” is referred to throughout the Contract Documents as if singular in number and means a Sub-subcontractor or an authorized representative of the Sub-subcontractor.

## **§ 5.2 AWARD OF SUBCONTRACTS AND OTHER CONTRACTS FOR PORTIONS OF THE WORK**

**§ 5.2.1** Unless otherwise stated in the Contract Documents or the bidding requirements, the Contractor, as soon as practicable after award of the Contract, shall furnish in writing to the Owner through the Architect the names of persons or entities (including those who are to furnish materials or equipment fabricated to a special design) proposed for each principal portion of the Work. The Architect may reply within 14 days to the Contractor in writing stating (1) whether the Owner or the Architect has reasonable objection to any such proposed person or entity or (2) that the Architect requires additional time for review. Failure of the Owner or Architect to reply within the 14-day period shall constitute notice of no reasonable objection.

**§ 5.2.2** The Contractor shall not contract with a proposed person or entity to whom the Owner or Architect has made reasonable and timely objection. The Contractor shall not be required to contract with anyone to whom the Contractor has made reasonable objection.

**§ 5.2.3** If the Owner or Architect has reasonable objection to a person or entity proposed by the Contractor, the Contractor shall propose another to whom the Owner or Architect has no reasonable objection. If the proposed but rejected Subcontractor was reasonably capable of performing the Work, the Contract Sum and Contract Time shall be increased or decreased by the difference, if any, occasioned by such change, and an appropriate Change Order shall be issued before commencement of the substitute Subcontractor’s Work. However, no increase in the Contract Sum or Contract Time shall be allowed for such change unless the Contractor has acted promptly and responsively in submitting names as required.

**§ 5.2.4** The Contractor shall not substitute a Subcontractor, person or entity previously selected if the Owner or Architect makes reasonable objection to such substitution.

## **§ 5.3 SUBCONTRACTUAL RELATIONS**

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

## **§ 5.4 CONTINGENT ASSIGNMENT OF SUBCONTRACTS**

**§ 5.4.1** Each subcontract agreement for a portion of the Work is assigned by the Contractor to the Owner, provided that

- .1 assignment is effective only after termination of the Contract by the Owner for cause pursuant to Section 14.2 and only for those subcontract agreements that the Owner accepts by notifying the Subcontractor and Contractor in writing; and
- .2 assignment is subject to the prior rights of the surety, if any, obligated under bond relating to the Contract.

When the Owner accepts the assignment of a subcontract agreement, the Owner assumes the Contractor’s rights and obligations under the subcontract.

**§ 5.4.2** Upon such assignment, if the Work has been suspended for more than 30 days, the Subcontractor's compensation shall be equitably adjusted for increases in cost resulting from the suspension.

**§ 5.4.3** Upon such assignment to the Owner under this Section 5.4, the Owner may further assign the subcontract to a successor contractor or other entity. If the Owner assigns the subcontract to a successor contractor or other entity, the Owner shall nevertheless remain legally responsible for all of the successor contractor's obligations under the subcontract.

## **ARTICLE 6 CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS**

### **§ 6.1 OWNER'S RIGHT TO PERFORM CONSTRUCTION AND TO AWARD SEPARATE CONTRACTS**

**§ 6.1.1** The Owner reserves the right to perform construction or operations related to the Project with the Owner's own forces, and to award separate contracts in connection with other portions of the Project or other construction or operations on the site under Conditions of the Contract identical or substantially similar to these including those portions related to insurance and waiver of subrogation. If the Contractor claims that delay or additional cost is involved because of such action by the Owner, the Contractor shall make such Claim as provided in Article 15.

**§ 6.1.2** When separate contracts are awarded for different portions of the Project or other construction or operations on the site, the term "Contractor" in the Contract Documents in each case shall mean the Contractor who executes each separate Owner-Contractor Agreement.

**§ 6.1.3** The Owner shall provide for coordination of the activities of the Owner's own forces and of each separate contractor with the Work of the Contractor, who shall cooperate with them. The Contractor shall participate with other separate contractors and the Owner in reviewing their construction schedules. The Contractor shall make any revisions to the construction schedule deemed necessary after a joint review and mutual agreement. The construction schedules shall then constitute the schedules to be used by the Contractor, separate contractors and the Owner until subsequently revised.

**§ 6.1.4** Unless otherwise provided in the Contract Documents, when the Owner performs construction or operations related to the Project with the Owner's own forces, the Owner shall be deemed to be subject to the same obligations and to have the same rights that apply to the Contractor under the Conditions of the Contract, including, without excluding others, those stated in Article 3, this Article 6 and Articles 10, 11 and 12.

### **§ 6.2 MUTUAL RESPONSIBILITY**

**§ 6.2.1** The Contractor shall afford the Owner and separate contractors reasonable opportunity for introduction and storage of their materials and equipment and performance of their activities, and shall connect and coordinate the Contractor's construction and operations with theirs as required by the Contract Documents.

**§ 6.2.2** If part of the Contractor's Work depends for proper execution or results upon construction or operations by the Owner or a separate contractor, the Contractor shall, prior to proceeding with that portion of the Work, promptly report to the Architect apparent discrepancies or defects in such other construction that would render it unsuitable for such proper execution and results. Failure of the Contractor so to report shall constitute an acknowledgment that the Owner's or separate contractor's completed or partially completed construction is fit and proper to receive the Contractor's Work, except as to defects not then reasonably discoverable.

**§ 6.2.3** The Contractor shall reimburse the Owner for costs the Owner incurs that are payable to a separate contractor because of the Contractor's delays, improperly timed activities or defective construction. The Owner shall be responsible to the Contractor for costs the Contractor incurs because of a separate contractor's delays, improperly timed activities, damage to the Work or defective construction.

**§ 6.2.4** The Contractor shall promptly remedy damage the Contractor wrongfully causes to completed or partially completed construction or to property of the Owner or separate contractors as provided in Section 10.2.5.

**§ 6.2.5** The Owner and each separate contractor shall have the same responsibilities for cutting and patching as are described for the Contractor in Section 3.14.

### **§ 6.3 OWNER'S RIGHT TO CLEAN UP**

If a dispute arises among the Contractor, separate contractors and the Owner as to the responsibility under their respective contracts for maintaining the premises and surrounding area free from waste materials and rubbish, the

Owner may clean up and the Architect will allocate the cost among those responsible.

## **ARTICLE 7 CHANGES IN THE WORK**

### **§ 7.1 GENERAL**

**§ 7.1.1** Changes in the Work may be accomplished after execution of the Contract, and without invalidating the Contract, by Change Order, Construction Change Directive or order for a minor change in the Work, subject to the limitations stated in this Article 7 and elsewhere in the Contract Documents.

**§ 7.1.2** A Change Order shall be based upon agreement among the Owner, Contractor and Architect; a Construction Change Directive requires agreement by the Owner and Architect and may or may not be agreed to by the Contractor; an order for a minor change in the Work may be issued by the Architect alone.

**§ 7.1.3** Changes in the Work shall be performed under applicable provisions of the Contract Documents, and the Contractor shall proceed promptly, unless otherwise provided in the Change Order, Construction Change Directive or order for a minor change in the Work.

### **§ 7.2 CHANGE ORDERS**

**§ 7.2.1** A Change Order is a written instrument prepared by the Architect and signed by the Owner, Contractor and Architect stating their agreement upon all of the following:

- .1 The change in the Work;
- .2 The amount of the adjustment, if any, in the Contract Sum; and
- .3 The extent of the adjustment, if any, in the Contract Time.

### **§ 7.3 CONSTRUCTION CHANGE DIRECTIVES**

**§ 7.3.1** A Construction Change Directive is a written order prepared by the Architect and signed by the Owner and Architect, directing a change in the Work prior to agreement on adjustment, if any, in the Contract Sum or Contract Time, or both. The Owner may by Construction Change Directive, without invalidating the Contract, order changes in the Work within the general scope of the Contract consisting of additions, deletions or other revisions, the Contract Sum and Contract Time being adjusted accordingly.

**§ 7.3.2** A Construction Change Directive shall be used in the absence of total agreement on the terms of a Change Order.

**§ 7.3.3** If the Construction Change Directive provides for an adjustment to the Contract Sum, the adjustment shall be based on one of the following methods:

- .1 Mutual acceptance of a lump sum properly itemized and supported by sufficient substantiating data to permit evaluation;
- .2 Unit prices stated in the Contract Documents or subsequently agreed upon;
- .3 Cost to be determined in a manner agreed upon by the parties and a mutually acceptable fixed or percentage fee; or
- .4 As provided in Section 7.3.7.

**§ 7.3.4** If unit prices are stated in the Contract Documents or subsequently agreed upon, and if quantities originally contemplated are materially changed in a proposed Change Order or Construction Change Directive so that application of such unit prices to quantities of Work proposed will cause substantial inequity to the Owner or Contractor, the applicable unit prices shall be equitably adjusted.

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

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



**§ 7.3.7** If the Contractor does not respond promptly or disagrees with the method for adjustment in the Contract Sum, the Architect shall determine the method and the adjustment on the basis of reasonable expenditures and savings of those performing the Work attributable to the change, including, in case of an increase in the Contract Sum, an amount for overhead and profit as set forth in the Agreement, or if no such amount is set forth in the Agreement, a reasonable amount. In such case, and also under Section 7.3.3.3, the Contractor shall keep and present, in such form as the Architect may prescribe, an itemized accounting together with appropriate supporting data. Unless otherwise provided in the Contract Documents, costs for the purposes of this Section 7.3.7 shall be limited to the following:

- .1 Costs of labor, including social security, old age and unemployment insurance, fringe benefits required by agreement or custom, and workers' compensation insurance;
- .2 Costs of materials, supplies and equipment, including cost of transportation, whether incorporated or consumed;
- .3 Rental costs of machinery and equipment, exclusive of hand tools, whether rented from the Contractor or others;
- .4 Costs of premiums for all bonds and insurance, permit fees, and sales, use or similar taxes related to the Work; and
- .5 Additional costs of supervision and field office personnel directly attributable to the change.

**§ 7.3.8** The amount of credit to be allowed by the Contractor to the Owner for a deletion or change that results in a net decrease in the Contract Sum shall be actual net cost as confirmed by the Architect. When both additions and credits covering related Work or substitutions are involved in a change, the allowance for overhead and profit shall be figured on the basis of net increase, if any, with respect to that change.

**§ 7.3.9** Pending final determination of the total cost of a Construction Change Directive to the Owner, the Contractor may request payment for Work completed under the Construction Change Directive in Applications for Payment. The Architect will make an interim determination for purposes of monthly certification for payment for those costs and certify for payment the amount that the Architect determines, in the Architect's professional judgment, to be reasonably justified. The Architect's interim determination of cost shall adjust the Contract Sum on the same basis as a Change Order, subject to the right of either party to disagree and assert a Claim in accordance with Article 15.

**§ 7.3.10** When the Owner and Contractor agree with a determination made by the Architect concerning the adjustments in the Contract Sum and Contract Time, or otherwise reach agreement upon the adjustments, such agreement shall be effective immediately and the Architect will prepare a Change Order. Change Orders may be issued for all or any part of a Construction Change Directive.

## **§ 7.4 MINOR CHANGES IN THE WORK**

The Architect has authority to order minor changes in the Work not involving adjustment in the Contract Sum or extension of the Contract Time and not inconsistent with the intent of the Contract Documents. Such changes will be effected by written order signed by the Architect and shall be binding on the Owner and Contractor.

## **ARTICLE 8 TIME**

### **§ 8.1 DEFINITIONS**

**§ 8.1.1** Unless otherwise provided, Contract Time is the period of time, including authorized adjustments, allotted in the Contract Documents for Substantial Completion of the Work.

**§ 8.1.2** The date of commencement of the Work is the date established in the Agreement.

**§ 8.1.3** The date of Substantial Completion is the date certified by the Architect in accordance with Section 9.8.

**§ 8.1.4** The term "day" as used in the Contract Documents shall mean calendar day unless otherwise specifically defined.

### **§ 8.2 PROGRESS AND COMPLETION**

**§ 8.2.1** Time limits stated in the Contract Documents are of the essence of the Contract. By executing the Agreement the Contractor confirms that the Contract Time is a reasonable period for performing the Work.

**§ 8.2.2** The Contractor shall not knowingly, except by agreement or instruction of the Owner in writing, prematurely commence operations on the site or elsewhere prior to the effective date of insurance required by Article 11 to be

furnished by the Contractor and Owner. The date of commencement of the Work shall not be changed by the effective date of such insurance.

**§ 8.2.3** The Contractor shall proceed expeditiously with adequate forces and shall achieve Substantial Completion within the Contract Time.

### **§ 8.3 DELAYS AND EXTENSIONS OF TIME**

**§ 8.3.1** If the Contractor is delayed at any time in the commencement or progress of the Work by an act or neglect of the Owner or Architect, or of an employee of either, or of a separate contractor employed by the Owner; or by changes ordered in the Work; or by labor disputes, fire, unusual delay in deliveries, unavoidable casualties or other causes beyond the Contractor's control; or by delay authorized by the Owner pending mediation and arbitration; or by other causes that the Architect determines may justify delay, then the Contract Time shall be extended by Change Order for such reasonable time as the Architect may determine.

**§ 8.3.2** Claims relating to time shall be made in accordance with applicable provisions of Article 15.

**§ 8.3.3** This Section 8.3 does not preclude recovery of damages for delay by either party under other provisions of the Contract Documents.

## **ARTICLE 9 PAYMENTS AND COMPLETION**

### **§ 9.1 CONTRACT SUM**

The Contract Sum is stated in the Agreement and, including authorized adjustments, is the total amount payable by the Owner to the Contractor for performance of the Work under the Contract Documents.

### **§ 9.2 SCHEDULE OF VALUES**

Where the Contract is based on a stipulated sum or Guaranteed Maximum Price, the Contractor shall submit to the Architect, before the first Application for Payment, a schedule of values allocating the entire Contract Sum to the various portions of the Work and prepared in such form and supported by such data to substantiate its accuracy as the Architect may require. This schedule, unless objected to by the Architect, shall be used as a basis for reviewing the Contractor's Applications for Payment.

### **§ 9.3 APPLICATIONS FOR PAYMENT**

**§ 9.3.1** At least ten days before the date established for each progress payment, the Contractor shall submit to the Architect an itemized Application for Payment prepared in accordance with the schedule of values, if required under Section 9.2, for completed portions of the Work. Such application shall be notarized, if required, and supported by such data substantiating the Contractor's right to payment as the Owner or Architect may require, such as copies of requisitions from Subcontractors and material suppliers, and shall reflect retainage if provided for in the Contract Documents.

**§ 9.3.1.1** As provided in Section 7.3.9, such applications may include requests for payment on account of changes in the Work that have been properly authorized by Construction Change Directives, or by interim determinations of the Architect, but not yet included in Change Orders.

**§ 9.3.1.2** Applications for Payment shall not include requests for payment for portions of the Work for which the Contractor does not intend to pay a Subcontractor or material supplier, unless such Work has been performed by others whom the Contractor intends to pay.

**§ 9.3.2** Unless otherwise provided in the Contract Documents, payments shall be made on account of materials and equipment delivered and suitably stored at the site for subsequent incorporation in the Work. If approved in advance by the Owner, payment may similarly be made for materials and equipment suitably stored off the site at a location agreed upon in writing. Payment for materials and equipment stored on or off the site shall be conditioned upon compliance by the Contractor with procedures satisfactory to the Owner to establish the Owner's title to such materials and equipment or otherwise protect the Owner's interest, and shall include the costs of applicable insurance, storage and transportation to the site for such materials and equipment stored off the site.

**§ 9.3.3** The Contractor warrants that title to all Work covered by an Application for Payment will pass to the Owner no later than the time of payment. The Contractor further warrants that upon submittal of an Application for Payment all Work for which Certificates for Payment have been previously issued and payments received from the

Owner shall, to the best of the Contractor's knowledge, information and belief, be free and clear of liens, claims, security interests or encumbrances in favor of the Contractor, Subcontractors, material suppliers, or other persons or entities making a claim by reason of having provided labor, materials and equipment relating to the Work.

#### **§ 9.4 CERTIFICATES FOR PAYMENT**

**§ 9.4.1** The Architect will, within seven days after receipt of the Contractor's Application for Payment, either issue to the Owner a Certificate for Payment, with a copy to the Contractor, for such amount as the Architect determines is properly due, or notify the Contractor and Owner in writing of the Architect's reasons for withholding certification in whole or in part as provided in Section 9.5.1.

**§ 9.4.2** The issuance of a Certificate for Payment will constitute a representation by the Architect to the Owner, based on the Architect's evaluation of the Work and the data comprising the Application for Payment, that, to the best of the Architect's knowledge, information and belief, the Work has progressed to the point indicated and that the quality of the Work is in accordance with the Contract Documents. The foregoing representations are subject to an evaluation of the Work for conformance with the Contract Documents upon Substantial Completion, to results of subsequent tests and inspections, to correction of minor deviations from the Contract Documents prior to completion and to specific qualifications expressed by the Architect. The issuance of a Certificate for Payment will further constitute a representation that the Contractor is entitled to payment in the amount certified. However, the issuance of a Certificate for Payment will not be a representation that the Architect has (1) made exhaustive or continuous on-site inspections to check the quality or quantity of the Work, (2) reviewed construction means, methods, techniques, sequences or procedures, (3) reviewed copies of requisitions received from Subcontractors and material suppliers and other data requested by the Owner to substantiate the Contractor's right to payment, or (4) made examination to ascertain how or for what purpose the Contractor has used money previously paid on account of the Contract Sum.

#### **§ 9.5 DECISIONS TO WITHHOLD CERTIFICATION**

**§ 9.5.1** The Architect may withhold a Certificate for Payment in whole or in part, to the extent reasonably necessary to protect the Owner, if in the Architect's opinion the representations to the Owner required by Section 9.4.2 cannot be made. If the Architect is unable to certify payment in the amount of the Application, the Architect will notify the Contractor and Owner as provided in Section 9.4.1. If the Contractor and Architect cannot agree on a revised amount, the Architect will promptly issue a Certificate for Payment for the amount for which the Architect is able to make such representations to the Owner. The Architect may also withhold a Certificate for Payment or, because of subsequently discovered evidence, may nullify the whole or a part of a Certificate for Payment previously issued, to such extent as may be necessary in the Architect's opinion to protect the Owner from loss for which the Contractor is responsible, including loss resulting from acts and omissions described in Section 3.3.2, because of

- .1 defective Work not remedied;
- .2 third party claims filed or reasonable evidence indicating probable filing of such claims unless security acceptable to the Owner is provided by the Contractor;
- .3 failure of the Contractor to make payments properly to Subcontractors or for labor, materials or equipment;
- .4 reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Sum;
- .5 damage to the Owner or a separate contractor;
- .6 reasonable evidence that the Work will not be completed within the Contract Time, and that the unpaid balance would not be adequate to cover actual or liquidated damages for the anticipated delay; or
- .7 repeated failure to carry out the Work in accordance with the Contract Documents.

**§ 9.5.2** When the above reasons for withholding certification are removed, certification will be made for amounts previously withheld.

**§ 9.5.3** If the Architect withholds certification for payment under Section 9.5.1.3, the Owner may, at its sole option, issue joint checks to the Contractor and to any Subcontractor or material or equipment suppliers to whom the Contractor failed to make payment for Work properly performed or material or equipment suitably delivered. If the Owner makes payments by joint check, the Owner shall notify the Architect and the Architect will reflect such payment on the next Certificate for Payment.

## **§ 9.6 PROGRESS PAYMENTS**

**§ 9.6.1** After the Architect has issued a Certificate for Payment, the Owner shall make payment in the manner and within the time provided in the Contract Documents, and shall so notify the Architect.

**§ 9.6.2** The Contractor shall pay each Subcontractor no later than seven days after receipt of payment from the Owner the amount to which the Subcontractor is entitled, reflecting percentages actually retained from payments to the Contractor on account of the Subcontractor's portion of the Work. The Contractor shall, by appropriate agreement with each Subcontractor, require each Subcontractor to make payments to Sub-subcontractors in a similar manner.

**§ 9.6.3** The Architect will, on request, furnish to a Subcontractor, if practicable, information regarding percentages of completion or amounts applied for by the Contractor and action taken thereon by the Architect and Owner on account of portions of the Work done by such Subcontractor.

**§ 9.6.4** The Owner has the right to request written evidence from the Contractor that the Contractor has properly paid Subcontractors and material and equipment suppliers amounts paid by the Owner to the Contractor for subcontracted Work. If the Contractor fails to furnish such evidence within seven days, the Owner shall have the right to contact Subcontractors to ascertain whether they have been properly paid. Neither the Owner nor Architect shall have an obligation to pay or to see to the payment of money to a Subcontractor, except as may otherwise be required by law.

**§ 9.6.5** Contractor payments to material and equipment suppliers shall be treated in a manner similar to that provided in Sections 9.6.2, 9.6.3 and 9.6.4.

**§ 9.6.6** A Certificate for Payment, a progress payment, or partial or entire use or occupancy of the Project by the Owner shall not constitute acceptance of Work not in accordance with the Contract Documents.

**§ 9.6.7** Unless the Contractor provides the Owner with a payment bond in the full penal sum of the Contract Sum, payments received by the Contractor for Work properly performed by Subcontractors and suppliers shall be held by the Contractor for those Subcontractors or suppliers who performed Work or furnished materials, or both, under contract with the Contractor for which payment was made by the Owner. Nothing contained herein shall require money to be placed in a separate account and not commingled with money of the Contractor, shall create any fiduciary liability or tort liability on the part of the Contractor for breach of trust or shall entitle any person or entity to an award of punitive damages against the Contractor for breach of the requirements of this provision.

## **§ 9.7 FAILURE OF PAYMENT**

If the Architect does not issue a Certificate for Payment, through no fault of the Contractor, within seven days after receipt of the Contractor's Application for Payment, or if the Owner does not pay the Contractor within seven days after the date established in the Contract Documents the amount certified by the Architect or awarded by binding dispute resolution, then the Contractor may, upon seven additional days' written notice to the Owner and Architect, stop the Work until payment of the amount owing has been received. The Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable costs of shut-down, delay and start-up, plus interest as provided for in the Contract Documents.

## **§ 9.8 SUBSTANTIAL COMPLETION**

**§ 9.8.1** Substantial Completion is the stage in the progress of the Work when the Work or designated portion thereof is sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work for its intended use.

**§ 9.8.2** When the Contractor considers that the Work, or a portion thereof which the Owner agrees to accept separately, is substantially complete, the Contractor shall prepare and submit to the Architect a comprehensive list of items to be completed or corrected prior to final payment. Failure to include an item on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

**§ 9.8.3** Upon receipt of the Contractor's list, the Architect will make an inspection to determine whether the Work or designated portion thereof is substantially complete. If the Architect's inspection discloses any item, whether or not included on the Contractor's list, which is not sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work or designated portion thereof for its intended use, the Contractor shall, before issuance of the Certificate of Substantial Completion, complete or correct such item upon notification

by the Architect. In such case, the Contractor shall then submit a request for another inspection by the Architect to determine Substantial Completion.

**§ 9.8.4** When the Work or designated portion thereof is substantially complete, the Architect will prepare a Certificate of Substantial Completion that shall establish the date of Substantial Completion, shall establish responsibilities of the Owner and Contractor for security, maintenance, heat, utilities, damage to the Work and insurance, and shall fix the time within which the Contractor shall finish all items on the list accompanying the Certificate. Warranties required by the Contract Documents shall commence on the date of Substantial Completion of the Work or designated portion thereof unless otherwise provided in the Certificate of Substantial Completion.

**§ 9.8.5** The Certificate of Substantial Completion shall be submitted to the Owner and Contractor for their written acceptance of responsibilities assigned to them in such Certificate. Upon such acceptance and consent of surety, if any, the Owner shall make payment of retainage applying to such Work or designated portion thereof. Such payment shall be adjusted for Work that is incomplete or not in accordance with the requirements of the Contract Documents.

## **§ 9.9 PARTIAL OCCUPANCY OR USE**

**§ 9.9.1** The Owner may occupy or use any completed or partially completed portion of the Work at any stage when such portion is designated by separate agreement with the Contractor, provided such occupancy or use is consented to by the insurer as required under Section 11.3.1.5 and authorized by public authorities having jurisdiction over the Project. Such partial occupancy or use may commence whether or not the portion is substantially complete, provided the Owner and Contractor have accepted in writing the responsibilities assigned to each of them for payments, retainage, if any, security, maintenance, heat, utilities, damage to the Work and insurance, and have agreed in writing concerning the period for correction of the Work and commencement of warranties required by the Contract Documents. When the Contractor considers a portion substantially complete, the Contractor shall prepare and submit a list to the Architect as provided under Section 9.8.2. Consent of the Contractor to partial occupancy or use shall not be unreasonably withheld. The stage of the progress of the Work shall be determined by written agreement between the Owner and Contractor or, if no agreement is reached, by decision of the Architect.

**§ 9.9.2** Immediately prior to such partial occupancy or use, the Owner, Contractor and Architect shall jointly inspect the area to be occupied or portion of the Work to be used in order to determine and record the condition of the Work.

**§ 9.9.3** Unless otherwise agreed upon, partial occupancy or use of a portion or portions of the Work shall not constitute acceptance of Work not complying with the requirements of the Contract Documents.

## **§ 9.10 FINAL COMPLETION AND FINAL PAYMENT**

**§ 9.10.1** Upon receipt of the Contractor's written notice that the Work is ready for final inspection and acceptance and upon receipt of a final Application for Payment, the Architect will promptly make such inspection and, when the Architect finds the Work acceptable under the Contract Documents and the Contract fully performed, the Architect will promptly issue a final Certificate for Payment stating that to the best of the Architect's knowledge, information and belief, and on the basis of the Architect's on-site visits and inspections, the Work has been completed in accordance with terms and conditions of the Contract Documents and that the entire balance found to be due the Contractor and noted in the final Certificate is due and payable. The Architect's final Certificate for Payment will constitute a further representation that conditions listed in Section 9.10.2 as precedent to the Contractor's being entitled to final payment have been fulfilled.

**§ 9.10.2** Neither final payment nor any remaining retained percentage shall become due until the Contractor submits to the Architect (1) an affidavit that payrolls, bills for materials and equipment, and other indebtedness connected with the Work for which the Owner or the Owner's property might be responsible or encumbered (less amounts withheld by Owner) have been paid or otherwise satisfied, (2) a certificate evidencing that insurance required by the Contract Documents to remain in force after final payment is currently in effect and will not be canceled or allowed to expire until at least 30 days' prior written notice has been given to the Owner, (3) a written statement that the Contractor knows of no substantial reason that the insurance will not be renewable to cover the period required by the Contract Documents, (4) consent of surety, if any, to final payment and (5), if required by the Owner, other data establishing payment or satisfaction of obligations, such as receipts, releases and waivers of liens, claims, security interests or encumbrances arising out of the Contract, to the extent and in such form as may be designated by the Owner. If a Subcontractor refuses to furnish a release or waiver required by the Owner, the Contractor may furnish a bond satisfactory to the Owner to indemnify the Owner against such lien. If such lien remains unsatisfied after payments are made, the Contractor shall refund to the Owner all money that the Owner may be compelled to pay in

discharging such lien, including all costs and reasonable attorneys' fees.

**§ 9.10.3** If, after Substantial Completion of the Work, final completion thereof is materially delayed through no fault of the Contractor or by issuance of Change Orders affecting final completion, and the Architect so confirms, the Owner shall, upon application by the Contractor and certification by the Architect, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed and accepted. If the remaining balance for Work not fully completed or corrected is less than retainage stipulated in the Contract Documents, and if bonds have been furnished, the written consent of surety to payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by the Contractor to the Architect prior to certification of such payment. Such payment shall be made under terms and conditions governing final payment, except that it shall not constitute a waiver of claims.

**§ 9.10.4** The making of final payment shall constitute a waiver of Claims by the Owner except those arising from

- .1 liens, Claims, security interests or encumbrances arising out of the Contract and unsettled;
- .2 failure of the Work to comply with the requirements of the Contract Documents; or
- .3 terms of special warranties required by the Contract Documents.

**§ 9.10.5** Acceptance of final payment by the Contractor, a Subcontractor or material supplier shall constitute a waiver of claims by that payee except those previously made in writing and identified by that payee as unsettled at the time of final Application for Payment.

## **ARTICLE 10 PROTECTION OF PERSONS AND PROPERTY**

### **§ 10.1 SAFETY PRECAUTIONS AND PROGRAMS**

The Contractor shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the performance of the Contract.

### **§ 10.2 SAFETY OF PERSONS AND PROPERTY**

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

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

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

**§ 10.2.3** The Contractor shall erect and maintain, as required by existing conditions and performance of the Contract, reasonable safeguards for safety and protection, including posting danger signs and other warnings against hazards, promulgating safety regulations and notifying owners and users of adjacent sites and utilities.

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

**§ 10.2.5** The Contractor shall promptly remedy damage and loss (other than damage or loss insured under property insurance required by the Contract Documents) to property referred to in Sections 10.2.1.2 and 10.2.1.3 caused in whole or in part by the Contractor, a Subcontractor, a Sub-subcontractor, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable and for which the Contractor is responsible under Sections 10.2.1.2 and 10.2.1.3, except damage or loss attributable to acts or omissions of the Owner or Architect or anyone directly or indirectly employed by either of them, or by anyone for whose acts either of them may be liable, and not attributable to the fault or negligence of the Contractor. The foregoing obligations of the Contractor are in addition to the Contractor's obligations under Section 3.18.

**§ 10.2.6** The Contractor shall designate a responsible member of the Contractor's organization at the site whose duty shall be the prevention of accidents. This person shall be the Contractor's superintendent unless otherwise designated by the Contractor in writing to the Owner and Architect.

**§ 10.2.7** The Contractor shall not permit any part of the construction or site to be loaded so as to cause damage or create an unsafe condition.

**§ 10.2.8 INJURY OR DAMAGE TO PERSON OR PROPERTY**

If either party suffers injury or damage to person or property because of an act or omission of the other party, or of others for whose acts such party is legally responsible, written notice of such injury or damage, whether or not insured, shall be given to the other party within a reasonable time not exceeding 21 days after discovery. The notice shall provide sufficient detail to enable the other party to investigate the matter.

**§ 10.3 HAZARDOUS MATERIALS**

**§ 10.3.1** The Contractor is responsible for compliance with any requirements included in the Contract Documents regarding hazardous materials. If the Contractor encounters a hazardous material or substance not addressed in the Contract Documents and if reasonable precautions will be inadequate to prevent foreseeable bodily injury or death to persons resulting from a material or substance, including but not limited to asbestos or polychlorinated biphenyl (PCB), encountered on the site by the Contractor, the Contractor shall, upon recognizing the condition, immediately stop Work in the affected area and report the condition to the Owner and Architect in writing.

**§ 10.3.2** Upon receipt of the Contractor's written notice, the Owner shall obtain the services of a licensed laboratory to verify the presence or absence of the material or substance reported by the Contractor and, in the event such material or substance is found to be present, to cause it to be rendered harmless. Unless otherwise required by the Contract Documents, the Owner shall furnish in writing to the Contractor and Architect the names and qualifications of persons or entities who are to perform tests verifying the presence or absence of such material or substance or who are to perform the task of removal or safe containment of such material or substance. The Contractor and the Architect will promptly reply to the Owner in writing stating whether or not either has reasonable objection to the persons or entities proposed by the Owner. If either the Contractor or Architect has an objection to a person or entity proposed by the Owner, the Owner shall propose another to whom the Contractor and the Architect have no reasonable objection. When the material or substance has been rendered harmless, Work in the affected area shall resume upon written agreement of the Owner and Contractor. By Change Order, the Contract Time shall be extended appropriately and the Contract Sum shall be increased in the amount of the Contractor's reasonable additional costs of shut-down, delay and start-up.

**§ 10.3.3** To the fullest extent permitted by law, the Owner shall indemnify and hold harmless the Contractor, Subcontractors, Architect, Architect's consultants and agents and employees of any of them from and against claims, damages, losses and expenses, including but not limited to attorneys' fees, arising out of or resulting from performance of the Work in the affected area if in fact the material or substance presents the risk of bodily injury or death as described in Section 10.3.1 and has not been rendered harmless, provided that such claim, damage, loss or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), except to the extent that such damage, loss or expense is due to the fault or negligence of the party seeking indemnity.

**§ 10.3.4** The Owner shall not be responsible under this Section 10.3 for materials or substances the Contractor brings to the site unless such materials or substances are required by the Contract Documents. The Owner shall be responsible for materials or substances required by the Contract Documents, except to the extent of the Contractor's fault or negligence in the use and handling of such materials or substances.

**§ 10.3.5** The Contractor shall indemnify the Owner for the cost and expense the Owner incurs (1) for remediation of a material or substance the Contractor brings to the site and negligently handles, or (2) where the Contractor fails to perform its obligations under Section 10.3.1, except to the extent that the cost and expense are due to the Owner's fault or negligence.

**§ 10.3.6** If, without negligence on the part of the Contractor, the Contractor is held liable by a government agency for the cost of remediation of a hazardous material or substance solely by reason of performing Work as required by the Contract Documents, the Owner shall indemnify the Contractor for all cost and expense thereby incurred.

## **§ 10.4 EMERGENCIES**

In an emergency affecting safety of persons or property, the Contractor shall act, at the Contractor's discretion, to prevent threatened damage, injury or loss. Additional compensation or extension of time claimed by the Contractor on account of an emergency shall be determined as provided in Article 15 and Article 7.

## **ARTICLE 11 INSURANCE AND BONDS**

### **§ 11.1 CONTRACTOR'S LIABILITY INSURANCE**

**§ 11.1.1** The Contractor shall purchase from and maintain in a company or companies lawfully authorized to do business in the jurisdiction in which the Project is located such insurance as will protect the Contractor from claims set forth below which may arise out of or result from the Contractor's operations and completed operations under the Contract and for which the Contractor may be legally liable, whether such operations be by the Contractor or by a Subcontractor or by anyone directly or indirectly employed by any of them, or by anyone for whose acts any of them may be liable:

- .1 Claims under workers' compensation, disability benefit and other similar employee benefit acts that are applicable to the Work to be performed;
- .2 Claims for damages because of bodily injury, occupational sickness or disease, or death of the Contractor's employees;
- .3 Claims for damages because of bodily injury, sickness or disease, or death of any person other than the Contractor's employees;
- .4 Claims for damages insured by usual personal injury liability coverage;
- .5 Claims for damages, other than to the Work itself, because of injury to or destruction of tangible property, including loss of use resulting therefrom;
- .6 Claims for damages because of bodily injury, death of a person or property damage arising out of ownership, maintenance or use of a motor vehicle;
- .7 Claims for bodily injury or property damage arising out of completed operations; and
- .8 Claims involving contractual liability insurance applicable to the Contractor's obligations under Section 3.18.

**§ 11.1.2** The insurance required by Section 11.1.1 shall be written for not less than limits of liability specified in the Contract Documents or required by law, whichever coverage is greater. Coverages, whether written on an occurrence or claims-made basis, shall be maintained without interruption from the date of commencement of the Work until the date of final payment and termination of any coverage required to be maintained after final payment, and, with respect to the Contractor's completed operations coverage, until the expiration of the period for correction of Work or for such other period for maintenance of completed operations coverage as specified in the Contract Documents.

**§ 11.1.3** Certificates of insurance acceptable to the Owner shall be filed with the Owner prior to commencement of the Work and thereafter upon renewal or replacement of each required policy of insurance. These certificates and the insurance policies required by this Section 11.1 shall contain a provision that coverages afforded under the policies will not be canceled or allowed to expire until at least 30 days' prior written notice has been given to the Owner. An additional certificate evidencing continuation of liability coverage, including coverage for completed operations, shall be submitted with the final Application for Payment as required by Section 9.10.2 and thereafter upon renewal or replacement of such coverage until the expiration of the time required by Section 11.1.2. Information concerning reduction of coverage on account of revised limits or claims paid under the General Aggregate, or both, shall be furnished by the Contractor with reasonable promptness.

**§ 11.1.4** The Contractor shall cause the commercial liability coverage required by the Contract Documents to include (1) the Owner, the Architect and the Architect's consultants as additional insureds for claims caused in whole or in part by the Contractor's negligent acts or omissions during the Contractor's operations; and (2) the Owner as an additional insured for claims caused in whole or in part by the Contractor's negligent acts or omissions during the Contractor's completed operations.

### **§ 11.2 OWNER'S LIABILITY INSURANCE**

The Owner shall be responsible for purchasing and maintaining the Owner's usual liability insurance.



### **§ 11.3 PROPERTY INSURANCE**

**§ 11.3.1** Unless otherwise provided, the Owner shall purchase and maintain, in a company or companies lawfully authorized to do business in the jurisdiction in which the Project is located, property insurance written on a builder's risk "all-risk" or equivalent policy form in the amount of the initial Contract Sum, plus value of subsequent Contract Modifications and cost of materials supplied or installed by others, comprising total value for the entire Project at the site on a replacement cost basis without optional deductibles. Such property insurance shall be maintained, unless otherwise provided in the Contract Documents or otherwise agreed in writing by all persons and entities who are beneficiaries of such insurance, until final payment has been made as provided in Section 9.10 or until no person or entity other than the Owner has an insurable interest in the property required by this Section 11.3 to be covered, whichever is later. This insurance shall include interests of the Owner, the Contractor, Subcontractors and Sub-subcontractors in the Project.

**§ 11.3.1.1** Property insurance shall be on an "all-risk" or equivalent policy form and shall include, without limitation, insurance against the perils of fire (with extended coverage) and physical loss or damage including, without duplication of coverage, theft, vandalism, malicious mischief, collapse, earthquake, flood, windstorm, falsework, testing and startup, temporary buildings and debris removal including demolition occasioned by enforcement of any applicable legal requirements, and shall cover reasonable compensation for Architect's and Contractor's services and expenses required as a result of such insured loss.

**§ 11.3.1.2** If the Owner does not intend to purchase such property insurance required by the Contract and with all of the coverages in the amount described above, the Owner shall so inform the Contractor in writing prior to commencement of the Work. The Contractor may then effect insurance that will protect the interests of the Contractor, Subcontractors and Sub-subcontractors in the Work, and by appropriate Change Order the cost thereof shall be charged to the Owner. If the Contractor is damaged by the failure or neglect of the Owner to purchase or maintain insurance as described above, without so notifying the Contractor in writing, then the Owner shall bear all reasonable costs properly attributable thereto.

**§ 11.3.1.3** If the property insurance requires deductibles, the Owner shall pay costs not covered because of such deductibles.

**§ 11.3.1.4** This property insurance shall cover portions of the Work stored off the site, and also portions of the Work in transit.

**§ 11.3.1.5** Partial occupancy or use in accordance with Section 9.9 shall not commence until the insurance company or companies providing property insurance have consented to such partial occupancy or use by endorsement or otherwise. The Owner and the Contractor shall take reasonable steps to obtain consent of the insurance company or companies and shall, without mutual written consent, take no action with respect to partial occupancy or use that would cause cancellation, lapse or reduction of insurance.

### **§ 11.3.2 BOILER AND MACHINERY INSURANCE**

The Owner shall purchase and maintain boiler and machinery insurance required by the Contract Documents or by law, which shall specifically cover such insured objects during installation and until final acceptance by the Owner; this insurance shall include interests of the Owner, Contractor, Subcontractors and Sub-subcontractors in the Work, and the Owner and Contractor shall be named insureds.

### **§ 11.3.3 LOSS OF USE INSURANCE**

The Owner, at the Owner's option, may purchase and maintain such insurance as will insure the Owner against loss of use of the Owner's property due to fire or other hazards, however caused. The Owner waives all rights of action against the Contractor for loss of use of the Owner's property, including consequential losses due to fire or other hazards however caused.

**§ 11.3.4** If the Contractor requests in writing that insurance for risks other than those described herein or other special causes of loss be included in the property insurance policy, the Owner shall, if possible, include such insurance, and the cost thereof shall be charged to the Contractor by appropriate Change Order.

**§ 11.3.5** If during the Project construction period the Owner insures properties, real or personal or both, at or adjacent to the site by property insurance under policies separate from those insuring the Project, or if after final payment property insurance is to be provided on the completed Project through a policy or policies other than those insuring

the Project during the construction period, the Owner shall waive all rights in accordance with the terms of Section 11.3.7 for damages caused by fire or other causes of loss covered by this separate property insurance. All separate policies shall provide this waiver of subrogation by endorsement or otherwise.

**§ 11.3.6** Before an exposure to loss may occur, the Owner shall file with the Contractor a copy of each policy that includes insurance coverages required by this Section 11.3. Each policy shall contain all generally applicable conditions, definitions, exclusions and endorsements related to this Project. Each policy shall contain a provision that the policy will not be canceled or allowed to expire, and that its limits will not be reduced, until at least 30 days' prior written notice has been given to the Contractor.

#### **§ 11.3.7 WAIVERS OF SUBROGATION**

The Owner and Contractor waive all rights against (1) each other and any of their subcontractors, sub-subcontractors, agents and employees, each of the other, and (2) the Architect, Architect's consultants, separate contractors described in Article 6, if any, and any of their subcontractors, sub-subcontractors, agents and employees, for damages caused by fire or other causes of loss to the extent covered by property insurance obtained pursuant to this Section 11.3 or other property insurance applicable to the Work, except such rights as they have to proceeds of such insurance held by the Owner as fiduciary. The Owner or Contractor, as appropriate, shall require of the Architect, Architect's consultants, separate contractors described in Article 6, if any, and the subcontractors, sub-subcontractors, agents and employees of any of them, by appropriate agreements, written where legally required for validity, similar waivers each in favor of other parties enumerated herein. The policies shall provide such waivers of subrogation by endorsement or otherwise. A waiver of subrogation shall be effective as to a person or entity even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, did not pay the insurance premium directly or indirectly, and whether or not the person or entity had an insurable interest in the property damaged.

**§ 11.3.8** A loss insured under the Owner's property insurance shall be adjusted by the Owner as fiduciary and made payable to the Owner as fiduciary for the insureds, as their interests may appear, subject to requirements of any applicable mortgagee clause and of Section 11.3.10. The Contractor shall pay Subcontractors their just shares of insurance proceeds received by the Contractor, and by appropriate agreements, written where legally required for validity, shall require Subcontractors to make payments to their Sub-subcontractors in similar manner.

**§ 11.3.9** If required in writing by a party in interest, the Owner as fiduciary shall, upon occurrence of an insured loss, give bond for proper performance of the Owner's duties. The cost of required bonds shall be charged against proceeds received as fiduciary. The Owner shall deposit in a separate account proceeds so received, which the Owner shall distribute in accordance with such agreement as the parties in interest may reach, or as determined in accordance with the method of binding dispute resolution selected in the Agreement between the Owner and Contractor. If after such loss no other special agreement is made and unless the Owner terminates the Contract for convenience, replacement of damaged property shall be performed by the Contractor after notification of a Change in the Work in accordance with Article 7.

**§ 11.3.10** The Owner as fiduciary shall have power to adjust and settle a loss with insurers unless one of the parties in interest shall object in writing within five days after occurrence of loss to the Owner's exercise of this power; if such objection is made, the dispute shall be resolved in the manner selected by the Owner and Contractor as the method of binding dispute resolution in the Agreement. If the Owner and Contractor have selected arbitration as the method of binding dispute resolution, the Owner as fiduciary shall make settlement with insurers or, in the case of a dispute over distribution of insurance proceeds, in accordance with the directions of the arbitrators.

#### **§ 11.4 PERFORMANCE BOND AND PAYMENT BOND**

**§ 11.4.1** The Owner shall have the right to require the Contractor to furnish bonds covering faithful performance of the Contract and payment of obligations arising thereunder as stipulated in bidding requirements or specifically required in the Contract Documents on the date of execution of the Contract.

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

## **ARTICLE 12 UNCOVERING AND CORRECTION OF WORK**

### **§ 12.1 UNCOVERING OF WORK**

**§ 12.1.1** If a portion of the Work is covered contrary to the Architect's request or to requirements specifically expressed in the Contract Documents, it must, if requested in writing by the Architect, be uncovered for the Architect's examination and be replaced at the Contractor's expense without change in the Contract Time.

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

### **§ 12.2 CORRECTION OF WORK**

#### **§ 12.2.1 BEFORE OR AFTER SUBSTANTIAL COMPLETION**

The Contractor shall promptly correct Work rejected by the Architect or failing to conform to the requirements of the Contract Documents, whether discovered before or after Substantial Completion and whether or not fabricated, installed or completed. Costs of correcting such rejected Work, including additional testing and inspections, the cost of uncovering and replacement, and compensation for the Architect's services and expenses made necessary thereby, shall be at the Contractor's expense.

#### **§ 12.2.2 AFTER SUBSTANTIAL COMPLETION**

**§ 12.2.2.1** In addition to the Contractor's obligations under Section 3.5, if, within one year after the date of Substantial Completion of the Work or designated portion thereof or after the date for commencement of warranties established under Section 9.9.1, or by terms of an applicable special warranty required by the Contract Documents, any of the Work is found to be not in accordance with the requirements of the Contract Documents, the Contractor shall correct it promptly after receipt of written notice from the Owner to do so unless the Owner has previously given the Contractor a written acceptance of such condition. The Owner shall give such notice promptly after discovery of the condition. During the one-year period for correction of Work, if the Owner fails to notify the Contractor and give the Contractor an opportunity to make the correction, the Owner waives the rights to require correction by the Contractor and to make a claim for breach of warranty. If the Contractor fails to correct nonconforming Work within a reasonable time during that period after receipt of notice from the Owner or Architect, the Owner may correct it in accordance with Section 2.4.

**§ 12.2.2.2** The one-year period for correction of Work shall be extended with respect to portions of Work first performed after Substantial Completion by the period of time between Substantial Completion and the actual completion of that portion of the Work.

**§ 12.2.2.3** The one-year period for correction of Work shall not be extended by corrective Work performed by the Contractor pursuant to this Section 12.2.

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

**§ 12.2.4** The Contractor shall bear the cost of correcting destroyed or damaged construction, whether completed or partially completed, of the Owner or separate contractors caused by the Contractor's correction or removal of Work that is not in accordance with the requirements of the Contract Documents.

**§ 12.2.5** Nothing contained in this Section 12.2 shall be construed to establish a period of limitation with respect to other obligations the Contractor has under the Contract Documents. Establishment of the one-year period for correction of Work as described in Section 12.2.2 relates only to the specific obligation of the Contractor to correct the Work, and has no relationship to the time within which the obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to the Contractor's obligations other than specifically to correct the Work.

### **§ 12.3 ACCEPTANCE OF NONCONFORMING WORK**

If the Owner prefers to accept Work that is not in accordance with the requirements of the Contract Documents, the Owner may do so instead of requiring its removal and correction, in which case the Contract Sum will be reduced as

appropriate and equitable. Such adjustment shall be effected whether or not final payment has been made.

## **ARTICLE 13 MISCELLANEOUS PROVISIONS**

### **§ 13.1 GOVERNING LAW**

The Contract shall be governed by the law of the place where the Project is located except that, if the parties have selected arbitration as the method of binding dispute resolution, the Federal Arbitration Act shall govern Section 15.4.

### **§ 13.2 SUCCESSORS AND ASSIGNS**

**§ 13.2.1** The Owner and Contractor respectively bind themselves, their partners, successors, assigns and legal representatives to covenants, agreements and obligations contained in the Contract Documents. Except as provided in Section 13.2.2, neither party to the Contract shall assign the Contract as a whole without written consent of the other. If either party attempts to make such an assignment without such consent, that party shall nevertheless remain legally responsible for all obligations under the Contract.

**§ 13.2.2** The Owner may, without consent of the Contractor, assign the Contract to a lender providing construction financing for the Project, if the lender assumes the Owner's rights and obligations under the Contract Documents. The Contractor shall execute all consents reasonably required to facilitate such assignment.

### **§ 13.3 WRITTEN NOTICE**

Written notice shall be deemed to have been duly served if delivered in person to the individual, to a member of the firm or entity, or to an officer of the corporation for which it was intended; or if delivered at, or sent by registered or certified mail or by courier service providing proof of delivery to, the last business address known to the party giving notice.

### **§ 13.4 RIGHTS AND REMEDIES**

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

**§ 13.4.2** No action or failure to act by the Owner, Architect or Contractor shall constitute a waiver of a right or duty afforded them under the Contract, nor shall such action or failure to act constitute approval of or acquiescence in a breach there under, except as may be specifically agreed in writing.

### **§ 13.5 TESTS AND INSPECTIONS**

**§ 13.5.1** Tests, inspections and approvals of portions of the Work shall be made as required by the Contract Documents and by applicable laws, statutes, ordinances, codes, rules and regulations or lawful orders of public authorities. Unless otherwise provided, the Contractor shall make arrangements for such tests, inspections and approvals with an independent testing laboratory or entity acceptable to the Owner, or with the appropriate public authority, and shall bear all related costs of tests, inspections and approvals. The Contractor shall give the Architect timely notice of when and where tests and inspections are to be made so that the Architect may be present for such procedures. The Owner shall bear costs of (1) tests, inspections or approvals that do not become requirements until after bids are received or negotiations concluded, and (2) tests, inspections or approvals where building codes or applicable laws or regulations prohibit the Owner from delegating their cost to the Contractor.

**§ 13.5.2** If the Architect, Owner or public authorities having jurisdiction determine that portions of the Work require additional testing, inspection or approval not included under Section 13.5.1, the Architect will, upon written authorization from the Owner, instruct the Contractor to make arrangements for such additional testing, inspection or approval by an entity acceptable to the Owner, and the Contractor shall give timely notice to the Architect of when and where tests and inspections are to be made so that the Architect may be present for such procedures. Such costs, except as provided in Section 13.5.3, shall be at the Owner's expense.

**§ 13.5.3** If such procedures for testing, inspection or approval under Sections 13.5.1 and 13.5.2 reveal failure of the portions of the Work to comply with requirements established by the Contract Documents, all costs made necessary by such failure including those of repeated procedures and compensation for the Architect's services and expenses shall be at the Contractor's expense.

**§ 13.5.4** Required certificates of testing, inspection or approval shall, unless otherwise required by the Contract Documents, be secured by the Contractor and promptly delivered to the Architect.

**§ 13.5.5** If the Architect is to observe tests, inspections or approvals required by the Contract Documents, the Architect will do so promptly and, where practicable, at the normal place of testing.

**§ 13.5.6** Tests or inspections conducted pursuant to the Contract Documents shall be made promptly to avoid unreasonable delay in the Work.

### **§ 13.6 INTEREST**

Payments due and unpaid under the Contract Documents shall bear interest from the date payment is due at such rate as the parties may agree upon in writing or, in the absence thereof, at the legal rate prevailing from time to time at the place where the Project is located.

### **§ 13.7 TIME LIMITS ON CLAIMS**

The Owner and Contractor shall commence all claims and causes of action, whether in contract, tort, breach of warranty or otherwise, against the other arising out of or related to the Contract in accordance with the requirements of the final dispute resolution method selected in the Agreement within the time period specified by applicable law, but in any case not more than 10 years after the date of Substantial Completion of the Work. The Owner and Contractor waive all claims and causes of action not commenced in accordance with this Section 13.7.

## **ARTICLE 14 TERMINATION OR SUSPENSION OF THE CONTRACT**

### **§ 14.1 TERMINATION BY THE CONTRACTOR**

**§ 14.1.1** The Contractor may terminate the Contract if the Work is stopped for a period of 30 consecutive days through no act or fault of the Contractor or a Subcontractor, Sub-subcontractor or their agents or employees or any other persons or entities performing portions of the Work under direct or indirect contract with the Contractor, for any of the following reasons:

- .1 Issuance of an order of a court or other public authority having jurisdiction that requires all Work to be stopped;
- .2 An act of government, such as a declaration of national emergency that requires all Work to be stopped;
- .3 Because the Architect has not issued a Certificate for Payment and has not notified the Contractor of the reason for withholding certification as provided in Section 9.4.1, or because the Owner has not made payment on a Certificate for Payment within the time stated in the Contract Documents; or
- .4 The Owner has failed to furnish to the Contractor promptly, upon the Contractor's request, reasonable evidence as required by Section 2.2.1.

**§ 14.1.2** The Contractor may terminate the Contract if, through no act or fault of the Contractor or a Subcontractor, Sub-subcontractor or their agents or employees or any other persons or entities performing portions of the Work under direct or indirect contract with the Contractor, repeated suspensions, delays or interruptions of the entire Work by the Owner as described in Section 14.3 constitute in the aggregate more than 100 percent of the total number of days scheduled for completion, or 120 days in any 365-day period, whichever is less.

**§ 14.1.3** If one of the reasons described in Section 14.1.1 or 14.1.2 exists, the Contractor may, upon seven days' written notice to the Owner and Architect, terminate the Contract and recover from the Owner payment for Work executed, including reasonable overhead and profit, costs incurred by reason of such termination, and damages.

**§ 14.1.4** If the Work is stopped for a period of 60 consecutive days through no act or fault of the Contractor or a Subcontractor or their agents or employees or any other persons performing portions of the Work under contract with the Contractor because the Owner has repeatedly failed to fulfill the Owner's obligations under the Contract Documents with respect to matters important to the progress of the Work, the Contractor may, upon seven additional days' written notice to the Owner and the Architect, terminate the Contract and recover from the Owner as provided in Section 14.1.3.

### **§ 14.2 TERMINATION BY THE OWNER FOR CAUSE**

**§ 14.2.1** The Owner may terminate the Contract if the Contractor

- .1 repeatedly refuses or fails to supply enough properly skilled workers or proper materials;

- .2 fails to make payment to Subcontractors for materials or labor in accordance with the respective agreements between the Contractor and the Subcontractors;
- .3 repeatedly disregards applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of a public authority; or
- .4 otherwise is guilty of substantial breach of a provision of the Contract Documents.

**§ 14.2.2** When any of the above reasons exist, the Owner, upon certification by the Initial Decision Maker that sufficient cause exists to justify such action, may without prejudice to any other rights or remedies of the Owner and after giving the Contractor and the Contractor's surety, if any, seven days' written notice, terminate employment of the Contractor and may, subject to any prior rights of the surety:

- .1 Exclude the Contractor from the site and take possession of all materials, equipment, tools, and construction equipment and machinery thereon owned by the Contractor;
- .2 Accept assignment of subcontracts pursuant to Section 5.4; and
- .3 Finish the Work by whatever reasonable method the Owner may deem expedient. Upon written request of the Contractor, the Owner shall furnish to the Contractor a detailed accounting of the costs incurred by the Owner in finishing the Work.

**§ 14.2.3** When the Owner terminates the Contract for one of the reasons stated in Section 14.2.1, the Contractor shall not be entitled to receive further payment until the Work is finished.

**§ 14.2.4** If the unpaid balance of the Contract Sum exceeds costs of finishing the Work, including compensation for the Architect's services and expenses made necessary thereby, and other damages incurred by the Owner and not expressly waived, such excess shall be paid to the Contractor. If such costs and damages exceed the unpaid balance, the Contractor shall pay the difference to the Owner. The amount to be paid to the Contractor or Owner, as the case may be, shall be certified by the Initial Decision Maker, upon application, and this obligation for payment shall survive termination of the Contract.

#### **§ 14.3 SUSPENSION BY THE OWNER FOR CONVENIENCE**

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

**§ 14.3.2** The Contract Sum and Contract Time shall be adjusted for increases in the cost and time caused by suspension, delay or interruption as described in Section 14.3.1. Adjustment of the Contract Sum shall include profit. No adjustment shall be made to the extent

- .1 that performance is, was or would have been so suspended, delayed or interrupted by another cause for which the Contractor is responsible; or
- .2 that an equitable adjustment is made or denied under another provision of the Contract.

#### **§ 14.4 TERMINATION BY THE OWNER FOR CONVENIENCE**

**§ 14.4.1** The Owner may, at any time, terminate the Contract for the Owner's convenience and without cause.

**§ 14.4.2** Upon receipt of written notice from the Owner of such termination for the Owner's convenience, the Contractor shall

- .1 cease operations as directed by the Owner in the notice;
- .2 take actions necessary, or that the Owner may direct, for the protection and preservation of the Work; and
- .3 except for Work directed to be performed prior to the effective date of termination stated in the notice, terminate all existing subcontracts and purchase orders and enter into no further subcontracts and purchase orders.

**§ 14.4.3** In case of such termination for the Owner's convenience, the Contractor shall be entitled to receive payment for Work executed, and costs incurred by reason of such termination, along with reasonable overhead and profit on the Work not executed.

## **ARTICLE 15 CLAIMS AND DISPUTES**

### **§ 15.1 CLAIMS**

#### **§ 15.1.1 DEFINITION**

A Claim is a demand or assertion by one of the parties seeking, as a matter of right, payment of money, or other relief with respect to the terms of the Contract. The term “Claim” also includes other disputes and matters in question between the Owner and Contractor arising out of or relating to the Contract. The responsibility to substantiate Claims shall rest with the party making the Claim.

#### **§ 15.1.2 NOTICE OF CLAIMS**

Claims by either the Owner or Contractor must be initiated by written notice to the other party and to the Initial Decision Maker with a copy sent to the Architect, if the Architect is not serving as the Initial Decision Maker. Claims by either party must be initiated within 21 days after occurrence of the event giving rise to such Claim or within 21 days after the claimant first recognizes the condition giving rise to the Claim, whichever is later.

#### **§ 15.1.3 CONTINUING CONTRACT PERFORMANCE**

Pending final resolution of a Claim, except as otherwise agreed in writing or as provided in Section 9.7 and Article 14, the Contractor shall proceed diligently with performance of the Contract and the Owner shall continue to make payments in accordance with the Contract Documents. The Architect will prepare Change Orders and issue Certificates for Payment in accordance with the decisions of the Initial Decision Maker.

#### **§ 15.1.4 CLAIMS FOR ADDITIONAL COST**

If the Contractor wishes to make a Claim for an increase in the Contract Sum, written notice as provided herein shall be given before proceeding to execute the Work. Prior notice is not required for Claims relating to an emergency endangering life or property arising under Section 10.4.

#### **§ 15.1.5 CLAIMS FOR ADDITIONAL TIME**

**§ 15.1.5.1** If the Contractor wishes to make a Claim for an increase in the Contract Time, written notice as provided herein shall be given. The Contractor’s Claim shall include an estimate of cost and of probable effect of delay on progress of the Work. In the case of a continuing delay, only one Claim is necessary.

**§ 15.1.5.2** If adverse weather conditions are the basis for a Claim for additional time, such Claim shall be documented by data substantiating that weather conditions were abnormal for the period of time, could not have been reasonably anticipated and had an adverse effect on the scheduled construction.

#### **§ 15.1.6 CLAIMS FOR CONSEQUENTIAL DAMAGES**

The Contractor and Owner waive Claims against each other for consequential damages arising out of or relating to this Contract. This mutual waiver includes

- .1 damages incurred by the Owner for rental expenses, for losses of use, income, profit, financing, business and reputation, and for loss of management or employee productivity or of the services of such persons; and
- .2 damages incurred by the Contractor for principal office expenses including the compensation of personnel stationed there, for losses of financing, business and reputation, and for loss of profit except anticipated profit arising directly from the Work.

This mutual waiver is applicable, without limitation, to all consequential damages due to either party’s termination in accordance with Article 14. Nothing contained in this Section 15.1.6 shall be deemed to preclude an award of liquidated damages, when applicable, in accordance with the requirements of the Contract Documents.

### **§ 15.2 INITIAL DECISION**

**§ 15.2.1** Claims, excluding those arising under Sections 10.3, 10.4, 11.3.9, and 11.3.10, shall be referred to the Initial Decision Maker for initial decision. The Architect will serve as the Initial Decision Maker, unless otherwise indicated in the Agreement. Except for those Claims excluded by this Section 15.2.1, an initial decision shall be required as a condition precedent to mediation of any Claim arising prior to the date final payment is due, unless 30 days have passed after the Claim has been referred to the Initial Decision Maker with no decision having been rendered. Unless the Initial Decision Maker and all affected parties agree, the Initial Decision Maker will not decide disputes between the Contractor and persons or entities other than the Owner.

**§ 15.2.2** The Initial Decision Maker will review Claims and within ten days of the receipt of a Claim take one or more of the following actions: (1) request additional supporting data from the claimant or a response with supporting data from the other party, (2) reject the Claim in whole or in part, (3) approve the Claim, (4) suggest a compromise, or (5) advise the parties that the Initial Decision Maker is unable to resolve the Claim if the Initial Decision Maker lacks sufficient information to evaluate the merits of the Claim or if the Initial Decision Maker concludes that, in the Initial Decision Maker's sole discretion, it would be inappropriate for the Initial Decision Maker to resolve the Claim.

**§ 15.2.3** In evaluating Claims, the Initial Decision Maker may, but shall not be obligated to, consult with or seek information from either party or from persons with special knowledge or expertise who may assist the Initial Decision Maker in rendering a decision. The Initial Decision Maker may request the Owner to authorize retention of such persons at the Owner's expense.

**§ 15.2.4** If the Initial Decision Maker requests a party to provide a response to a Claim or to furnish additional supporting data, such party shall respond, within ten days after receipt of such request, and shall either (1) provide a response on the requested supporting data, (2) advise the Initial Decision Maker when the response or supporting data will be furnished or (3) advise the Initial Decision Maker that no supporting data will be furnished. Upon receipt of the response or supporting data, if any, the Initial Decision Maker will either reject or approve the Claim in whole or in part.

**§ 15.2.5** The Initial Decision Maker will render an initial decision approving or rejecting the Claim, or indicating that the Initial Decision Maker is unable to resolve the Claim. This initial decision shall (1) be in writing; (2) state the reasons therefor; and (3) notify the parties and the Architect, if the Architect is not serving as the Initial Decision Maker, of any change in the Contract Sum or Contract Time or both. The initial decision shall be final and binding on the parties but subject to mediation and, if the parties fail to resolve their dispute through mediation, to binding dispute resolution.

**§ 15.2.6** Either party may file for mediation of an initial decision at any time, subject to the terms of Section 15.2.6.1.

**§ 15.2.6.1** Either party may, within 30 days from the date of an initial decision, demand in writing that the other party file for mediation within 60 days of the initial decision. If such a demand is made and the party receiving the demand fails to file for mediation within the time required, then both parties waive their rights to mediate or pursue binding dispute resolution proceedings with respect to the initial decision.

**§ 15.2.7** In the event of a Claim against the Contractor, the Owner may, but is not obligated to, notify the surety, if any, of the nature and amount of the Claim. If the Claim relates to a possibility of a Contractor's default, the Owner may, but is not obligated to, notify the surety and request the surety's assistance in resolving the controversy.

**§ 15.2.8** If a Claim relates to or is the subject of a mechanic's lien, the party asserting such Claim may proceed in accordance with applicable law to comply with the lien notice or filing deadlines.

## **§ 15.3 MEDIATION**

**§ 15.3.1** Claims, disputes, or other matters in controversy arising out of or related to the Contract except those waived as provided for in Sections 9.10.4, 9.10.5, and 15.1.6 shall be subject to mediation as a condition precedent to binding dispute resolution.

**§ 15.3.2** The parties shall endeavor to resolve their Claims by mediation which, unless the parties mutually agree otherwise, shall be administered by the American Arbitration Association in accordance with its Construction Industry Mediation Procedures in effect on the date of the Agreement. A request for mediation shall be made in writing, delivered to the other party to the Contract, and filed with the person or entity administering the mediation. The request may be made concurrently with the filing of binding dispute resolution proceedings but, in such event, mediation shall proceed in advance of binding dispute resolution proceedings, which shall be stayed pending mediation for a period of 60 days from the date of filing, unless stayed for a longer period by agreement of the parties or court order. If an arbitration is stayed pursuant to this Section 15.3.2, the parties may nonetheless proceed to the selection of the arbitrator(s) and agree upon a schedule for later proceedings.

**§ 15.3.3** The parties shall share the mediator's fee and any filing fees equally. The mediation shall be held in the place where the Project is located, unless another location is mutually agreed upon. Agreements reached in



mediation shall be enforceable as settlement agreements in any court having jurisdiction thereof.

#### **§ 15.4 ARBITRATION**

**§ 15.4.1** If the parties have selected arbitration as the method for binding dispute resolution in the Agreement, any Claim subject to, but not resolved by, mediation shall be subject to arbitration which, unless the parties mutually agree otherwise, shall be administered by the American Arbitration Association in accordance with its Construction Industry Arbitration Rules in effect on the date of the Agreement. A demand for arbitration shall be made in writing, delivered to the other party to the Contract, and filed with the person or entity administering the arbitration. The party filing a notice of demand for arbitration must assert in the demand all Claims then known to that party on which arbitration is permitted to be demanded.

**§ 15.4.1.1** A demand for arbitration shall be made no earlier than concurrently with the filing of a request for mediation, but in no event shall it be made after the date when the institution of legal or equitable proceedings based on the Claim would be barred by the applicable statute of limitations. For statute of limitations purposes, receipt of a written demand for arbitration by the person or entity administering the arbitration shall constitute the institution of legal or equitable proceedings based on the Claim.

**§ 15.4.2** The award rendered by the arbitrator or arbitrators shall be final, and judgment may be entered upon it in accordance with applicable law in any court having jurisdiction thereof.

**§ 15.4.3** The foregoing agreement to arbitrate and other agreements to arbitrate with an additional person or entity duly consented to by parties to the Agreement shall be specifically enforceable under applicable law in any court having jurisdiction thereof.

#### **§ 15.4.4 CONSOLIDATION OR JOINDER**

**§ 15.4.4.1** Either party, at its sole discretion, may consolidate an arbitration conducted under this Agreement with any other arbitration to which it is a party provided that (1) the arbitration agreement governing the other arbitration permits consolidation, (2) the arbitrations to be consolidated substantially involve common questions of law or fact, and (3) the arbitrations employ materially similar procedural rules and methods for selecting arbitrator(s).

**§ 15.4.4.2** Either party, at its sole discretion, may include by joinder persons or entities substantially involved in a common question of law or fact whose presence is required if complete relief is to be accorded in arbitration, provided that the party sought to be joined consents in writing to such joinder. Consent to arbitration involving an additional person or entity shall not constitute consent to arbitration of any claim, dispute or other matter in question not described in the written consent.

**§ 15.4.4.3** The Owner and Contractor grant to any person or entity made a party to an arbitration conducted under this Section 15.4, whether by joinder or consolidation, the same rights of joinder and consolidation as the Owner and Contractor under this Agreement.

# **Additions and Deletions Report for**

## **AIA® Document A201® – 2007**

This Additions and Deletions Report, as defined on page 1 of the associated document, reproduces below all text the author has added to the standard form AIA document in order to complete it, as well as any text the author may have added to or deleted from the original AIA text. Added text is shown underlined. Deleted text is indicated with a horizontal line through the original AIA text.

Note: This Additions and Deletions Report is provided for information purposes only and is not incorporated into or constitute any part of the associated AIA document. This Additions and Deletions Report and its associated document were generated simultaneously by AIA software at 15:14:10 EDT on 04/30/2026.

### **Changes to original AIA text**

**There are no edits to the original text**

### **Variable Information**

#### **PAGE 1**

#### **for the following PROJECT:**

*(Name and location or address)*

Lansing Gardner Elementary Chiller Replacement  
333 Dahlia Dr  
Lansing, 48911

#### **THE OWNER:**

*(Name, legal status and address)*

Lansing School District  
519 W Kalamazoo St  
Lansing, MI 48933

#### **THE ARCHITECT:**

*(Name, legal status and address)*

Matrix Consulting Engineers  
544 Cherbourg Drive  
Lansing, MI 48917

## SECTION 230500 - COMMON WORK RESULTS FOR HVAC

### PART 1 GENERAL

#### 1.01 RELATED DOCUMENTS

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

#### 1.02 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, 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 in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
  - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
  - 2. CPVC: Chlorinated polyvinyl chloride plastic.
  - 3. PE: Polyethylene plastic.
  - 4. 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.

#### 1.03 REFERENCE STANDARDS

- A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- B. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges; 2021.
- C. ASME B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series); 2012 (Reaffirmed 2021).
- D. ASTM B32 - Standard Specification for Solder Metal; 2020.

- E. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2016.
- F. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2023.
- G. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.
- H. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings; 2022.
- I. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2020.
- J. ASTM D2657 - Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings; 2007 (Reapproved 2023).
- K. ASTM D2661 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings; 2021.
- L. ASTM D2846/D2846M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems; 2019a.
- M. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets; 2020.
- N. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals; 2019 (Reapproved 2025).
- O. ASTM F402 - Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings; 2026.
- P. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings; 2022.
- Q. ASTM F656 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) and Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings; 2025.
- R. AWWA C219 - Bolted Sleeve-Type Couplings for Plain-End Pipe; 2023.

#### 1.04 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. Mechanical sleeve seals.
  - 5. Sleeves.
  - 6. Escutcheons.

7. Grout.
8. Mechanical demolition.
9. Equipment installation requirements common to equipment sections.
10. Painting and finishing.
11. Concrete bases.
12. Supports and anchorages.
13. Pipe curbs and equipment supports.

#### 1.05 SUBMITTALS

- A. Product Data: For the following:
  1. Transition fittings.
  2. Dielectric fittings.
  3. Mechanical sleeve seals.
  4. Escutcheons.
- B. Welding certificates.
- C. Operation and Maintenance Data: At the end of the project the contractor shall submit two paper copies of the Operation and Maintenance Data to the owner in three ring binders with the project title and contractor's contact information.
- D. Project Record Documents: Throughout the project the contractor shall keep a running record of as-builts showing deviations from the plans. At the end of the project the contractor shall submit one clean hand sketch set of documents to the owner.

#### 1.06 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Mechanical 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.
- D. Install all equipment, materials, and accessories per manufacturers written instructions.

#### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

#### 1.08 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical 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 mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors and Frames."

### PART 2 PRODUCTS

#### 2.01 MANUFACTURERS

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

#### 2.02 PIPE, TUBE AND FITTINGS

- A. Refer to individual Division 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.

#### 2.03 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 B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining Plastic Piping:
  - 1. ABS Piping: ASTM D2235.
  - 2. CPVC Piping: ASTM F493.
  - 3. PVC Piping: ASTM D2564. Include primer according to ASTM F656.
  - 4. PVC to ABS Piping Transition: ASTM D 3138.
- I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

## 2.04 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
  - 1. Manufacturers:
    - a. Cascade Waterworks Mfg. Co.
    - b. Dresser Industries, Inc.; DMD Div.
    - c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
    - d. JCM Industries.
    - e. Smith-Blair, Inc.
    - f. Viking Johnson.
  - 2. Underground Piping NPS 1½ and Smaller: Manufactured fitting or coupling.
  - 3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
  - 4. Aboveground Pressure Piping: Pipe fitting.
- B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
  - 1. Manufacturers:
    - a. Eslon Thermoplastics.
- C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
  - 1. Manufacturers:
    - a. Thompson Plastics, Inc.
- D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
  - 1. Manufacturers:
    - a. NIBCO INC.
    - b. NIBCO, Inc.; Chemtrol Div.
- E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve ends same size as piping to be joined, and corrosion-resistant metal band on each end.

1. Manufacturers:
  - a. Cascade Waterworks Mfg. Co.
  - b. Fernco, Inc.
  - c. Mission Rubber Company.
  - d. Plastic Oddities, Inc.

## 2.05 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
  1. Manufacturers:
    - a. Capitol Manufacturing Co.
    - b. Central Plastics Company.
    - c. Eclipse, Inc.
    - d. Epco Sales, Inc.
    - e. Hart Industries, International, Inc.
    - f. Watts Industries, Inc.; Water Products Div.
    - g. Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150 or 300-psig minimum working pressure as required to suit system pressures.
  1. Manufacturers:
    - a. Capitol Manufacturing Co.
    - b. Central Plastics Company.
    - c. Epco Sales, Inc.
    - d. Watts Industries, Inc.; Water Products Div.
- E. 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. Manufacturers:
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Central Plastics Company.
    - d. Pipeline Seal and Insulator, Inc.
  2. Separate companion flanges and steel bolts and nuts shall have 150 or 300-psig minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
  1. Manufacturers:
    - a. Calpico, Inc.
    - b. Lochinvar Corp.



- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
  - 1. Manufacturers:
    - a. Perfection Corp.
    - b. Precision Plumbing Products, Inc.
    - c. Sioux Chief Manufacturing Co., Inc.
    - d. Victaulic Co. of America.

## 2.06 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
  - 1. Manufacturers:
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Metraflex Co.
    - d. Pipeline Seal and Insulator, Inc.
  - 2. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 3. Pressure Plates: Plastic, Carbon steel or Stainless steel. Include two for each sealing element.
  - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating or Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## 2.07 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

## 2.08 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
  - 1. Finish: Polished chrome-plated and rough brass.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
  - 1. Finish: Polished chrome-plated and rough brass.
- E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With concealed or exposed-rivet hinge, set screw or spring clips, and chrome-plated finish.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

## 2.09 GROUT

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

## 2.10 PIPE CURBS AND EQUIPMENT CURBS

- A. Manufacturers:
  - 1. Pate.
  - 2. RPS Corporation.
  - 3. Thy Curb, Thybar Corporation.
- B. Equipment Support Rails:
  - 1. 18 Gauge galvanized steel with integral base plate, continuous welded corner seams, pressure treated wood nailer, counter flashing with leg screws, and internally reinforced for load bearing requirements.
  - 2. Height: Minimum 18 inches (457.2 mm) high or as specified.
  - 3. Length: As required for equipment and to span structural supports.
- C. Pipe Curb Assemblies:
  - 1. Heavy Gauge galvanized steel with unitized construction and integral base plate, 3 lb density insulation and 2x2 nailer. Furnish acrylic clad thermo plastic cover, fastening screws, & graduated step boots with stainless steel clamps.
  - 2. Height: 18 inches (457.2 mm)
  - 3. Multiple Pipes: Size and configure cover to accommodate all pipes serving equipment including power conduit and control conduit.

- D. Pipe Seals for Single Roof Penetrations:
  - 1. One piece spun aluminum base with 5 inch (127 mm) flange, polyvinyl chloride boot with graduated widths and adjustable stainless steel clamps.
  - 2. Reference Product: Pate-Pipe Seal.

### PART 3 EXECUTION

#### 3.01 MECHANICAL DEMOLITION

- A. Refer to Division 1 Sections "Cutting and Patching" and "Selective Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.
  - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or 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.

#### 3.02 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
  - 1. New Piping:
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
    - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
    - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
    - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
    - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
    - g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.
    - h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated or rough-brass finish.
    - i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
    - j. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
    - k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
    - l. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
  - 2. Existing Piping: Use the following:
    - a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
    - b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge and spring clips.
    - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
    - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
    - e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
    - f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.

- g. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with polished chrome-plated or rough-brass finish.
  - h. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
  - i. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.
  - j. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
  - k. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.
- M. Permanent sleeves are not required for holes formed by removable PE sleeves.
- N. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- O. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
    - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50.8 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
  - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
    - a. PVC or Steel Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
    - b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
    - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50.8 mm) above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
      - 1) Seal space outside of sleeve fittings with grout.
  - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.
- P. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - 1. Install steel pipe for sleeves smaller than 6 inches (152.4 mm) in diameter.
  - 2. Install cast-iron "wall pipes" for sleeves 6 inches (152.4 mm) and larger in diameter.
  - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- Q. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- R. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials.
- S. Verify final equipment locations for roughing-in.
- T. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

### 3.03 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, 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 F402 for safe-handling practice of cleaners, primers, and solvent cements.
  2. ABS Piping: Join according to ASTM D2235 and ASTM D2661 Appendixes.
  3. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.

4. PVC Pressure Piping: Join schedule number ASTM D1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.
  5. PVC Nonpressure Piping: Join according to ASTM D2855.
  6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D3139.
- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657.
1. Plain-End Pipe and Fittings: Use butt fusion.
  2. Plain-End Pipe and Socket Fittings: Use socket fusion.
- M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

### 3.04 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
  2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
  3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
  4. Wet Piping Systems: Install dielectric nipple fittings to connect piping materials of dissimilar metals.
    - a. For piping systems operating below ambient temperature, provide dielectric nipple and brass ball valve or dielectric coupling to separate interior and exterior dissimilar metals.

### 3.05 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.
- E. Install equipment per the manufacturer's recommendations. If the manufacturer's recommendations are different than shown on the construction documents or as otherwise specified contact the engineer.

- F. Contractor shall provide all equipment and associated controls required to provide a complete and operable system.
- G. The scope of work for all Division 23 sections includes all miscellaneous work needed (whether or not specified or shown on the documents) to produce a complete and fully operational system.

### 3.06 PAINTING

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

### 3.07 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 (101.6 mm) larger in both directions than supported unit.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
  - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
  - 7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."

### 3.08 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 5 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

### 3.09 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.



- C. Attach to substrates as required to support applied loads.

### 3.10 GROUTING

- A. Mix and install grout for mechanical 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.

### 3.11 EQUIPMENT LABEL INSTALLATION

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

END OF SECTION

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## SECTION 230516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Flexible pipe connectors.
- B. Expansion joints and compensators.
- C. Pipe loops, offsets, and swing joints.
- D. Alignment guides and anchors.

#### 1.02 RELATED REQUIREMENTS

- A. Section 232113 - Hydronic Piping.
- B. Section 232213 - Steam and Condensate Heating Piping.
- C. Section 232300 - Refrigerant Piping.

#### 1.03 REFERENCE STANDARDS

- A. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2022.
- B. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984, with Editorial Revision (2019).
- C. EJMA (STDS) - EJMA Standards; Eleventh Edition.
- D. FM (AG) - FM Approval Guide; Current Edition.
- E. ITS (DIR) - Directory of Listed Products; Current Edition.
- F. UL (DIR) - Online Certifications Directory; Current Edition.

#### 1.04 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products shall be suitable for piping system fluids, materials, working pressures, and temperatures.
- B. Capability: Products shall absorb 200 percent of maximum axial movement between anchors.

#### 1.05 SUBMITTALS: Signed and sealed by a qualified professional engineer.

- A. Product Data:
  - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot (meter) and per

- assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
  - 2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
  - B. Shop Drawings: Signed and sealed by a qualified professional engineer.
    - 1. Design Calculations: Calculate requirements for thermal expansion of piping systems for and for selecting and designing expansion joints, loops, and bends.
    - 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
    - 3. Alignment Guide Details: Detail field assembly and attachment to building structure.
    - 4. Schedule: Indicate type, manufacturer's number, size material pressure rating, end connections, and location for each expansion joint.
    - 5. Grooved joint couplings shall be shown on drawings and product submittals, and be specifically identified with the applicable Victaulic style number.
  - C. Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.
  - D. Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors, and guides.
  - E. Welding Certificate.
- 1.06 QUALITY ASSURANCE
- A. Welding: Qualify procedures and personnel according to the following:
    - 1. Steel Shapes and Plates: AWS D1.1, "Structural Welding Code – Steel."
    - 2. Welding to Piping: ASME Boiler and Pressure Vessel Code: Section IX.
  - B. To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be supplied by Victaulic. Grooving tools shall be supplied by the same manufacturer as the grooved components.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

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

### 2.02 Flexible-Hose Expansion Joints

- A. Manufactured assembly with two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose; with inlet and outlet elbow fittings, corrugated-metal inner hoses, and braided outer sheaths.

- B. Manufacturers:
  - 1. Flex-Hose Co., Inc.
  - 2. Flex-Weld, Inc: [www.kelcoind.com/#sl](http://www.kelcoind.com/#sl)
  - 3. Flexicraft Industries.
  - 4. Flex-Pression, Ltd.
  - 5. Mercer Rubber Company: [www.mercer-rubber.com/#sle](http://www.mercer-rubber.com/#sle).
  - 6. The Metraflex Company: [www.metraflex.com/#sle](http://www.metraflex.com/#sle).
  - 7. Unisource Manufacturing, Inc; Series 401, Stainless Steel Threaded Connectors: [www.unisource-mfg.com/#sle](http://www.unisource-mfg.com/#sle).
- C. Flexible-Hose Expansion Joints for Copper Piping: Copper-alloy fittings with solder-joint end connections.
  - 1. NPS 2 and Smaller: Bronze hoses and single-braid bronze sheaths.
  - 2. NPS 2-1/2 to NPS 4: Stainless-steel hoses and single-braid, stainless-steel sheaths.
- D. Flexible-Hose Expansion Joints for Steel Pipings: Carbon-steel fittings with threaded end connections for NPS 2 and smaller and flanged, weld end connections for NPS 2-1/2 and larger.
  - 1. NPS 2 and Smaller: Stainless-steel hoses and single-braid, stainless-steel sheaths.
  - 2. NPS 2-1/2 to NPS 6: Stainless-steel hoses and single-braid, stainless steel sheaths.

## 2.03 FLEXIBLE PIPE CONNECTORS - STEEL PIPING

- A. Manufacturers:
  - 1. Flex-Hose Co., Inc.
  - 2. Flex-Weld, Inc: [www.kelcoind.com/#sl](http://www.kelcoind.com/#sl)
  - 3. Flexicraft Industries.
  - 4. Flex-Pression, Ltd.
  - 5. Mercer Rubber Company: [www.mercer-rubber.com/#sle](http://www.mercer-rubber.com/#sle).
  - 6. The Metraflex Company: [www.metraflex.com/#sle](http://www.metraflex.com/#sle).
  - 7. Unisource Manufacturing, Inc; Series 401, Stainless Steel Threaded Connectors: [www.unisource-mfg.com/#sle](http://www.unisource-mfg.com/#sle).
- B. Inner Hose: Bronze.
- C. Exterior Sleeve: Single braided, stainless steel.
- D. Pressure Rating: 125 psi up to 12 inch (862 kPa up to 300 mm, DN).
- E. Maximum Service Temperature: 450 degrees F (232 degrees C).
- F. NPS 2 and smaller end connections: Threaded.
- G. NPS 2-1/2 to NPS 6 end connections: Welded or Flanged
- H. Size: Use pipe sized units.
- I. Maximum offset: 3/4 inch (20 mm) on each side of installed center line.
  - 1. Anchors as shown on the Plans.

2.04 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

- A. Manufacturers:
  - 1. Flex-Hose Co., Inc.
  - 2. Flexicraft Industries.
  - 3. Flex-Pression, Ltd.
  - 4. Mercer Rubber Company: [www.mercer-rubber.com/#sle](http://www.mercer-rubber.com/#sle).
  - 5. The Metraflex Company: [www.metraflex.com/#sle](http://www.metraflex.com/#sle).
  - 6. Unisource Manufacturing, Inc; Series 411, Bronze Braided Flex Connectors: [www.unisource-mfg.com/#sle](http://www.unisource-mfg.com/#sle).
- B. NPS 2 and Smaller: Bronze hoses and single-braid bronze sheaths.
- C. NPS 2-1/2 to NPS 4: Stainless-steel hoses and single-braid, stainless-steel sheaths.
- D. Pressure Rating: 125 psi up to 2 inch (862 kPa up to 50 mm, DN).
- E. Maximum Service Temperature: 450 degrees F (232 degrees C).
- F. End Connections: Solder- joint end connections.
- G. Size: Use pipe sized units.
- H. Maximum offset: 3/4 inch (20 mm) on each side of installed center line.
- I. Application: Copper piping.

2.05 EXPANSION JOINTS - METAL BELLOWS TYPE

- A. Manufacturers:
  - 1. Flex-Weld, Inc; Keflex 308/311 Series: [www.kelcoind.com/#sle](http://www.kelcoind.com/#sle).
- B. Provide shroud to protect from external damage and allows for the application of external insulation.
- C. Provide with tie rods to prevent over-compression or over-elongation.
- D. Pressure Rating: 125 psi and 400 degrees F (862 kPa and 204 degrees C).
- E. Maximum Compression: 1-3/4 inches (45 mm).
- F. End Connections: Flanged.
- G. Size: Use pipe sized units.
- H. Application: Steel piping 2 inches (50 mm) and larger.

2.06 EXPANSION JOINTS - STAINLESS STEEL BELLOWS TYPE

- A. Manufacturers:
  - 1. Flex-Weld, Inc; Keflex 7Q Series - Quadra-Side: [www.kelcoind.com/#sle](http://www.kelcoind.com/#sle).
  - 2. Mercer Rubber Company: [www.mercer-rubber.com/#sle](http://www.mercer-rubber.com/#sle).
  - 3. The Metraflex Company: [www.metraflex.com/#sle](http://www.metraflex.com/#sle).

- B. Pressure Rating: 125 psi and 400 degrees F (862 kPa and 204 degrees C).
- C. Maximum Compression: 1-3/4 inches (45 mm).
- D. Maximum Extension: 1/4 inch (6 mm).
- E. End Connections: Externally pressurized with flanged ends.
- F. Size: Use pipe sized units.
- G. Application: Steel piping 3 inches (75 mm) and under.

2.07 Grooved End Expansion Joints for Steel Piping: Use in water piping systems 3/4" and larger that are installed within enclosures where a pipe bend or loop cannot be applied.

- A. Manufacturers:
  - 1. Victaulic
- B. 2" Through 6": Packless, gasketed, slip-type expansion joint with grooved end telescoping body for installation with Victaulic Style 07 rigid couplings. Provides axial end movement to 3", designed for water services up to 230°F and working pressure to 350 psi. Victaulic Style 150 Mover®.
- C. 3/4" Through 24: Combination of short nipples and Victaulic Style 75 or 77 flexible couplings joined in tandem for increased expansion. Joint movement and expansion capabilities dependent on number of couplings/nipples used in the joint. Pressure rating dependent on size and style of flexible couplings used. Victaulic Style 155.

2.08 ACCESSORIES

- A. Pipe Alignment Guides:
  - 1. Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.
  - 2. Manufacturers:
    - a. Adsko Manufacturing, LLC.
    - b. Advanced Thermal Systems, Inc.
    - c. Flex-Hose Co., Inc.
    - d. Flexicraft Industries.
    - e. Hyspan Precision Products, Inc.
    - f. The Metraflex Company; PGQ Glide Riser Guide: [www.metraflex.com/#sle](http://www.metraflex.com/#sle).
    - g. Piping Technology & Products, Inc.
    - h. Senior Flexonics, Inc.; Pathway Division.
  - 3. Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch (25 mm) thick insulation, minimum 3 inches (75 mm) travel.
- B. Steel Shapes and Plates: ASTM A 36/A 36M.
- C. Bolts and Nuts: ASME B18.10 or ASTM A183, steel, hex head.
- D. Washers: ASTM F 84, steel plain, flat washers.

- E. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, and tension and shear capacities appropriate for application.
  - 1. Stud: Threaded, zinc-coated carbon steel.
  - 2. Expansion Plug: Zinc-coated steel.
  - 3. Washer and Nut: Zinc-coated steel.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with EJMA (Expansion Joint Manufacturers Association) Standards.
- C. Install manufactured, nonmetallic expansion joints according to FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."
- D. Install expansion joints of sizes matching size of piping in which they are installed.
- E. Grooved end expansion joints shall be installed in accordance with the manufacturer's (Victaulic) guidelines and recommendations. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be supplied by the grooved coupling manufacturer. Grooved end shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. A Victaulic factory trained field representative shall provide on-site training to contractor's field personnel in the installation of grooved piping products. Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.
- F. Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line size flexible connectors.
- G. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
- H. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- I. Install pipe bends and loops in grooved piping systems with (8) Victaulic Style 75 or 77 flexible couplings, (4) Victaulic 90° elbows, and (3) grooved end pipe spools provided in water systems to 230°F in accordance with the latest Victaulic recommendations for expansion compensation.
- J. Attach pipe bends and loops to anchors.
  - 1. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.
- K. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.



- L. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.
- M. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.
- N. Install alignment guides to allow expansion and to avoid end-loading and torsional stress.
- O. Install guides to pipe and secure to building structure.
- P. Attach guides to pipe and secure to building structure.
- Q. Anchor pipe to building structure where indicated. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
- R. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- S. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.
- T. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.
- U. Install pipe anchors according to expansion-joint manufacturer's written instructions if expansions joints or compensators are indicated.
- V. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.
- W. Use grout to form flat bearing surfaces for expansion fittings, guides and anchors installed on or in concrete.

END OF SECTION

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## SECTION 230519 - METERS AND GAUGES FOR HVAC PIPING

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Pressure gauges and pressure gauge taps.
- B. Thermometers and thermometer wells.

#### 1.02 RELATED REQUIREMENTS

- A. Section 230923 - Direct-Digital Control System for HVAC.
- B. Section 230993 - Sequence of Operations for HVAC Controls.
- C. Section 232113 - Hydronic Piping.
- D. Section 232213 - Steam and Condensate Heating Piping.

#### 1.03 REFERENCE STANDARDS

- A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2022.
- B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014 (Reapproved 2020).
- C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014 (Reapproved 2021).
- D. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.

#### 1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
- C. Shop Drawings: Schedule for [thermometers] [and] [gages] indicating manufacturer's number, scale range, and location for each.

#### 1.05 FIELD CONDITIONS

- A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

## PART 2 PRODUCTS

### 2.01 PRESSURE GAUGES:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AMETEK, Inc.: U.S. Gauge Div.
  2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
  3. Dwyer Instruments, Inc: [www.dwyer-inst.com/#sle](http://www.dwyer-inst.com/#sle).
  4. Ernst Gage Co.
  5. KOBOLD Instruments, Inc.
  6. Marsch Bellofram.
  7. Miljoco Corp.
  8. Moeller Instrument Company, Inc: [www.moellerinstrument.com/#sle](http://www.moellerinstrument.com/#sle).
  9. Omega Engineering, Inc: [www.omega.com/#sle](http://www.omega.com/#sle).
  10. Palmer - Wahl Instruments Inc.
  11. REO TEMP Instrument Corporation
  12. Terice, H.O. Co.
  13. Weiss Instruments, Inc.
  14. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
  15. WIKA Instrument Corporation.
  16. Winters Instruments: [www.winters.com/#sle](http://www.winters.com/#sle).
- B. Direct-Mounting, Dial-Type Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
1. Case: Liquid filled type, Steel with brass bourdon tube.
  2. Size: 4-1/2 inch (115 mm) diameter.
  3. Mid-Scale Accuracy: One percent.
  4. Scale: Psi.
  5. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
  6. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
  7. Pointer: Red or other dark-color metal.
  8. Window: Glass or plastic.
  9. Ring: Metal or plastic.
  10. Range for Fluids under Pressure: Two times operating pressure.

### 2.02 PRESSURE GAUGE TAPPINGS

- A. Gauge Cock: Tee or lever handle, brass for maximum 150 psi (1034 kPa).
- B. Needle Valve: Brass, 1/4 inch (6 mm) NPT for minimum 150 psi (1034 kPa).
- C. Pulsation Damper: Pressure snubber, brass with 1/4 inch (6 mm) connections
- D. Syphon: Brass, 1/4 inch (6 mm) angle or straight pattern.

## 2.03 STEM TYPE THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Dwyer Instruments, Inc: [www.dwyer-inst.com/#sle](http://www.dwyer-inst.com/#sle).
  2. Omega Engineering, Inc: [www.omega.com/#sle](http://www.omega.com/#sle).
  3. Palmer - Wahl Instruments Inc.
  4. Terice, H.O. Co.
  5. Weiss Instruments, Inc.
  6. Weksler Glass Thermometer Corp: [www.wekslerglass.com/#sle](http://www.wekslerglass.com/#sle).
  7. Winters Instruments: [www.winters.com/#sle](http://www.winters.com/#sle).
- B. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, magnifying lens, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
1. Size: 7 inch (175 mm) scale.
  2. Window: Clear glass.
  3. Stem: 3/4 inch (20 mm) NPT brass for thermowell installation and of length to suit installation.
  4. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range, per ASTM E77.
  5. Calibration: Degrees F.
  6. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

## 2.04 DIAL THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrumet Div.
  2. Dwyer Instruments, Inc: [www.dwyer-inst.com/#sle](http://www.dwyer-inst.com/#sle).
  3. KOBOLD Instruments, Inc.
  4. Marsh Bellofram.
  5. Omega Engineering, Inc: [www.omega.com/#sle](http://www.omega.com/#sle).
  6. Terice, H.O. Co.
  7. Weiss Instruments, Inc.
  8. Weksler Glass Thermometer Corp: [www.wekslerglass.com/#sle](http://www.wekslerglass.com/#sle).
  9. Winters Instruments: [www.winters.com/#sle](http://www.winters.com/#sle).
- B. Thermometers: Dial type vapor or liquid actuated; ASTM E1; stainless steel liquid filled case, with brass or copper bulb, copper or bronze braided capillary, white with black markings and black pointer, glass lens.
1. Size: diameter dial.
  2. Lens: Clear glass.
  3. Length of Capillary: Minimum 5 feet (1500 mm).
  4. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

5. Calibration: Degrees F.
6. Movement: Mechanical, connecting element and pointer.
7. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
8. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
9. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem for thermowell installation and of length to suit installation.

## 2.05 THERMOMETER SUPPORTS

- A. Socket: Pressure-tight, Brass separable sockets for thermometer stems with or without extensions as required for insertion inot piping and of type, diameter, and lenght required to hold thermometer.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. AEMETEK.
    - b. Ashcroft Commerical Instrument Operations; Dresser Industries; Instrument Div.
    - c. Ernst Gage Co..
    - d. Marsh Bellofram.
    - e. Miljoco Corp.
    - f. NANMAC Corporation
    - g. Noshok, Inc.
    - h. Palmer-Wahl Instruments Inc.
    - i. REO TEMP Instrument Corporation
    - j. Tel-Tru Manufacturing Company.
    - k. Trerice, H.O. Co.
    - l. Weiss Instruments, Inc.
    - m. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
    - n. WIKA Instrument Corporation.
    - o. Winters Instruments.
- B. Manufacturers: Same manufacturer of thermometer being used.

## 2.06 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Dwyer Instruments, Inc: [www.dwyer-inst.com/#sle](http://www.dwyer-inst.com/#sle).
  2. Flow Design, Inc.
  3. MG Piping Products Co.
  4. National Meter, Inc.
  5. Peterson Equipment Co., Inc.
  6. Sisco Manufacturing Co.
  7. Trerice, H. O. Co.
  8. Watts Water Technologies, Inc: [www.watts.com/#sle](http://www.watts.com/#sle).
  9. Weiss Instruments, LLC: [www.weissinstruments.com/#sle](http://www.weissinstruments.com/#sle).
  10. Weksler Glass Thermometer Corp: [www.wekslerglass.com/#sle](http://www.wekslerglass.com/#sle).
  11. Winters Instruments: [www.winters.com/#sle](http://www.winters.com/#sle).

- B. Test Plug: 1/4 inch (6 mm) or 1/2 inch (13 mm) brass fitting and cap for receiving 1/8 inch (3 mm) outside diameter pressure or temperature probe with neoprene core inserts for pressures up to 500 psig and temperatures up to 200 degrees F (93 degrees C). Provide extended stem for units to be installed in insulated piping.
  - 1. Core Inserts: One or two self-sealing rubber valves.
    - a. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.
    - b. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.
- C. Test Kit: Furnish one test kit(s) containing one pressure gage and adaptor, one thermometer(s), and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.
  - 1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be 0 to 200 psig.
  - 2. Low-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 125 deg F.
  - 3. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.
  - 4. Carrying case shall have formed instrument padding.

### PART 3 EXECUTION

#### 3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.
- C. Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Provide siphon on gauges in steam systems. Extend nipples and siphons to allow clearance from insulation.
- D. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.
- E. Install needle-valve and snubber fitting in piping for each pressure gage for fluids (except steam).
- F. Install needle-valve and syphon fitting in piping for each pressure gage for steam.
- G. Install test plugs in tees in piping.
- H. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch (60 mm) for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- I. Install thermometers in air duct systems on flanges.
- J. Install thermometer sockets adjacent to controls system thermostat, transmitter, or sensor sockets.

- K. Install thermowells with socket extending one-third of diameter of pipe and in vertical position in piping tees where thermometers are indicated.
- L. Locate duct mounted thermometers minimum 10 feet (3 m) downstream of mixing dampers, coils, or other devices causing air turbulence.
- M. Duct Thermometer Support Flanges: Install in wall of duct where duct thermometers are indicated. Attach to duct with screws.
- N. Coil and conceal excess capillary on remote element instruments.
- O. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- P. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- Q. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- R. Locate test plugs adjacent thermometers and thermometer sockets.

### 3.02 Connections

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.

### 3.03 ADJUSTING

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

### 3.04 SCHEDULE

- A. Pressure Gauges, Location:
  - 1. Install dry-case type pressure gages for each pressure-reducing valve.
  - 2. Install liquid-filled-case type pressure gages at chilled- and condenser-water inlets and outlets of chillers.
  - 3. Install liquid-filled-case-type pressure gages at suction and discharge of each pump.
- B. Stem Type Thermometers, Location:
  - 1. Inlet and outlet of each hydronic zone.
  - 2. Inlet and outlet of each hydronic boiler and chiller.
  - 3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
  - 4. Inlet and outlet of each hydronic heat exchanger.
  - 5. Inlet and outlet of each hydronic heat-recovery unit.
  - 6. Inlet and outlet of each thermal storage tank.
  - 7. Outside-air, return-air, and mixed-air ducts.
- C. Dial Thermometers, Location:
  - 1. Inlet and outlet of each hydronic zone.



2. Inlet and outlet of each hydronic boiler and chiller.
  3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
  4. Inlet and outlet of each hydronic heat exchanger.
  5. Inlet and outlet of each hydronic heat-recovery unit.
  6. Inlet and outlet of each thermal storage tank.
- D. Install liquid-filled case type, bimetallic-actuated dial thermometers at suction and discharge of each pump
- E. Provide the following temperature ranges for thermometers:
1. Heating Hot Water Scale Range: 30 to 240 deg F, with 2-degree scale divisions
  2. Condenser Water Scale Range: 0 to 160 deg F, with 2-degree scale divisions
  3. Chilled Water Scale Range: 0 to 100 deg F, with 2-degree scale divisions
  4. Steam and Condensate Scale Range: 30 to 300 deg F, with 5-degree scale divisions
  5. Air Ducts Scale Range: 30 to 240 deg F, with 2-degree scale divisions

END OF SECTION

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SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Globe valves.
- B. Ball valves.
- C. Butterfly valves.
- D. Check valves.
- E. Gate valves.

1.02 REFERENCE STANDARDS

- A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.
- C. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard; 2025.
- D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- E. ASME B16.34 - Valves — Flanged, Threaded, and Welding End; 2025.
- F. ASME B31.9 - Building Services Piping; 2020.
- G. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2023).
- H. ASTM A216/A216M - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service; 2021.
- I. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984, with Editorial Revision (2019).
- J. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2017.
- K. AWWA C606 - Grooved and Shouldered Joints; 2022.
- L. MSS SP-45 - Drain and Bypass Connections; 2020.
- M. MSS SP-67 - Butterfly Valves; 2022.
- N. MSS SP-70 - Gray Iron Gate Valves, Flanged and Threaded Ends; 2011.
- O. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends; 2018.

- P. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.
- Q. MSS SP-85 - Gray Iron Globe and Angle Valves, Flanged and Threaded Ends; 2011.
- R. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

#### 1.03 SUBMITTALS

- A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; furnished specialties; and accessories.
- B. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.
- D. Maintenance Materials: Furnish Owner with one wrench for every five plug valves, in each size of square plug valve head.

#### 1.04 QUALITY ASSURANCE

- A. Manufacturer:
  - 1. Obtain valves for each valve type from single manufacturer.
  - 2. Company must specialize in manufacturing products specified in this section, with not less than three years of documented experience.

#### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
  - 1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
  - 2. Protect valve parts exposed to piped medium against rust and corrosion.
  - 3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
  - 4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
  - 5. Adjust butterfly valves to closed or partially closed position.
- B. Use the following precautions during storage:
  - 1. Store valves in shipping containers and maintain in place until installation.
    - a. Store valves indoors in dry environment.
    - b. Store valves off the ground in watertight enclosures when indoor storage is not an option.

## PART 2 PRODUCTS

### 2.01 APPLICATIONS

- A. Listed pipe sizes shown using nominal pipe sizes (NPS) and nominal diameter (DN).
- B. Provide the following valves for the applications if not indicated on drawings:
  - 1. Throttling (Hydronic): Butterfly, Ball, and Globe.
  - 2. Isolation (Shutoff): Butterfly, Gate, and Ball.
- C. Substitutions of valves with higher CWP classes or WSP ratings for same valve types are permitted when specified CWP ratings or WSP classes are not available.

### 2.02 GENERAL REQUIREMENTS

- A. Bronze Valves: NPS 2 and Smaller: Threaded ends, unless otherwise indicated.
- B. Brass Valves: NPS 2 and Smaller: Victaulic VIP Press 304™ ends, unless otherwise indicated
- C. Ferrous Valves NPS 2-1/2 and Larger: Grooved or flanged ends, unless otherwise indicated.
- D. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.
- E. Valve Sizes: Match upstream piping unless otherwise indicated.
- F. Valve Actuator Types:
  - 1. Handwheel: Valves other than quarter-turn types.
  - 2. Hand Lever: Quarter-turn valves 6 inch (150 mm, DN) and smaller except plug valves.
  - 3. Wrench: Plug valves with square heads.
  - 4. Extended Valve Stems: On insulated valves.
- G. Valve-End Connections:
  - 1. Threaded End Valves: ASME B1.20.1.
  - 2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
  - 3. Pipe Flanges and Flanged Fittings 1/2 inch (15 mm, DN) through 24 inch (600 mm, DN): ASME B16.5.
  - 4. Solder Joint Connections: ASME B16.18.
    - a. Caution: Use solder with melting point below 840 deg F for check, gate, and globe valves; below 421 deg F for ball valves.
  - 5. Grooved End Connections: AWWA C606.
- H. General ASME Compliance:
  - 1. Building Services Piping Valves: ASME B31.9.
- I. Bronze Valves:
  - 1. Fabricate from dezincification resistant material.
  - 2. Copper alloys containing more than 15 percent zinc are not permitted.
- J. Valve Bypass and Drain Connections: MSS SP-45.

- K. Source Limitations: Obtain each valve type from a single manufacturer.

## 2.03 BRONZE, GLOBE VALVES

- A. Ratings for Class 125 and Class 250:
1. Class 125:
    - a. WOG Rating: 200 psi (1,380 kPa).
    - b. WSP Rating: 125 psi (861.8 kPa), saturated.
  2. Class 250: WOG Rating; 300 psi (2,070 kPa).
  3. Comply with MSS SP-80, Type 1.
  4. Body: ASTM B62, bronze with integral seat and screw-in bonnet.
  5. End Connections: Threaded or solder.
  6. Bonnet: NRS; Nonrising Stem.
  7. Nonrising Stem: Bronze.
  8. Disc: PTFE.
  9. Packing: Asbestos free.
  10. Handwheel Operator: Malleable Iron.

## 2.04 IRON, GLOBE VALVES

- A. CWP Ratings: Class 125: 200 psi (1,380 kPa) and Class 250: 500 psi (3,450 kPa):
1. Comply with MSS SP-85, Type I.
  2. Body: Gray iron; ASTM A126, with bolted bonnet.
  3. Ends: Flanged.
  4. Trim: Bronze.
  5. Packing and Gasket: Asbestos free.
  6. Operator: Handwheel or chainwheel.

## 2.05 CARBON STEEL, GLOBE VALVES

- A. Class 150:
1. Body: ASTM A216/A216M.
  2. WOG Rating: 150 psi (1,034 kPa).
  3. Bonnet: NRS; Nonrising Stem.
  4. End Connections: Flanged.
  5. Packing and Gasket: Asbestos free.
  6. Operator: Malleable Iron handwheel.
  7. Pressure and Temperature Rating: ASME B16.34.

## 2.06 BRASS, BALL VALVES

- A. One Piece, Full Port with Brass Trim and Press, Threaded, or Soldered Connections:
1. Comply with MSS SP-110.
  2. CWP Rating: 200 psi (1,379 kPa).
  3. Body: Forged brass.
  4. Ends: Threaded.
  5. Seats: PTFE.

6. Stem: Brass.
7. Ball: Chrome-plated brass.

B. Two Piece, Full Port with Stainless Steel Trim and Female Thread or Solder Connections:

1. Comply with MSS SP-110.
2. SWP Rating: 150 psi (1,035 kPa).
3. WOG Rating: 600 psi (4,140 kPa).
4. Vacuum Rating: 28.9 in-Hg (97.9 kPa).
5. Body: Forged brass.
6. Seats: PTFE.
7. Stem: Stainless Steel.
8. Ball: Chrome-plated brass.

C. Two Piece, Full Port with Press Connection:

1. WOG Rating: 250 psi (1,724 kPa).
2. Body: Forged brass.
3. Seats: EPDM.
4. Ball: Chrome-plated brass.
5. Blow-out Proof Stem: Forged brass.
6. Maximum Service Temperature: 250 degrees F (121.1 degrees C).

2.07 BRONZE, BALL VALVES

A. General:

1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.

B. Two Piece, Full Port with Bronze or Brass Trim:

1. Comply with MSS SP-110.
2. WSP Rating: 150 psi (1,035 kPa).
3. WOG Rating: 400 psi (2,758 kPa).
4. Body: Forged bronze or dezincified-brass alloy.
5. End Connections: Pipe thread or solder.
6. Seats: PTFE.

2.08 IRON, SINGLE FLANGE BUTTERFLY VALVES

A. Lug Style:

1. Comply with MSS SP-67, Type I.
2. Lug Style, CWP Ratings:
  - a. Sizes 2 to 12 inch (50 to 300 mm, DN): 150 psi (1034 kPa).
  - b. Vacuum Service: Down to 29.9 in-Hg (101.2 kPa).
3. Body Material: ASTM A126 cast iron or ASTM A536 ductile iron.
4. Stem: Two-piece stainless steel. Stem journal, blow-out proof stem
5. Seat: EPDM.
6. Disc: Aluminum-bronze.

2.09 IRON, GROOVED-END BUTTERFLY VALVES

- A. CWP Rating: 300 psi (2070 kPa).
  - 1. Comply with MSS SP-67, Type I.
  - 2. Body: Coated ductile iron.
  - 3. Stem: Two-piece stainless steel. Stem shall be offset from the disc centerline to provide complete 360-degree circumferential seating.
  - 4. Disc: Coated ductile iron.
  - 5. Disc Seal: EPDM.
  - 6. Manufacturers:
    - a. Victaulic; Vic300 Masterseal and AGS-Vic300.

2.10 BRONZE, LIFT CHECK VALVES

- A. Class 125:
  - 1. Comply with MSS SP-80, Type 1, Metal Disc to Metal Seat and Type 2, Nonmetallic Disc to Metal Seat.
  - 2. CWP Rating: 200 psi (1,380 kPa).
  - 3. Design: Vertical flow.
  - 4. Body: Bronze.
  - 5. Ends: Threaded.
  - 6. Disc (Type 1): Bronze.

2.11 BRONZE, SWING CHECK VALVES

- A. Class 150:
  - 1. Pressure and Temperature Rating: MSS SP-80, Type 3.
  - 2. Design: Y-pattern, horizontal or vertical flow.
  - 3. CWP Rating: 300 psi (2,068 kPa).
  - 4. Body: Bronze, ASTM B62.
  - 5. End Connections: Threaded or soldered.
  - 6. Disc: Bronze.

2.12 IRON, FLANGED END SWING CHECK VALVES

- A. Class 125:
  - 1. 200 psi (1,380 kPa) with metal seats and nonmetallic-to-metal seats.

2.13 IRON, SWING CHECK VALVES WITH CLOSURE CONTROL

- A. Class 125:
  - 1. Comply with MSS SP-71, Type I.
  - 2. Body Design: Clear or full waterway.
  - 3. Body Material: ASTM A126, gray iron with bolted bonnet.
  - 4. Ends: Flanged.
  - 5. Trim: Bronze.
  - 6. Gasket: Asbestos free.



7. Closer Control: Factory installed, exterior lever, and spring.
8. Manufacturers:
  - a. Victualic Company; Series 716 (300-psig) and AGS Series W715 (230-psig).

## 2.14 IRON, GROOVED-END SWING CHECK VALVES

- A. Class 300:
  1. CWP Rating: 300 psi (2,070 kPa).
  2. Body Material: ASTM A536, Grade 65-45-12 ductile iron.
  3. Seal: EPDM or Nitrile.
  4. Disc: Ductile iron.
  5. Coating: Black, non-lead paint.

## 2.15 IRON, GATE VALVES

- A. NRS or OS&Y:
  1. Comply with MSS SP-70, Type I.
  2. Class 125:
    - a. Sizes 2-1/2 to 12 inch (65 to 300 mm, DN), CWP Rating; 200 psi (1,380 kPa).
  3. Body Material: Gray iron with bolted bonnet.
  4. Ends: Flanged.
  5. Trim: Bronze.
  6. Disc: Solid wedge.
  7. Packing and Gasket: Asbestos free.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Discard all packing materials and verify that valve interior, including threads and flanges, are completely clean without signs of damage or degradation that could result in leakage.
- B. Verify valve parts to be fully operational in all positions from closed to fully open.
- C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.
- D. Should valve is determined to be defective, replace with new valve.

### 3.02 INSTALLATION

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Unions and flanges for servicing and disconnect are not required in installations using grooved mechanical joint couplings. (The couplings shall service as disconnect points if required.)

- D. Locate valves for easy access and provide separate support where necessary.
- E. Install valves in horizontal piping with stem at or above center of pipe.
- F. Install valves in position to allow full stem movement.
- G. Provide stem extensions for ball valves being installed on insulated lines.
- H. Provide memory stops for all valves to be used for balancing.
- I. Install butterfly valves with stem at the horizontal, and so that the handle points down when closed, and in the direction of flow when in the open position.
- J. Adjust all packing nuts after installation.
- K. Provide lever handles for 6" and smaller butterfly valves.
- L. Provide gear operator for 8" and larger butterfly valves.
- M. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.
- N. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.
- O. Install check valves where necessary to maintain direction of flow as follows:
  - 1. Lift Check: Install with stem plumb and vertical.
  - 2. Swing Check: Install horizontal maintaining hinge pin level.
- P. Provide chainwheels on operators for valves 4 NPS (100 DN) and larger where located 84 inches (2.1 m) or more above finished floor, terminating 60 inches (1.5 m) above finished floor.

### 3.03 JOINT CONSTRUCTION

- A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.
- B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

### 3.04 ADJUSTING

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

END OF SECTION

## SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

### PART 1 GENERAL

#### 1.01 Section Includes

- A. Support and attachment components.
- B. Hangers and supports for mechanical system piping and equipment.
- C. See Division 21 Sections on fire-suppression piping for fire-suppression piping hangers and supports.
- D. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.
- E. Section 055000 - Metal Fabrications: Materials and requirements for fabricated metal supports.

#### 1.02 Reference Standards

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- D. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- F. MFMA-4 - Metal Framing Standards Publication; 2004.
- G. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).
- H. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

#### 1.03 Administrative Requirements

- A. Coordination:
  - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
  - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.

3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

1.04 Performance Requirements

- A. Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

1.05 Submittals

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.
  1. Each type of hanger and channel support system component.
- B. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
  1. Application of protective inserts, saddles, and shields at pipe hangers for each type of insulation and hanger.

1.06 Quality Assurance

- A. Comply with applicable building code.
- B. Installer Qualifications for Powder-Actuated Fasteners (when specified): Certified by fastener system manufacturer with current operator's license.
- C. Installer Qualifications for Field-Welding: As specified in Section 055000.
  1. Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

1.07 Delivery, Storage, and Handling

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

## PART 2 PRODUCTS

### 2.01 Manufacturers

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

### 2.02 Support and Attachment Components

- A. General Requirements:
1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of plumbing work.
  2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
  3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 2. Include consideration for vibration, equipment operation, and shock loads where applicable.
  4. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
  5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
    - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
    - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
    - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
    - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Materials for Metal Fabricated Supports: Comply with Section 055000.
- C. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components.
1. Manufacturers:
    - a. AAA Technology and Specialties Co., Inc.
    - b. B-Line Systems, Inc.
    - c. Carpenter & Patterson, Inc.
    - d. Empire Tool & Manufacturing Co., Inc.
    - e. Globe Pipe Hanger Products, Inc.
    - f. Grinnell Corp.
    - g. GS Metals Corp.
    - h. Michigan Hanger Co., Inc.
    - i. National Pipe Hanger Corp.
    - j. PHD Manufacturing, Inc.
    - k. PHS Industries, Inc.
    - l. Piping Technology & Products, Inc.

2. Galvanized, Metallic Coatings: For piping and equipment that will not have field-applied finish.
  3. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- D. Prefabricated Trapeze-Framed Metal Strut Systems:
1. Manufacturers:
    - a. ABB Installation Products: [electrification.us.abb.com/#sle](http://electrification.us.abb.com/#sle).
    - b. B-Line, a brand of Eaton Corporation: [www.eaton.com/#sle](http://www.eaton.com/#sle).
    - c. Grinnell Corp.
    - d. GS Metals Corp.
    - e. Custom Strut and Roll Forming, LLC: [www.customstrut.com/#sle](http://www.customstrut.com/#sle).
    - f. Elgen Manufacturing Company, Inc: [www.elgenmfg.com/#sle](http://www.elgenmfg.com/#sle).
    - g. Gripple, Inc; Fast Track - Standard: [www.gripple.com/#sle](http://www.gripple.com/#sle).
    - h. Michigan Hanger Co., Inc.
    - i. National Pipe Hanger Corp.
    - j. Thomas & Betts Corp.
    - k. Unistrut, a brand of Atkore International Inc: [www.unistrut.com/#sle](http://www.unistrut.com/#sle).
    - l. Wesanco, Inc.
    - m. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
  2. MFMA-4 compliant, pre-fabricated, MSS SP-58 type 59, low profile continuous-slot metal strut channel with associated tracks, fittings, and related accessories.
  3. Strut Channel or Bracket Material:
    - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
    - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
  4. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch (2.66 mm).
  5. Minimum Channel Dimensions: 1-5/8 inch (41 mm) width by 13/16 inch (21 mm) height.
  6. Accessories: Provide bracket covers, cable basket clips, cable tray clips, clamps, conduit clamps, fire-retarding brackets, j-hooks, protectors, and vibration dampeners.
- E. Strut Channels:
1. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
  2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
  3. Manufacturers:
    - a. B-Line, a brand of Eaton Corporation: [www.eaton.com/#sle](http://www.eaton.com/#sle).
    - b. Grinnell Corp.
    - c. GS Metals Corp.
    - d. Michigan Hanger Co.,
    - e. National Pipe Hanger Corp.
    - f. Thomas & Betts Corp.
    - g. Wesanco, Inc.
    - h. Gripple, Inc; Universal Bracket: [www.gripple.com/#sle](http://www.gripple.com/#sle).
    - i. Unistrut, a brand of Atkore International Inc: [www.unistrut.com/#sle](http://www.unistrut.com/#sle).
    - j. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.

4. ASTM A653/A653M galvanized steel bracket with clamps for surface mounting of piping or plumbing equipment support.
  5. Channel or Bracket Kits: Include rods, brackets, end-fixed fittings, covers, clips, and other related hardware required to complete sectional trapeze section for piping or other support.
- F. Channel Nuts:
1. Provide carbon steel channel nut with epoxy copper or zinc finish and long, regular, or short spring.
- G. Hanger Rods:
1. Threaded zinc-plated steel unless otherwise indicated.
  2. Minimum Size, Unless Otherwise Indicated or Required:
    - a. Equipment Supports: 1/2 inch (13 mm) diameter.
    - b. Piping up to 1 inch (25 mm, DN): 1/4 inch (6 mm) diameter.
    - c. Piping larger than 1 inch (25 mm, DN): 3/8 inch (10 mm) diameter.
    - d. Trapeze Support for Multiple Pipes: 3/8 inch (10 mm) diameter.
- H. Steel Cable:
1. Manufacturers:
    - a. Ductmate Industries, Inc, a DMI Company; Clutcher Cable Hanging System: [www.ductmate.com/#sle](http://www.ductmate.com/#sle).
    - b. Elgen Manufacturing Company, Inc: [www.elgenmfg.com/#sle](http://www.elgenmfg.com/#sle).
    - c. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
- I. Cable Hanging System Kits:
1. Manufacturers:
    - a. B-Line, a brand of Eaton Corporation: [www.eaton.com/#sle](http://www.eaton.com/#sle).
    - b. Ductmate Industries, Inc: [ductmate.com/#sle](http://ductmate.com/#sle).
    - c. Gripple, Inc: [www.gripple.com/#sle](http://www.gripple.com/#sle).
    - d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
  2. Provide cable-wire in bulk or precut lengths with respective cable hangers as required to hold minimum weight of 120 lb (54.4 kg).
  3. Accessories: Provide brackets, clip or c-clip hangers, covers, and y-hook hangers.
- J. Thermal Insulated Pipe Supports:
1. General Requirements:
    - a. Insulated pipe supports to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
    - b. Surface Burning Characteristics: Flame spread index/smoke developed index of 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.
    - c. Pipe supports to be provided for nominally sized, 1/2 to 30 inch (15 to 750 mm, DN) iron pipes.
    - d. Insulation inserts to consist of rigid polyisocyanurate (urethane) insulation surrounded by a 360 degree, PVC jacketing.
- K. Thermal-Hanger Shield Inserts: 100-psi minimum compressive-strength insulation, encased in sheet metal shield.

1. Manufacturers:
  - a. Carpenter & Patterson, Inc.
  - b. Michigan Hanger Co., Inc.
  - c. PHS Industries, Inc.
  - d. Pipe Shields, Inc.
  - e. Rilco Manufacturing Co., Inc.
  - f. Value Engineered Products, Inc.
2. Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength and vapor barrier.
3. Material for Hot Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psi, ASTM C552, Type II cellular glass with 100-psi, or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi.
4. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
5. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.
6. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

## 2.03 MISCELLANEOUS MATERIALS

- A. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- B. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.
- C. Hanger Rods: Galvanized all-thread, ASTM A 36.
- D. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.
  1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
  2. Properties: Nonstaining, noncorrosive, and nongaseous.
  3. Design Mix: 5000-psi, 28-day compressive strength.

## PART 3 EXECUTION

### 3.01 Examination

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

### 3.02 APPLICATIONS

- A. Specific hanger requirements are specified in Sections specifying equipment and systems.



- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.
- C. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
  - 1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30 .
  - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, 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 24, requiring clamp flexibility and up to 4 inches of insulation.
  - 4. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
  - 5. U-Bolts (MSS Type 24): For support of heavy pipe, NPS 1/2 to NPS 30.
  - 6. 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.
  - 7. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
  - 8. 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.
- D. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
  - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
  - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- E. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification 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.
- F. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification 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. 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.
  - 8. Heavy (MSS Type 33): 3000 lb.
  - 9. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  - 10. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- G. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification 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 by manufacturer to prevent crushing insulation.
  - 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- H. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
  - 1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
  - 2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
- I. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.

### 3.03 Installation

Install products in accordance with manufacturer's instructions.

- A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems. Field assemble and install according to manufacturer's written instructions.
- C. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes. Support pipes of various sizes together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- D. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, 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.
- E. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

- F. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- G. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- H. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- I. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- J. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.
- K. Equipment Support and Attachment:
  - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
  - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
  - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
  - 4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 3 inch (80 mm) high concrete pad constructed in accordance with Section 033000.
  - 5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- L. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

Secure fasteners according to manufacturer's recommended torque settings.
- M. Remove temporary supports.
- N. 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.
- O. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- P. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.
- Q. Insulated Piping: Comply with the following:
  - 1. Attach clamps and spacers to piping.
    - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    - c. Do not exceed pipe stress limits according to ASME B31.9.
  - 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.

3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span arc of 180 degrees.
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 inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

### 3.04 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor. Place grout under supports for equipment and make smooth bearing surface.

### 3.05 METAL FABRICATION

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

### 3.06 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

### 3.07 PAINTING

- A. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils. See Division 9 Section "Painting" for paint materials and application requirements.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.08 Field Quality Control

- A. Inspect support and attachment components for damage and defects.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- C. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

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## SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Nameplates.
- B. Equipment Markers
- C. Tags.
- D. Adhesive-backed duct markers.
- E. Pipe markers.
- F. Ceiling tacks.

#### 1.02 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.
- B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2017.

#### 1.03 SUBMITTALS

- A. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- B. Product Data: Provide manufacturers catalog literature for each product required.
- C. Samples: For color, letter style, and graphic representation required for each identification material and device.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

#### 1.04 Quality Assurance

- A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

#### 1.05 Coordination

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

- B. Coordinate installation of identifying devices with location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

## PART 2 PRODUCTS

### 2.01 IDENTIFICATION APPLICATIONS

- A. Air Handling Units: Nameplates and Equipment Markers
- B. Air Terminal Units: Nameplates and Equipment Markers, Ceiling tacks or sticker (where located above lay-in ceiling).
- C. Automatic Controls: Tags. Key to control schematic.
- D. Control Panels: Equipment Markers
- E. Dampers: Ceiling tacks or sticker (where located above lay-in ceiling).
- F. Ductwork: Duct Markers
- G. Heat Transfer Equipment: Nameplates and Equipment Markers
- H. Instrumentation: Tags.
- I. Major Control Components: Nameplates.
- J. Piping: Pipe Markers
- K. Pumps, compressors, chillers, condensers, and similar motor-driven units: Nameplates and Equipment Markers.
- L. Small-sized Equipment: Equipment Markers
- M. Tanks: Equipment Markers
- N. Thermostats: Nameplates.
- O. Valves: Tags and ceiling tacks where located above lay-in ceiling.
- P. Water Treatment Devices: Nameplates.

### 2.02 NAMEPLATES

- A. Metal, with data engraved or stamped, for permanent attachment on equipment.
  - 1. Data:
    - a. Manufacturer, product name, model number, and serial number.
    - b. Capacity, operating and power characteristics, and essential data.
    - c. Labels of tested compliances.
  - 2. Location: Accessible and visible.
  - 3. Fasteners: As required to mount on equipment.



## 2.03 EQUIPMENT MARKERS

- A. Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.
  - 1. Terminology: Match schedules as closely as possible.
  - 2. Data: Name and plan number.
  - 3. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.
  - 4. Letter Size: Minimum 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.

## 2.04 TAGS

- A. Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme approved by Architect. Provide 5/32-inch hole for fastener.
  - 1. Plastic Tags: 3/32-inch thick laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch (40 mm) diameter.
  - 2. Metal Tags: 0.032-inch thick Brass with stamped letters; tag size minimum 1-1/2 inch (40 mm) diameter with smooth edges.
  - 3. Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.

## 2.05 Valve schedules

- A. Valve Schedules: For each piping system, on standard-size 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-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
  - 2. Frame: Finished hardwood or Extruded aluminum.
  - 3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

## 2.06 ADHESIVE-BACKED DUCT MARKERS

- A. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch (0.76 mm); printed with UV and chemical resistant inks. Include direction and quantity of airflow and duct service (such as supply, return, and exhaust).
- B. Style: Individual Label.
- C. Color:
  - 1. Green: For cold-air supply ducts.
  - 2. Yellow: For hot-air supply ducts.
  - 3. Blue: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
  - 4. ASME A13.1 Colors and Designs: For hazardous material exhaust.
  - 5. Letter Size: Minimum 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.

## 2.07 PIPE MARKERS

- A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
  - 1. Color: Comply with ASME A13.1.
  - 2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length
  - 3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
  - 4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
  - 5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
- B. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.
- C. Plastic Tape Pipe Markers: Flexible, continuously printed, vinyl film tape at least 3 mils thick with pressure-sensitive adhesive backing and printed markings.
  - 1. Width for Markers on Pipes with OD, Including Insulation, and Less Than 6 Inches: 3/4 inch minimum.
  - 2. Width for Markers on Pipes with OD, Including Insulation, and 6 Inches or Larger: 1-1/2 inch minimum.
- D. Color code as follows:
  - 1. Heating, Cooling, and Boiler Feedwater: Green with white letters.
  - 2. Toxic and Corrosive Fluids: Orange with black letters.
  - 3. Compressed Air: Blue with white letters.

## 2.08 CEILING TACKS

- A. Description: Steel with 3/4 inch (20 mm) diameter color coded head.
- B. Color code as follows:
  - 1. HVAC Equipment: Yellow.
  - 2. Fire Dampers and Smoke Dampers: Red.
  - 3. Heating/Cooling Valves: Blue.

## PART 3 EXECUTION

### 3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

### 3.02 INSTALLATION

- A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Install plastic pipe markers in accordance with manufacturer's instructions.
- D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- E. Install ductwork with duct markers. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
- F. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.
- G. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.
- H. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- I. Mount valve schedule on wall in accessible location in each major equipment room.
- J. Relocate mechanical identification materials and devices that have become visually blocked by other work.
- K. Clean faces of mechanical identification devices and glass frames of valve schedules.

### 3.03 piping identification

- A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
  - 1. Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, 1-1/2 inches wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
  - 2. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.
- B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed 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 nonaccessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

END OF SECTION

## SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

### PART 1 GENERAL

#### 1.01 SUMMARY

- A. The scope of work for this section includes all miscellaneous work needed (whether or not specified or shown on the documents) to produce a complete and fully operational system.

#### 1.02 SECTION INCLUDES

- A. Testing, adjustment, and balancing of air systems.
  - 1. Constant-volume air systems.
  - 2. Variable-air-volume systems.
  - 3. Multizone systems.
- B. Testing, adjustment, and balancing of hydronic, steam, and refrigerating systems.
  - 1. Constant-flow systems.
  - 2. Variable-flow systems.
- C. HVAC equipment quantitative-performance settings.
- D. Verifying that automatic control devices are functioning properly.
- E. Reporting results of activities and procedures specified in this Section.
- F. Field quality-control testing of Laboratory fume hoods.
- G. Measurement of final operating condition of HVAC systems.
- H. Sound measurement of equipment operating conditions.
- I. Vibration measurement of equipment operating conditions.

#### 1.03 REFERENCE STANDARDS

- A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition; 2016.
- B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2008, with Errata (2019).
- C. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing; 2023.

#### 1.04 SUBMITTALS

- A. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

- B. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.
- C. Warranties specified in this Section.
  - 1. Revise TAB plan to reflect actual procedures and submit as part of final report.
  - 2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
  - 3. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
  - 4. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
  - 5. Units of Measure: Report data in I-P (inch-pound) units only.
- D. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

#### 1.05 QUALITY ASSURANCE

- A. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.
- B. 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.
- C. TAB Report Forms: Use standard forms from AABC's National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems, NEBB's Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems, or SMACNA's HVAC Systems - Testing, Adjusting, and Balancing.

#### 1.06 PROJECT CONDITIONS

- A. 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.

#### 1.07 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. 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

### 3.01 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
  - 1. AABC (NSTSB), AABC National Standards for Total System Balance.
  - 2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
  - 3. SMACNA (TAB).
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. TAB Agency Qualifications:
  - 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
  - 2. Certified by one of the following:
    - a. AABC, Associated Air Balance Council: [www.aabc.com/#sle](http://www.aabc.com/#sle); upon completion submit AABC National Performance Guaranty.
    - b. NEBB, National Environmental Balancing Bureau: [www.nebb.org/#sle](http://www.nebb.org/#sle).
    - c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: [www.tabbcertified.org/#sle](http://www.tabbcertified.org/#sle).
- D. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

### 3.02 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.
  - 1. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- B. Examine approved submittal data of HVAC systems and equipment.
- C. 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.
- D. Examine equipment performance data including fan and pump curves. 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. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201,

"Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

- E. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- F. Examine system and equipment test reports.
- G. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- H. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- I. Examine HVAC equipment to ensure that clean filters have been installed, 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, to verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers for clean screens and proper 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 equipment for installation and for properly operating safety interlocks and controls.
- P. Examine automatic temperature system components to verify the following:
  - 1. Dampers, valves, and other controlled devices are operated by the intended controller.
  - 2. Dampers and valves are in the position indicated by the controller.
  - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
  - 4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
  - 5. Sensors are located to sense only the intended conditions.
  - 6. Sequence of operation for control modes is according to the Contract Documents.
  - 7. Interlocked systems are operating.
- Q. 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.
- R. Verify that systems are complete and operable before commencing work. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing. Ensure the following conditions:



1. Systems are started and operating in a safe and normal condition.
  2. Temperature control systems are installed complete and operable.
  3. Proper thermal overload protection is in place for electrical equipment.
  4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
  5. Duct systems are clean of debris.
  6. Fans are rotating correctly.
  7. Fire and volume dampers are in place and open.
  8. Air coil fins are cleaned and combed.
  9. Access doors are closed and duct end caps are in place.
  10. Air outlets are installed and connected.
  11. Duct system leakage is minimized.
  12. Hydronic systems are flushed, filled, and vented.
  13. Pumps are rotating correctly.
  14. Proper strainer baskets are clean and in place.
  15. Service and balance valves are open.
- S. Submit field reports. 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.
- T. Beginning of work means acceptance of existing conditions.

### 3.03 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system readiness checks and prepare system readiness reports. Verify the following:
1. Permanent electrical power wiring is complete.
  2. Hydronic systems are filled, clean, and free of air.
  3. Automatic temperature-control systems are operational.
  4. Equipment and duct access doors are securely closed.
  5. Balance, smoke, and fire dampers are open.
  6. Isolating and balancing valves are open and control valves are operational.
  7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
  8. Windows and doors can be closed so indicated conditions for system operations can be met.

### 3.04 ADJUSTMENT TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: 0 to plus 10 percent.
  2. Air Outlets and Inlets: 0 to minus 10 percent.
  3. Heating-Water Flow Rate: 0 to minus 10 percent.
  4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.05 RECORDING AND ADJUSTING

- A. Field Logs: Maintain written logs including:
  - 1. Running log of events and issues.
  - 2. Discrepancies, deficient or uncompleted work by others.
  - 3. Contract interpretation requests.
  - 4. Lists of completed tests.
- B. Ensure recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.06 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

3.07 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 outside-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. Check for proper sealing of air duct system.
- M. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- N. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- O. Measure air quantities at air inlets and outlets.
- P. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- Q. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- R. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- S. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- T. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- U. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

### 3.08 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
  - 1. Measure fan static pressures to determine actual static pressure as follows:
    - a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
    - b. Measure static pressure directly at the fan outlet or through the flexible connection.
    - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
    - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
  - 2. Measure static pressure across each component that makes up an air-handling unit, and other air-handling and -treating equipment.
    - a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
  - 3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
  - 4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.

5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
  6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.
  7. Measure the performance of enthalpy wheel including pressure drop, entering and leaving air temperatures and moisture contact.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
    - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
  2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure terminal outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
  2. Adjust patterns of adjustable outlets for proper distribution without drafts.
- 3.09 General procedures for hydronic systems
- A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
1. Open all manual valves for maximum flow.
  2. Check expansion tank liquid level.
  3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
  4. Check flow-control valves for specified sequence of operation and set at indicated flow.
  5. 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.

6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

### 3.10 PROCEDURES FOR HYDRONIC SYSTEMS

- A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:
  1. Verify impeller size by operating the pump 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.
  2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
  3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
  4. Report flow rates that are not within plus or minus 5 percent of design.
- B. Set calibrated balancing valves, if installed, at calculated presettings.
- C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
  1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
  1. Determine the balancing station with the highest percentage over indicated flow.
  2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
  3. Record settings and mark balancing devices.
- F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.
- H. Adjust water systems to provide required or design quantities.
- I. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

- J. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- K. Effect system balance with automatic control valves fully open to heat transfer elements.
- L. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- M. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

### 3.11 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.

### 3.12 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
  - 1. Manufacturer, model, and serial numbers.
  - 2. Motor horsepower rating.
  - 3. Motor rpm.
  - 4. Efficiency rating.
  - 5. Nameplate and measured voltage, each phase.
  - 6. Nameplate and measured amperage, each phase.
  - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

### 3.13 PROCEDURES FOR CHILLERS

- A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:
  - 1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
  - 2. If water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
  - 3. Capacity: Calculate in tons of cooling.

### 3.14 PROCEDURES FOR COOLING TOWERS

- A. Shut off makeup water for the duration of the test, and verify that makeup and blowdown systems are fully operational after tests and before leaving the equipment. Perform the following tests and record the results:
  - 1. Measure condenser-water flow to each cell of the cooling tower.
  - 2. Measure entering-and-leaving-water temperatures.
  - 3. Measure wet-and-dry-bulb temperatures of entering air.
  - 4. Measure wet-and-dry-bulb temperatures of leaving air.
  - 5. Measure condenser-water flow rate recirculating through the cooling tower.
  - 6. Adjust water level and feed rate of makeup-water system.

### 3.15 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.
- D. Check free travel and proper operation of control devices such as damper and valve operators.
- E. Check the interaction of interlock and lockout systems.
- F. Note operation of electric actuators using spring return for proper fail-safe operations.

### 3.16 TEMPERATURE-CONTROL VERIFICATION

- A. Check free travel and proper operation of control devices such as damper and valve operators.
- B. Check the interaction of interlock and lockout systems.
- C. Note operation of electric actuators using spring return for proper fail-safe operations.

### 3.17 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
  - 1. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
    - a. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field report data, include the following:
  - 1. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
  - 1. Title page.
  - 2. Name and address of TAB firm.

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 firm 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.
  12. Nomenclature sheets for each item of equipment.
  13. Data for terminal units, including manufacturer, type size, and fittings.
  14. Notes to explain why certain final data in the body of reports varies from indicated values.
  15. Test conditions for fans and pump performance forms including the following:
    - a. Conditions of filters.
    - b. Face and bypass damper settings at coils.
    - c. Fan drive settings including settings and percentage of maximum pitch diameter.
    - d. Settings for supply-air, static-pressure controller.
    - e. 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 outside, 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.
- 3.18 ADDITIONAL TESTS
- A. After deficiencies have been corrected, rebalance system and resubmit report.
  - B. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
  - C. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION



## SECTION 230700 - HVAC INSULATION

### PART 1 GENERAL

#### 1.01 REFERENCE STANDARDS

- A. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2026.
- B. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2019).
- C. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2019).
- D. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging; 2018 (Reapproved 2026).
- E. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2022a.
- F. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013 (Reapproved 2019).
- G. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2023.
- H. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing; 2022.
- I. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation; 2022.
- J. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014 (Reapproved 2019).
- K. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2023).
- L. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation; 2023.
- M. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts; 2016 (Reapproved 2021).
- N. ASTM D1784 - Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds; 2025.
- O. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.

- P. ASTM F1249 - Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor; 2025.
- Q. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- R. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2024.

#### 1.02 RELATED DOCUMENTS

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

#### 1.03 SUMMARY

- A. This Section includes mechanical insulation for boiler breeching, duct, equipment, and pipe, including the following:
  - 1. Insulation Materials:
    - a. Flexible elastomeric.
    - b. Mineral fiber.
  - 2. Insulating cements.
  - 3. Adhesives.
  - 4. Mastics.
  - 5. Lagging adhesives.
  - 6. Sealants.
  - 7. Factory-applied jackets.
  - 8. Field-applied jackets.
  - 9. Tapes.
  - 10. Securements.
  - 11. Corner angles.
- B. Related Sections include the following:
  - 1. Division 23 Section "Metal Ducts" for duct liners.

#### 1.04 DEFINITIONS

- A. ASJ: All-service jacket.
- B. FSK: Foil, scrim, kraft paper.
- C. FSP: Foil, scrim, polyethylene.
- D. PVDC: Polyvinylidene chloride.
- E. SSL: Self-sealing lap.

#### 1.05 SUBMITTALS

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

- B. Shop Drawings: Show details for the following:
  - 1. Application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
  - 2. Insulation application at pipe expansion joints for each type of insulation.
  - 3. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
  - 4. Removable insulation at piping specialties, equipment connections, and access panels.
  - 5. Application of field-applied jackets.
  - 6. Field application for each equipment type.

#### 1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- C. National Commercial and Industrial Insulation Standards: Comply with installation standards.
- D. ASHRAE Standard 90.1-2004: Comply with insulation values required by the Energy Standards.

#### 1.07 DELIVERY, STORAGE, AND HANDLING

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

#### 1.08 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.09 SCHEDULING

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

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

2.02 INSULATION MATERIALS

- A. Refer to Part 3 schedule articles for requirements about where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials. Paint flexible Elastomeric insulation exposed to sun light with Armaflex WB finish, white.
  - 1. Products:
    - a. Aeroflex USA Inc.; Aerocel.
    - b. Armacell LLC; AP Armaflex.
    - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
  - 1. Products:
    - a. CertainTeed Corp.; Duct Wrap.

- b. Johns Manville; Microlite.
  - c. Knauf Insulation; Duct Wrap.
  - d. Manson Insulation Inc.; Alley Wrap.
  - e. Owens Corning; All-Service Duct Wrap.
- H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. For equipment applications, provide insulation without factory-applied jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
  - 1. Products:
    - 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.
- I. Mineral-Fiber, Preformed Pipe Insulation:
  - 1. Products:
    - a. Fibrex Insulations Inc.; Coreplus 1200.
    - b. Johns Manville; Micro-Lok.
    - c. Knauf Insulation; 1000(Pipe Insulation.
    - d. Manson Insulation Inc.; Alley-K.
    - e. Owens Corning; Fiberglas Pipe Insulation.
  - 2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
- J. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C612, 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 Part 2 "Factory-Applied Jackets" Article.
  - 1. Products:
    - 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.

## 2.03 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.
  - 1. Products:
    - a. Insulco, Division of MFS, Inc.; Triple I.
    - b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
  - 1. Products:
    - a. P. K. Insulation Mfg. Co., Inc.; Thermal-V-Kote.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449/C 449M.
  - 1. Products:
    - a. Insulco, Division of MFS, Inc.; SmoothKote.
    - b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
    - c. Rock Wool Manufacturing Company; Delta One Shot.

## 2.04 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
  - 1. Products:
    - a. Aeroflex USA Inc.; Aeroseal.
    - b. Armacell LCC; 520 Adhesive.
    - c. Foster Products Corporation, H. B. Fuller Company; 85-75.
    - d. RBX Corporation; Rubatex Contact Adhesive.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. Products:
    - a. Childers Products, Division of ITW; CP-82.
    - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
    - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
    - d. Marathon Industries, Inc.; 225.
    - e. Mon-Eco Industries, Inc.; 22-25.
- 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:
    - a. Childers Products, Division of ITW; CP-82.
    - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
    - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
    - d. Marathon Industries, Inc.; 225.
    - e. Mon-Eco Industries, Inc.; 22-25.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
  - 1. Products:
    - a. Dow Chemical Company (The); 739, Dow Silicone.
    - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
    - c. P.I.C. Plastics, Inc.; Welding Adhesive.
    - d. Red Devil, Inc.; Celulon Ultra Clear.
    - e. Speedline Corporation; Speedline Vinyl Adhesive.

2.05 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
  - 1. Products:
    - a. Childers Products, Division of ITW; CP-35.
    - b. Foster Products Corporation, H. B. Fuller Company; 30-90.
    - c. ITW TACC, Division of Illinois Tool Works; CB-50.
    - d. Marathon Industries, Inc.; 590.
    - e. Mon-Eco Industries, Inc.; 55-40.
    - f. Vimasco Corporation; 749.
  - 2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
  - 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
  - 1. Products:
    - a. Childers Products, Division of ITW; CP-30.
    - b. Foster Products Corporation, H. B. Fuller Company; 30-35.
    - c. ITW TACC, Division of Illinois Tool Works; CB-25.
    - d. Marathon Industries, Inc.; 501.
    - e. Mon-Eco Industries, Inc.; 55-10.
  - 2. Water-Vapor Permeance: ASTM F1249, 0.05 perm at 35-mil dry film thickness.
  - 3. Service Temperature Range: 0 to 180 deg 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:
    - a. Childers Products, Division of ITW; Encacel.
    - b. Foster Products Corporation, H. B. Fuller Company; 60-95/60-96.
    - c. Marathon Industries, Inc.; 570.
    - d. Mon-Eco Industries, Inc.; 55-70.
  - 2. Water-Vapor Permeance: ASTM F1249, 0.05 perm at 30-mil dry film thickness.
  - 3. Service Temperature Range: Minus 50 to plus 220 deg 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:
    - a. Childers Products, Division of ITW; CP-10.
    - b. Foster Products Corporation, H. B. Fuller Company; 35-00.
    - c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
    - d. Marathon Industries, Inc.; 550.

- e. Mon-Eco Industries, Inc.; 55-50.
- f. Vimasco Corporation; WC-1/WC-5.
- 2. Water-Vapor Permeance: ASTM F1249, 3 perms at 0.0625-inch dry film thickness.
- 3. Service Temperature Range: Minus 20 to plus 200 deg F.
- 4. Solids Content: 63 percent by volume and 73 percent by weight.
- 5. Color: White.

## 2.06 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
  - 1. Products:
    - a. Childers Products, Division of ITW; CP-52.
    - b. Foster Products Corporation, H. B. Fuller Company; 81-42.
    - c. Marathon Industries, Inc.; 130.
    - d. Mon-Eco Industries, Inc.; 11-30.
    - e. Vimasco Corporation; 136.
  - 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
  - 3. Service Temperature Range: Minus 50 to plus 180 deg F.
  - 4. Color: White.

## 2.07 SEALANTS

- A. Joint Sealants:
  - 1. Joint Sealants for Cellular-Glass, Phenolic-Foam, and Polyisocyanurate Products:
    - a. Childers Products, Division of ITW; CP-76.
    - b. Foster Products Corporation, H. B. Fuller Company; 30-45.
    - c. Marathon Industries, Inc.; 405.
    - d. Mon-Eco Industries, Inc.; 44-05.
    - e. Pittsburgh Corning Corporation; Pittseal 444.
    - f. Vimasco Corporation; 750.
  - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 3. Permanently flexible, elastomeric sealant.
  - 4. Service Temperature Range: Minus 100 to plus 300 deg F.
  - 5. Color: White or gray.
- B. FSK and Metal Jacket Flashing Sealants:
  - 1. Products:
    - a. Childers Products, Division of ITW; CP-76-8.
    - b. Foster Products Corporation, H. B. Fuller Company; 95-44.
    - c. Marathon Industries, Inc.; 405.
    - d. Mon-Eco Industries, Inc.; 44-05.
    - e. Vimasco Corporation; 750.
  - 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 deg F.



5. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products:
  - a. Childers Products, Division of ITW; CP-76.
  - b. Materials shall be compatible with insulation materials, jackets, and substrates.
  - c. Fire- and water-resistant, flexible, elastomeric sealant.
  - d. Service Temperature Range: Minus 40 to plus 250 deg F.
  - e. Color: White.

2.08 FACTORY-APPLIED JACKETS

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

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E84.
6. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E84.
7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
  - a. Products:
    - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
8. Vinyl Jacket: UL-rated white vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.09 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
  1. Products:
    - a. Johns Manville; Zeston.

- b. P.I.C. Plastics, Inc.; FG Series.
    - c. Proto PVC Corporation; LoSmoke.
    - d. Speedline Corporation; SmokeSafe.
  - 2. Adhesive: As recommended by jacket material manufacturer.
  - 3. Color: Color-code jackets based on system. Color as selected by Architect.
  - 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
    - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
  - 5. Factory-fabricated tank heads and tank side panels.
- D. Metal Jacket:
  - 1. Products:
    - a. Childers Products, Division of ITW; Metal Jacketing Systems.
    - b. PABCO Metals Corporation; Surefit.
    - c. RPR Products, Inc.; Insul-Mate.
    - d. Insert manufacturer's name; product name or designation.
  - 2. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005, Temper H-14.
    - a. Sheet and roll stock ready for shop or field sizing Factory cut and rolled to size.
    - b. Finish and thickness are indicated in field-applied jacket schedules.
    - c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
    - d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
    - e. Factory-Fabricated Fitting Covers:
      - 1) Same material, finish, and thickness as jacket.
      - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      - 3) Tee covers.
      - 4) Flange and union covers.
      - 5) End caps.
      - 6) Beveled collars.
      - 7) Valve covers.
      - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- E. Underground Direct-Buried Jacket: 125-mil-thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
  - 1. Products:
    - a. Pittsburgh Corning Corporation; Pittwrap.
    - b. Polyguard; Insulrap No Torch 125.
    - c. MFM Building Products Corp.-Flex Clad
- F. Self-Adhesive Outdoor Jacket: 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a

rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.

1. Products:
  - a. Polyguard; Alumaguard 60.
  - b. MFM Building Products Corp; Flex-Clad 400
- G. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E84.
  1. Products:
    - a. Dow Chemical Company (The), Saran 540 Vapor Retarder Film.
- H. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E84.
  1. Products:
    - a. Dow Chemical Company (The), Saran 560 Vapor Retarder Film.
- I. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

## 2.10 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136 and UL listed.
  1. Products:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
    - b. Compac Corp.; 104 and 105.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
    - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
  2. Width: 3 inches (76.2 mm).
  3. Thickness: 11.5 mils (0.2921 mm).
  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 C1136 and UL listed.
  1. Products:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
    - b. Compac Corp.; 110 and 111.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
    - d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
  2. Width: 3 inches (76.2 mm).
  3. Thickness: 6.5 mils (0.1651 mm).
  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:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
    - b. Compac Corp.; 130.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
    - d. Venture Tape; 1506 CW NS.
  2. Width: 2 inches (50.8 mm).
  3. Thickness: 6 mils (0.1524 mm).
  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 and UL listed.
  1. Products:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    - b. Compac Corp.; 120.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
    - d. Venture Tape; 3520 CW.
  2. Width: 2 inches (50.8 mm).
  3. Thickness: 3.7 mils (0.09398 mm).
  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:
    - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.
  2. Width: 3 inches (76.2 mm).
  3. Film Thickness: 4 mils (0.1016 mm).
  4. Adhesive Thickness: 1.5 mils (0.0381 mm).
  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:
    - a. Dow Chemical Company (The); Saran 560 Vapor Retarder Tape.
  2. Width: 3 inches (76.2 mm).
  3. Film Thickness: 6 mils (0.1524 mm).
  4. Adhesive Thickness: 1.5 mils (0.0381 mm).
  5. Elongation at Break: 145 percent.
  6. Tensile Strength: 55 lbf/ inch in width.

## 2.11 SECUREMENTS

- A. Bands:

1. Products:
    - a. Childers Products; Bands.
    - b. PABCO Metals Corporation; Bands.
    - c. RPR Products, Inc.; Bands.
  2. Stainless Steel: ASTM A 167 or ASTM A240/A240M, Type 304 or Type 316; 0.015 inch (0.38 mm) thick, 3/4 inch (19.05 mm) wide with wing or closed seal.
  3. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 3/4 inch (19.05 mm) wide with wing 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. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated.
    - a. Products:
      - 1) AGM Industries, Inc.; CWP-1.
      - 2) GEMCO; CD.
      - 3) Midwest Fasteners, Inc.; CD.
      - 4) Nelson Stud Welding; TPA, TPC, and TPS.
  2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
    - a. Products:
      - 1) AGM Industries, Inc.; CWP-1.
      - 2) GEMCO; Cupped Head Weld Pin.
      - 3) Midwest Fasteners, Inc.; Cupped Head.
      - 4) Nelson Stud Welding; CHP.
  3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
    - a. Products:
      - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
      - 2) GEMCO; Perforated Base.
      - 3) Midwest Fasteners, Inc.; Spindle.
    - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50.8 mm) square.
    - c. Spindle: Copper- or zinc-coated, low carbon steel, Aluminum, or Stainless 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, securely

- in position indicated when self-locking washer is in place. Comply with the following requirements:
- a. Products:
    - 1) GEMCO; Nylon Hangers.
    - 2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
  - b. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
  - c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (64 mm).
  - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
- a. Products:
    - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
    - 2) GEMCO; Press and Peel.
    - 3) Midwest Fasteners, Inc.; Self Stick.
    - 4) Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50.8 mm) square.
  - b. Spindle: Copper- or zinc-coated, low carbon steel, Aluminum, or Stainless steel, fully annealed, 0.106-inch diameter shank, length to suit depth of insulation indicated.
  - c. Adhesive-backed base with a peel-off protective cover.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel, aluminum, or stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
- a. Products:
    - 1) AGM Industries, Inc.; RC-150.
    - 2) GEMCO; R-150.
    - 3) Midwest Fasteners, Inc.; WA-150.
    - 4) Nelson Stud Welding; Speed Clips.
  - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
- a. Manufacturers:
    - 1) GEMCO.
    - 2) Midwest Fasteners, Inc.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- D. Wire: 0.080-inch nickel-copper alloy, 0.062-inch soft-annealed, stainless steel, or 0.062-inch soft-annealed, galvanized steel.
1. Manufacturers:
    - a. ACS Industries, Inc.

- b. C & F Wire.
- c. Childers Products.
- d. PABCO Metals Corporation.
- e. RPR Products, Inc.

## 2.12 CORNER ANGLES

- A. PVC Corner Angles: 30 mils (0.762 mm) thick, minimum 1 by 1 inch (25.4 mm), PVC according to ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch (1.02 mm) thick, minimum 1 by 1 inch (25.4 mm), aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: 0.024 inch (0.61 mm) thick, minimum 1 by 1 inch (25.4 mm), stainless steel according to ASTM A 167 or ASTM A240/A240M, Type 304.

## PART 3 EXECUTION

### 3.01 EXAMINATION

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

### 3.02 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. 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 (0.127 mm) 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.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.03 COMMON INSTALLATION REQUIREMENTS

- A. Install insulation in strict accordance with the manufacturer's installation instructions and the National Commercial and Industrial Insulation Standards.
- B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- D. 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.
- E. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- F. Install multiple layers of insulation with longitudinal and end seams staggered.
- G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- H. Keep insulation materials dry during application and finishing.
- I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- J. Install insulation with least number of joints practical.
- K. 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.
- L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- M. 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 (101.6 mm) o.c.



3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50.8 mm) o.c.
    - a. For below ambient services, apply vapor-barrier mastic over staples.
  4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
  5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (101.6 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- Q. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
  2. Testing agency labels and stamps.
  3. Nameplates and data plates.
  4. Manholes.
  5. Handholes.
  6. Cleanouts.

### 3.04 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50.8 mm) below top of roof flashing.
  4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Below-Grade Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50.8 mm).
  4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated):  
Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches (50.8 mm).
1. Firestopping and fire-resistive joint sealers are specified in Division 7 Section "Through-Penetration Firestop Systems."
- F. Insulation Installation at Floor Penetrations:
1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches (50.8 mm).
  2. Pipe: Install insulation continuously through floor penetrations.
  3. Seal penetrations through fire-rated assemblies according to Division 7 Section "Through-Penetration Firestop Systems."

### 3.05 DUCT AND PLENUM INSULATION INSTALLATION

- 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 100 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 (457.2 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (76.2 mm) maximum from insulation end joints, and 16 inches (406.4 mm) o.c.
    - b. On duct sides with dimensions larger than 18 inches (457.2 mm), place pins 16 inches (406.4 mm) o.c. each way, and 3 inches (76.2 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

### 3.06 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

- A. 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 (76.2 mm) from insulation end joints, and 16 inches (406.4 mm) o.c. in both directions.
    - d. Do not overcompress insulation during installation.
    - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    - f. Impale insulation over anchor pins and attach speed washers.
    - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
  5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
  6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches (152.4 mm) from each end. Install wire or cable between two circumferential girdles 12 inches (304.8 mm) o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches (1219.2 mm) o.c. Use this network for securing insulation with tie wire or bands.
  7. Stagger joints between insulation layers at least 3 inches (76.2 mm).
  8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
  9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
  10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
  2. Seal longitudinal seams and end joints.
- C. Insulation Installation on Pumps:
1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.

2. Fabricate boxes from galvanized steel, at least 0.050 inch (1.27 mm) thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

### 3.07 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, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- 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 (50.8 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
  - 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### 3.08 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- 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.

### 3.09 MINERAL-FIBER INSULATION INSTALLATION

#### A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe 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 surfaces, secure laps with outward clinched staples at 6 inches (152.4 mm) o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

#### B. 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 mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25.4 mm), and seal joints with flashing sealant.

#### C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

#### D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

#### E. 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 100 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 (457.2 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (76.2 mm) maximum from insulation end joints, and 16 inches (406.4 mm) o.c.
    - b. On duct sides with dimensions larger than 18 inches (457.2 mm), place pins 16 inches (406.4 mm) o.c. each way, and 3 inches (76.2 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - d. Do not overcompress 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 (50.8 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch (25.4 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    - b. Install vapor stops for ductwork and plenums operating below 50 degrees Fahrenheit (10 degrees Celsius) 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 2 times the insulation thickness but not less than 3 inches (76.2 mm).
  5. Overlap unfaced blankets a minimum of 2 inches (50.8 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (457.2 mm) 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 (152.4 mm) o.c.
- F. 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 100 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 (457.2 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (76.2 mm) maximum from insulation end joints, and 16 inches (406.4 mm) o.c.
  - b. On duct sides with dimensions larger than 18 inches (457.2 mm), space pins 16 inches (406.4 mm) o.c. each way, and 3 inches (76.2 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
  - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
  - d. Do not overcompress 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 (50.8 mm) from 1 edge and 1 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 degrees Fahrenheit (10 degrees Celsius) 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 2 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 (152.4 mm) o.c.

### 3.10 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
  1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
  2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
  3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
  1. Draw jacket material smooth and tight.
  2. Install lap or joint strips with same material as jacket.
  3. Secure jacket to insulation with manufacturer's recommended adhesive.



4. Install jacket with 1½-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.
- C. 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.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (304.8 mm) o.c. and at end joints.
- E. Where PVDC jackets are indicated, install as follows:
1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
  2. Wrap factory-presize jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presize jacket with an approximate overlap at butt joint of 2 inches (50.8 mm) over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1¼ circumferences of appropriate PVDC tape around overlapped butt joint.
  3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
  4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33½-inches or less. The 33½-inch-circumference limit allows for 2-inch-overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
  5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.
- F. Where rubberized bituminous resin jackets are installed comply with manufacturers installation instructions.
- 3.11 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 exhaust between isolation damper and penetration of building exterior.
  4. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
  5. Outdoor, above ground exposed supply and return.
- B. Items Not Insulated:
1. Fibrous-glass ducts.

2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.
8. Exposed supply ductwork outside of the mechanical room, in an occupied area being conditioned by the supply ductwork

### 3.12 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Concealed, round and flat-oval, supply-air duct insulation shall be any of the following:
  1. Flexible Elastomeric: 1-inch thick.
  2. Mineral-Fiber Blanket: 1½-inches thick and 0.75-lb/cu. ft. nominal density.
- B. Concealed, round and flat-oval, exhaust-air duct insulation between isolation damper and penetration of building exterior shall be any of the following:
  1. Flexible Elastomeric: 1-inch thick.
  2. Mineral-Fiber Blanket: 1½-inches thick and 0.75-lb/cu. ft. nominal density.
- C. Concealed, rectangular, supply-air duct insulation shall be any of the following:
  1. Flexible Elastomeric: 1-inch thick.
  2. Mineral-Fiber Blanket: 1½-inches thick and 0.75-lb/cu. ft. nominal density.
- D. Concealed, rectangular, exhaust-air duct insulation between isolation damper and penetration of building exterior shall be any of the following:
  1. Flexible Elastomeric: 1-inch thick.
  2. Mineral-Fiber Board: 1½-inches thick and 2-lb/cu. ft. nominal density.
- E. Concealed, supply-air plenum insulation shall be any of the following:
  1. Flexible Elastomeric: 1-inch thick.
  2. Mineral-Fiber Board: 1½-inches thick and 2-lb/cu. ft. nominal density.
- F. Concealed, outdoor-air plenum insulation shall be the following:
  1. Mineral-Fiber Board: 1½-inches thick and 2-lb/cu.ft. nominal density.
- G. Concealed, exhaust-air plenum insulation shall be the following:
  1. Mineral-Fiber Board: 2-inches thick and 2-lb/cu. ft. nominal density.
- H. Exposed, round and flat-oval, supply-air duct insulation shall be any of the following:
  1. Flexible Elastomeric: 1½-inches thick.
  2. Mineral-Fiber Board: 1½-inches thick and 2-lb/cu. ft. nominal density.
- I. Exposed, round and flat-oval, outdoor-air duct insulation shall be any of the following:
  1. Flexible Elastomeric: 2-inches thick.
  2. Mineral-Fiber Board: 2-inches thick and 2-lb/cu. ft. nominal density.
- J. Exposed, round and flat-oval, exhaust-air duct insulation between isolation damper and penetration of building exterior shall be any of the following:

1. Flexible Elastomeric: 2-inches thick.
  2. Mineral-Fiber Board: 2-inches thick and 2-lb/cu. ft. nominal density.
- K. Exposed, rectangular, supply-air duct insulation shall be any of the following:
1. Flexible Elastomeric: 1½-inches thick.
  2. Mineral-Fiber Board: 1½-inches thick and 2-lb/cu. ft. nominal density.
- L. Exposed, rectangular, exhaust-air duct insulation insulation between isolation damper and penetration of building exterior shall be any of the following:
1. Flexible Elastomeric: 2-inches thick.
  2. Mineral-Fiber Board: 2-inches thick and 2-lb/cu. ft. nominal density.
- M. Exposed, supply-air plenum insulation shall be any of the following:
1. Flexible Elastomeric: 1½-inches thick.
  2. Mineral-Fiber Board: 1½-inches thick and 2-lb/cu. ft. nominal density.
- N. Exposed, outdoor-air plenum insulation shall be any of the following:
1. Mineral-Fiber Board: 2-inches thick and 2-lb/cu. ft. nominal density.
  2. Flexible Elastomeric: 2-inches thick.
- O. Exposed, exhaust-air plenum insulation shall be any of the following:
1. Mineral-Fiber Board: 2-inches thick and 2-lb/cu. ft. nominal density.
  2. Flexible Elastomeric: 2-inches thick.

### 3.13 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.
- B. Exposed, rectangular, supply-air duct insulation shall be the following:
1. Mineral-Fiber Board: 3 inches (76.2 mm) thick and 3-lb/cu. ft. nominal density.
- C. Exposed, rectangular, return-air duct insulation shall be the following:
1. Mineral-Fiber Board: 3 inches (76.2 mm) thick and 3-lb/cu. ft. nominal density.

### 3.14 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
- C. Chilled-water pump insulation shall be any of the following:
1. Flexible Elastomeric: 1-inch thick
- D. Chilled-water expansion/compression tank insulation shall be the following:
1. Flexible Elastomeric: 1-inch thick.
- E. Chilled-water air-separator insulation shall be any of the following:
1. Flexible Elastomeric: 1-inch thick.

3.15 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
  - 1. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.16 INDOOR PIPING INSULATION SCHEDULE

- A. Chilled Water, above 40 Deg F:
  - 1. NPS 12 and Smaller: Insulation shall be any of the following:
    - a. Flexible Elastomeric: 1-inch thick.
- B. Condenser-Water Glycol Supply and Return:
  - 1. NPS 12 and Smaller: Insulation shall be any of the following:
    - a. Flexible Elastomeric: 1-inch thick.
- C. Heating-Hot-Water Supply and Return, 200 Deg F and below:
  - 1. NPS 1¼ and Smaller: Insulation shall be the following:
    - a. Mineral Fiber pre-formed pipe: 1½-inches thick.
  - 2. NPS 1½ and Larger: Insulation shall be the following:
    - a. Mineral Fiber pre-formed pipe: 2-inches thick.
- D. Condensate Drain Piping:
  - 1. NPS 12 and Smaller: Insulation shall be the following:
    - a. Flexible Elastomeric: 1/2-inch thick.

3.17 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Chilled Water and Glycol:
  - 1. All Pipe Sizes: Insulation shall be any of the following:
    - a. Flexible Elastomeric: 2-inches thick.
- B. Condenser-Water Glycol Supply and Return:
  - 1. All Pipe Sizes: Insulation shall be any of the following:
    - a. Flexible Elastomeric: 2-inches thick.

3.18 OUTDOOR, 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. Ductwork, piping and equipment, Exposed:
  - 1. PVC: 30 mils (0.762 mm) thick.
  - 2. Painted Aluminum, Stucco Embossed: 0.020 inch (0.51 mm) thick.
  - 3. Rubberized Bituminous self adhesion jacket.

Lansing School District  
Gardner Elementary School Chiller Replacement  
LSD Project No. SO-1858

Project No. 260150  
May 2026  
Bid Documents

END OF SECTION 230700

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## SECTION 230800 - COMMISSIONING OF HVAC

### PART 1 GENERAL

#### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. OPR, BoD, and BoD-HVAC documentation prepared by Owner and Architect contains requirements that apply to this Section.

#### 1.02 SUMMARY

- A. This Section includes requirements for commissioning the HVAC system and its subsystems and equipment. This Section supplements the general requirements specified in Division 01 Section "General Commissioning Requirements."
- B. Related Sections include the following:
  - 1. Division 01 Section "General Commissioning Requirements" for general requirements for commissioning processes that apply to this Section.

#### 1.03 DEFINITIONS

- A. Architect: Includes Architect identified in the Contract for Construction between Owner and Contractor, plus consultant/design professionals responsible for design of HVAC, electrical, communications, controls for HVAC systems, and other related systems.
- B. BoD: Basis of Design.
- C. BoD-HVAC: HVAC systems basis of design.
- D. CxA: Commissioning Authority.
- E. OPR: Owner's Project Requirements.
- F. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.
- G. TAB: Testing, Adjusting, and Balancing.

#### 1.04 CONTRACTOR'S RESPONSIBILITIES

- A. The following responsibilities are in addition to those specified in Division 01 Section "General Commissioning Requirements."
- B. Contractor:
  - 1. Attend procedures meeting for TAB Work.
  - 2. Certify that TAB Work is complete.

- C. Mechanical Subcontractor:
  - 1. Complete all pre-start-up, start-up, and commissioning forms and procedures as directed by the CxA.
  - 2. Attend TAB verification testing.
  - 3. Provide measuring instruments and logging devices to record test data, and data acquisition equipment to record data for the complete range of testing for the required test period.
- D. HVAC Instrumentation and Control Subcontractor: With the CxA, review control designs for compliance with the OPR and BoD, controllability with respect to actual equipment to be installed, and recommend adjustments to control designs and sequence of operation descriptions.
- E. TAB Subcontractor:
  - 1. Contract Documents Review: With the CxA, review the Contract Documents before developing TAB procedures.
    - a. Verify the following:
      - 1) Accessibility of equipment and components required for TAB Work.
      - 2) Adequate number and placement of duct balancing dampers to allow proper balancing while minimizing sound levels in occupied spaces.
      - 3) Adequate number and placement of balancing valves to allow proper balancing and recording of water flow.
      - 4) Adequate number and placement of test ports and test instrumentation to allow reading and compilation of system and equipment performance data needed to conduct both TAB and commissioning testing.
      - 5) Air and water flow rates have been specified and compared to central equipment output capacities.
    - b. Identify discontinuities and omissions in the Contract Documents.
    - c. This review of the Contract Documents by the TAB Subcontractor satisfies requirements for a design review report as specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."
  - 2. Additional Responsibilities: Participate in tests specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls" and
- F. Electrical Subcontractor:
  - 1. With the Mechanical Subcontractor, coordinate installations and connections between and among electrical and HVAC systems, subsystems, and equipment.
  - 2. Attend TAB verification testing.

#### 1.05 COMMISSIONING DOCUMENTATION

- A. The following are in addition to documentation specified in Division 01 Section "General Commissioning Requirements."
- B. BoD HVAC: Owner will provide BoD-HVAC documents, prepared by Architect and approved by Owner, to the CxA and each Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.



- C. Test Checklists: CxA with assistance of Architect shall develop test checklists for HVAC systems, subsystems, and equipment, including interfaces and interlocks with other systems. CxA shall prepare separate checklists for each mode of operation and provide space to indicate whether the mode under test responded as required. In addition to the requirements specified in Division 01 Section "General Commissioning Requirements," checklists shall include, but not be limited to, the following:
1. Calibration of sensors and sensor function.
  2. Testing conditions under which test was conducted, including (as applicable) ambient conditions, set points, override conditions, and status and operating conditions that impact the results of test.
  3. Control sequences for HVAC systems.
  4. Strength of control signal for each set point at specified conditions.
  5. Responses to control signals at specified conditions.
  6. Sequence of response(s) to control signals at specified conditions.
  7. Electrical demand or power input at specified conditions.
  8. Power quality and related measurements.
  9. Expected performance of systems, subsystems, and equipment at each step of test.
  10. Narrative description of observed performance of systems, subsystems, and equipment. Notation to indicate whether the observed performance at each step meets the expected results.
  11. Interaction of auxiliary equipment.
  12. Issues log.

#### 1.06 SUBMITTALS

- A. The following submittals are in addition to those specified in Division 01 Section "General Commissioning Requirements."
- B. Testing Procedures: CxA shall submit detailed testing plan, procedures, and checklists for each series of tests. Submittals shall include samples of data reporting sheets that will be part of the reports.
- C. Certificate of Readiness: CxA shall compile certificates of readiness from each Contractor certifying that systems, subsystems, equipment, and associated controls are ready for testing.
- D. Certificate of Completion of Installation, Prestart, and Startup: CxA shall certify that installation, prestart, and startup activities have been completed. Certification shall include completed checklists provided by TAB Subcontractor as specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."
- E. Certified Pipe Cleaning and Flushing Report: CxA shall certify that pipe cleaning, flushing, hydrostatic testing, and chemical treating have been completed.
- F. Test and Inspection Reports: CxA shall compile and submit test and inspection reports and certificates, and shall include them in systems manual and commissioning report.
- G. Corrective Action Documents: CxA shall submit corrective action documents.
- H. Certified TAB Reports: CxA shall submit verified, certified TAB reports.

## PART 2 ASHRAE 90.1-2019 SPECIFIC COMPLIANCE IN COMMISSIONING

### 2.01 FUNCTIONAL PERFORMANCE TESTING AND VERIFICATION PROVIDER

- A. The commissioning agent is responsible for reviewing, commissioning, and testing the mechanical, plumbing, and electrical systems as required by ASHRAE 90.1-2019 (current adopted Michigan Energy Code).

### 2.02 ITEMS TO BE REVIEWED

- A. The following are required to be reviewed for proper control and/or inclusion in accordance with ASHRAE 90.1-2019 by the CxA provider.

- 1. Building Envelope/Shell
  - a. Insulation Design/Installation
  - b. Air Barrier Installation/Testing
  - c. Fenestration and Doors
  - d. Building Envelope
- 2. Mechanical HVAC Systems
  - a. HVAC/Plumbing/Electrical equipment efficiency (according to Simplified Approach HVAC)
  - b. Equipment Labeling
  - c. Load Calculations
  - d. Zone Thermostatic Controls
  - e. Set-Point Overlap Restriction
  - f. Off-Hour Controls
  - g. Automatic Control of HVAC in Hotel/Motel Guest Rooms
  - h. Ventilation Systems Controls
  - i. Heat-Pump Auxiliary Heat Control
  - j. Humidifier Pre-Heat
  - k. Humidification/Dehumidification Controls
  - l. Freeze Protection and Snowmelt
  - m. Ventilation Controls for high-occupancy areas
  - n. Vestibule temperature setpoints
  - o. Chilled-Water Plant Monitoring
  - p. Single-zone VAV control
  - q. Ductwork/Plenum leakage
  - r. Walk-In Coolers/Freezers
  - s. Refrigerated Display Cases
  - t. Liquid to Liquid Heat Exchangers
  - u. Air economizers
  - v. Water economizers
  - w. Simultaneous Heat/Cool Zone Controls
  - x. Hydronic System Controls
  - y. Preheat Coils
  - z. Fan System Power/Efficiencies
  - aa. Fan Controls
  - bb. Multi-zone VAV system ventilation optimization control

- cc. Parallel-flow fan powered VAV air-terminal control
- dd. Supply air temperature reset controls
- ee. Fractional horsepower fan motors
- ff. Ventilation Design
- gg. Occupied/Standby Controls
- hh. Boiler turndown
- ii. Hydronic variable flow systems
- jj. Chiller and Boiler Isolation
- kk. Chilled and hot-water temperature reset controls
- ll. Energy Recovery systems
- mm. Exhaust Systems
- nn. Radiant Heating systems
- oo. Door switches
- pp. Refrigeration Switches
- 3. Plumbing Systems
  - a. Plumbing equipment efficiency (according to Simplified Approach HVAC)
  - b. Service Water Heating System Controls
  - c. Pool Time Switch Controls
  - d. Service Water Pressure Boosting Systems
- 4. Electrical Systems
  - a. Electrical equipment efficiency (according to Simplified Approach HVAC)
  - b. Automatic Receptacle Control
  - c. Electrical Energy Monitoring
  - d. Interior Lighting Control
  - e. Parking Garage Lighting Control
  - f. Special Application Lighting Control
  - g. Exterior Lighting Control
- 5. Other Building Systems
  - a. Energy Systems Monitoring
  - b. Energy-Cost Budget/Performance Paths laid out not in the prescriptive path.

## 2.03 ITEMS TO BE VERIFIED AND PERFORMANCE TESTED

- A. The following are required to be verified and performance tested in accordance with ASHRAE 90.1-2019 by the CxA provider.
  - 1. Building Envelope
    - a. Building Envelope and Blower Test
  - 2. Mechanical Systems
    - a. Chilled-Water Plant Monitoring
    - b. HVAC/Piping Insulation
    - c. Hydronic System Controls
    - d. Chiller and Boiler Isolation
    - e. Chilled and hot-water temperature reset controls
    - f. Exhaust Systems
    - g. Refrigeration Switches
  - 3. Electrical Systems
    - a. Automatic Receptacle Control

- b. Electrical Energy Monitoring
- c. Interior Lighting Control
- d. Parking Garage Lighting Control
- e. Special Application Lighting Control
- f. Exterior Lighting Control
- 4. Other Building Systems
  - a. Energy Systems Monitorin

## PART 3 EXECUTION

### 3.01 TESTING PREPARATION

- A. Prerequisites for Testing:
  - 1. Certify that HVAC systems, subsystems, and equipment have been completed, calibrated, and started; are operating according to the OPR, BoD, and Contract Documents; and that Certificates of Readiness are signed and submitted.
  - 2. Certify that HVAC instrumentation and control systems have been completed and calibrated; are operating according to the OPR, BoD, and Contract Documents; and that pretest set points have been recorded.
  - 3. Certify that TAB procedures have been completed, and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.
  - 4. Test systems and intersystem performance after approval of test checklists for systems, subsystems, and equipment.
  - 5. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shut down, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
  - 6. Verify each operating cycle after it has been running for a specified period and is operating in a steady-state condition.
  - 7. Inspect and verify the position of each device and interlock identified on checklists. Sign off each item as acceptable, or failed. Repeat this test for each operating cycle that applies to system being tested.
  - 8. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
  - 9. Annotate checklist or data sheet when a deficiency is observed.
  - 10. Verify equipment interface with monitoring and control system and TAB criteria; include the following:
    - a. Supply and return flow rates for VAV and constant volume systems in each operational mode.
    - b. Operation of terminal units in both heating and cooling cycles.
    - c. Minimum outdoor-air intake in each operational mode and at minimum and maximum airflows.
    - d. Building pressurization.
    - e. Total exhaust airflow and total outdoor-air intake.
    - f. Operation of indoor-air-quality monitoring systems.
  - 11. Verify proper responses of monitoring and control system controllers and sensors to include the following:

- a. For each controller or sensor, record the indicated monitoring and control system reading and the test instrument reading. If initial test indicates that the test reading is outside of the control range of the installed device, check calibration of the installed device and adjust as required. Retest malfunctioning devices and record results on checklist or data sheet.
    - b. Report deficiencies and prepare an issues log entry.
  12. Verify that HVAC equipment field quality-control testing has been completed and approved. CxA shall direct, witness, and document field quality-control tests, inspections, and startup specified in individual Division 23 Sections.
- B. Testing Instrumentation: Install measuring instruments and logging devices to record test data for the required test period. Instrumentation shall monitor and record full range of operating conditions and shall allow for calculation of total capacity of system for each mode of operation. For individual room cooling tests, provide temporary heaters to impose a cooling load indicated in BoD. Operational modes include the following:
  1. Occupied and unoccupied.
  2. Warm up and cool down.
  3. Economizer cycle.
  4. Emergency power supply.
  5. Life-safety and safety systems.
  6. Smoke control.
  7. Fire safety.
  8. Stair pressurization system.
  9. Temporary upset of system operation.
  10. Partial occupancy conditions.
  11. Special cycles.

### 3.02 TAB VERIFICATION

- A. TAB Subcontractor shall coordinate with CxA for work required in Division 23 Section "Testing, Adjusting, and Balancing for HVAC" TAB Subcontractor shall copy CxA with required reports, sample forms, checklists, and certificates.
- B. HVAC Subcontractor, and CxA shall witness TAB Work.
- C. TAB Preparation:
  1. TAB Subcontractor shall provide CxA with data required for "Pre-Field TAB Engineering Reports" specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."
    - a. CxA shall use this data to certify that prestart and startup activities have been completed for systems, subsystems, and equipment installation.
- D. Ductwork Air Leakage Testing:
  1. Architect will identify, for HVAC Subcontractor and CxA, portions of duct systems to have ductwork air leakage testing. Ductwork air leakage testing shall be performed according to Division 23 Section "Metal Ducts," and shall be witnessed by the CxA.
  2. On approval of preliminary ductwork air leakage testing report, the CxA shall coordinate verification testing of ductwork air leakage testing. Verification testing shall include random retests of portions of duct section tests, reported in preliminary ductwork air

leakage testing report. The HVAC Subcontractor shall perform tests using the same instrumentation (by model and serial number) as for original testing; the CxA shall witness verification testing.

E. Verification of Final TAB Report:

1. CxA shall select, at random, 10 percent of report for field verification.
2. CxA shall notify TAB Subcontractor 10 days in advance of the date of field verification; however, notice shall not include data points to be verified. The TAB Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
3. Failure of an item is defined as follows:
  - a. For all readings other than sound, a deviation of more than 10 percent.
    - 1) For sound pressure readings, a deviation of 3 dB. (Note: Variations in background noise must be considered.)
4. Failure of more than 10 percent of selected items shall result in rejection of final TAB report.

F. If deficiencies are identified during verification testing, CxA shall notify the HVAC Subcontractor and Architect, and shall take action to remedy the deficiency. Architect shall review final tabulated checklists and data sheets to determine if verification is complete and that system is operating according to the Contract Documents.

G. CxA shall certify that TAB Work has been successfully completed.

3.03 TESTING

A. Test systems and intersystem performance after test checklists for systems, subsystems, and equipment have been approved.

B. Perform tests using design conditions whenever possible.

1. Simulate conditions by imposing an artificial load when it is not practical to test under design conditions and when written approval for simulated conditions is received from CxA. Before simulating conditions, calibrate testing instruments. Set and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
2. Alter set points when simulating conditions is not practical and when written approval is received from CxA.
3. Alter sensor values with a signal generator when design or simulating conditions and altering set points are not practical. Do not use sensor to act as signal generator to simulate conditions or override values.

C. Scope of HVAC Subcontractor Testing:

1. Testing scope shall include entire HVAC installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. It shall include measuring capacities and effectiveness of operational and control functions.
2. Test all operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

- D. Detailed Testing Procedures: CxA, with HVAC Subcontractor, TAB Subcontractor, and HVAC Instrumentation and Control Subcontractor, shall prepare detailed testing plans, procedures, and checklists for HVAC systems, subsystems, and equipment.
- E. Boiler Testing and Acceptance Procedures: Testing requirements are specified in Division 23 boiler Sections. CxA shall review and comment on submittals, test data, inspector record, and boiler certification and shall compile information for inclusion in systems manual.
- F. HVAC Instrumentation and Control System Testing:
  - 1. Field testing plans and testing requirements are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operation for HVAC Controls" The CxA, HVAC Subcontractor, and the HVAC Instrumentation and Control Subcontractor shall collaborate to prepare testing plans.
  - 2. CxA shall convene a meeting of appropriate entities to review test report of HVAC instrumentation and control systems.
- G. Pipe cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 23 piping Sections. HVAC Subcontractor shall prepare pipe system cleaning, flushing, and hydrostatic testing. CxA shall review and comment on plan and final reports. CxA shall certify that pipe cleaning, flushing, hydrostatic tests, and chemical treatment have been completed. Plan shall include the following:
  - 1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed Drawings for each pipe sector showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
  - 2. Description of equipment for flushing operations.
  - 3. Minimum flushing water velocity.
  - 4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.
- H. Energy Supply System Testing: HVAC Subcontractor shall prepare a testing plan to verify performance of gas, steam, hot-water, and solar systems and equipment. Plan shall include the following:
  - 1. Sequence of testing and testing procedures for each equipment item and pipe section to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in system testing plan.
  - 2. Tracking checklist for managing and ensuring that all pipe sections have been tested.
- I. Heat-Generation System Testing: HVAC Subcontractor shall prepare a testing plan to verify performance of boilers, feedwater equipment, furnaces, and auxiliary equipment. Plan shall include the following:
  - 1. Sequence of testing and testing procedures for each item of equipment and section of pipe to be tested, identified by identification marker. Markers shall be keyed to Drawings for each pipe sector showing the physical location of each item of equipment and pipe test

- section. Drawings shall be formatted to allow each item of equipment and section of piping to be physically located and identified when referred to in the system testing plan.
2. Tracking checklist for managing and ensuring that all pipe sections have been tested.
- J. Refrigeration System Testing: HVAC Subcontractor shall prepare a testing plan to verify performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. Plan shall include the following:
1. Sequence of testing and testing procedures for each item of equipment and section of pipe to be tested, identified by identification marker. Markers shall be keyed to Drawings showing the physical location of each item of equipment and pipe test section. Drawings shall be formatted to allow each item of equipment and section of piping to be physically located and identified when referred to in the system testing plan.
  2. Tracking checklist for managing and ensuring that all pipe sections have been tested.
- K. HVAC Distribution System Testing: HVAC Subcontractor shall prepare a testing plan to verify performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems. Include HVAC terminal equipment and unitary equipment. Plan shall include the following:
1. Sequence of testing and testing procedures for each item of equipment and section of pipe to be tested, identified by identification marker. Markers shall be keyed to Drawings showing the physical location of each item of equipment and pipe test section. Drawings shall be formatted to allow each item of equipment and section of piping to be physically located and identified when referred to in the system testing plan.
  2. Tracking checklist for managing and ensuring that all pipe sections have been tested.
- L. Vibration and Sound Tests: HVAC Subcontractor shall prepare testing plans to verify performance of vibration isolation and seismic controls. CxA shall witness and certify tests and inspections.
- M. Deferred Testing:
1. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, the deficiency shall be documented and reported to Owner. Deficiencies shall be resolved and corrected by appropriate parties and test rescheduled.
  2. If the testing plan indicates specific seasonal testing, appropriate initial performance tests shall be completed and documented and additional tests scheduled.
- N. Testing Reports:
1. Reports shall include measured data, data sheets, and a comprehensive summary describing the operation of systems at the time of testing.
  2. Include data sheets for each controller to verify proper operation of the control system, the system it serves, the service it provides, and its location. For each controller, provide space for recording its readout, the reading at the controller's sensor(s), plus comments. Provide space for testing personnel to sign off on each data sheet.
  3. Prepare a preliminary test report. Deficiencies will be evaluated by Architect to determine corrective action. Deficiencies shall be corrected and test repeated.



4. If it is determined that the system is constructed according to the Contract Documents, Owner will decide whether modifications required to bring the performance of the system to the OPR and BoD documents shall be implemented or if tests will be accepted as submitted. If corrective Work is performed, Owner will decide if tests shall be repeated and a revised report submitted.

END OF SECTION

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## SECTION 230913 - INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Control panels.
- B. Control Valves:
- C. Pressure independent valves and actuators.
- D. Dampers.
- E. Damper Operators:
- F. Humidistats:
- G. Wall-, Surface-, and Duct-Mounted Sensors:
  - 1. Temperature sensors.
  - 2. Humidity sensors.
  - 3. IAQ (indoor air quality) sensors.
  - 4. Building static pressure transmitters.
  - 5. Static air pressure sensors.
- H. Fan and pump motor run-status monitoring.
- I. Pipe-Mounted Sensors and Transmitters:
  - 1. Temperature sensors.

#### 1.02 REFERENCE STANDARDS

- A. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code); 1989 (Corrigendum 2019).

#### 1.03 SUBMITTALS

- A. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
- B. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.
  - 1. Quantities of items submitted shall be reviewed by the Engineer and Owner. Such review shall not relieve the contractor from furnishing quantities and specified functionality required for completion.
  - 2. Submit the following within 60 days of contract award:

- a. A complete bill of materials of equipment to be used indicating quantity, manufacturer and model number.
  - b. A schedule of all control valves including the valve size, model number (including pattern and connections), flow, CV, pressure rating, and location.
  - c. A schedule of all control dampers. This shall include the damper size, pressure drop, manufacturer and model number.
  - d. Provide manufacturers cut sheets for major system components. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is being submitted to cover. Include:
    - 1) Auxiliary Control Devices
- C. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
- D. Project Record Documents: Record actual location of control components, including panels, thermostats, and sensors.
  - 1. Revise shop drawings to reflect actual installation and operating sequences.
- E. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

#### 1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum \_\_\_\_\_ years documented experience.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years experience approved by manufacturer.

#### 1.05 WARRANTY

- A. Labor & materials for control system specified shall be warranted free from defects for a period of twelve (12) months after final completion acceptance by the Owner. Control System failures during the warranty period shall be adjusted, repaired, or replaced at no charge or reduction in service to the Owner. The Contractor shall respond to the Owner's request for warranty service within 24 hours during customary business hours.
- B. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the Owner and Engineer, the Owner shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of warranty.

## PART 2 PRODUCTS

### 2.01 EQUIPMENT - GENERAL

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

### 2.02 CONTROL PANELS

- A. All indoor control cabinets shall be fully enclosed NEMA 1 Type construction with hinged door, key-lock latch, removable sub-panels. A single key shall be common to all field panels and sub-panels.
- B. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face.
- C. Interconnections between internal and face-mounted devices pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600-volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
- D. Provide on/off power switch with over-current protection and main air gauge for control power sources to each local panel.

### 2.03 CONTROL VALVES

- A. Control valves shall be two-way or three-way type for two-position or modulating service as scheduled or shown.
- B. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
  - 1. Water Valves:
    - a. Two-way: 150% of total system (pump) head.
    - b. Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
  - 2. Steam Valves: 150% of operating (inlet) pressure.
- C. Water Valves:
  - 1. Body and trim style and materials shall be per manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.
  - 2. Sizing Criteria:
    - a. Two-position service: Line size.
    - b. Two-way modulating service: Pressure drop shall be equal to the greater of twice the pressure drop through heat exchanger (load) or 50% of the pressure difference between supply and return mains but not greater than 5 psi unless noted otherwise.
    - c. Three-way Modulating Service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), 4 psi maximum.

- d. Valves 1/2" through 2" shall be bronze body or cast brass ANSI Class 250, spring loaded, Teflon packing, quick opening for two-position service. Two-way valves to have replaceable composition disc, or stainless steel ball.
    - e. 2-1/2" valves and larger shall be cast iron ANSI Class 125 with guided plug and Teflon packing.
  3. Water valves shall fail normally open or closed as indicated in the sequence of operation as follows:
    - a. Heating coils in air handlers - normally open.
    - b. Chilled water control valves - normally closed.
    - c. Other applications - as scheduled or as required by sequence of operation.
  4. Zone valves shall be sized to meet the control application and they shall maintain their last position in the event of a power failure.

## 2.04 DAMPER / VALVE ACTUATORS

### A. Electronic damper/valve actuators.

1. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.
2. Where shown, for power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing.
3. All rotary spring return actuators shall be capable of both clockwise or counter clockwise spring return operation. Linear actuators shall spring return to the retracted position.
4. Proportional actuators shall accept a 0-10 VDC or 0-20 ma control signal and provide a 2-10 VDC or 4-20 ma operating range.
5. All 24 VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 W for DC applications. Actuators operating on 120 VAC or 230 VAC shall not required more than 11 VA.
6. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb. torque capacity shall have a manual crank for this purpose.
7. All modulating actuators shall have an external, built-in switch to allow the reversing of direction of rotation
8. Actuators shall be provided with a conduit fitting and a minimum 1m electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
9. Actuators shall be Underwriters Laboratories Standard 873 listed.
10. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque.

## 2.05 DAMPERS

### A. Motorized dampers, unless otherwise specified elsewhere, shall be as follows:

1. Damper frames shall be 16 gauge galvanized sheet metal or 1/8" extruded aluminum with reinforced corner bracing.
2. Damper blades shall not exceed 8" in width or 48" in length. Blades are to be suitable for medium velocity performance (2,000 fpm). Blades shall be not less than 16 gauge.
3. Damper shaft bearings shall be as recommended by manufacturer for application.

4. All blade edges and top and bottom of the frame shall be provided with compressible seals. Side seals shall be compressible stainless steel. The blade seals shall provide for a maximum leakage rate of 10 CFM per square foot at 2.5" w.c. differential pressure.
5. All leakage testing and pressure ratings will be based on AMCA Publication 500.
6. Individual damper sections shall not be larger than 48" x 60". Provide a minimum of one damper actuator per section.

- B. Control dampers shall be parallel or opposed blade type as indicated in the sequence of operation.

## 2.06 WALL-, SURFACE-, AND DUCT-MOUNT SENSORS

### A. Temperature Sensors:

1. Use thermistor or RTD type temperature sensing elements with characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy.
2. Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F (26 degrees C).
3. 100 ohm platinum RTD is acceptable if used with project DDC controllers.
4. Temperature Sensing Device: Compatible with project DDC controllers.
5. Performance Characteristics:
  - a. RTD:
    - 1) Room Sensor Accuracy: Plus/minus 0.50 degrees F (0.28 degrees C) minimum.
    - 2) Duct Averaging Accuracy: Plus/minus 0.50 degrees F (0.28 degrees C) minimum.
    - 3) Chilled Water Accuracy: Plus/minus 0.50 degrees F (0.28 degrees C) minimum.
    - 4) All Other Accuracy: Plus/minus 0.75 degrees F (0.42 degrees C) minimum.
    - 5) Range: Minus 40 degrees F (Minus 40 degrees C) through 220 degrees F (104.4 degrees C) minimum.
  - b. Immersion Temperature Sensors: Provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed..
  - c. Room Temperature Sensors with Integral Digital Display:
    - 1) Provide a four button keypad with the following capabilities:
      - a) Indication of space temperature.
      - b) Setpoint adjustment to accommodate room setpoint.
      - c) Display and control fan operation status (where applicable).
      - d) Manual occupancy override and indication of occupancy status.
      - e) Communication port
      - f) Controller mode status.
      - g) Password enabled setpoint and override modes.
  - d. Temperature Averaging Elements:
    - 1) Use on duct sensors for ductwork 10 sq ft (0.93 sq m) or larger.
    - 2) Use averaging elements where prone to stratification with minimum sensor length 5 ft (1.524 m).

- 3) Provide for all mixed air and heating coil discharge sensors regardless of duct size.
- e. Insertion Elements:
  - 1) Use in ducts not affected by temperature stratification or where temperature averaging element is not used.
- B. Building Static Pressure Transmitters:
  1. Single port for direct or tubing connection into wall or ceiling static pressure tip, direct acting, double bell, scale range 0.01 to 6.0 in-wc (.0025 to 1.5 kPa) positive or negative, and sensitivity of 0.0005 in-wc (0.125 Pa). Transmit electronic signal to receiver with matching scale range.
- C. Static-Air Pressure Sensors:
  1. Sensor shall have linear output signal. Zero and span shall be field-adjustable.
  2. Sensor sensing elements shall withstand continuous operating conditions plus or minus 50% greater than calibrated span without damage.
  3. Water pressure sensor shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Sensor shall be complete with 4-20 ma output, required mounting brackets, and block and bleed valves. Mount in location accessible for service.
  4. Water differential pressure sensor shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Over-range limit (DP) and maximum static pressure shall be 3,000 psi. Transmitter shall be complete with 4-20 ma output, required mounting brackets, and five-valve manifold. Mount in a location accessible for service.
  5. Unidirectional with ranges not exceeding 150 percent of maximum expected input.
  6. Temperature compensate with typical thermal error or 0.06 percent of full scale in temperature range of 40 to 100 degrees F (5 to 40 degrees C).
  7. Accuracy: One percent of full scale with repeatability 0.3 percent.
  8. Output: 0 to 5 vdc with power at 12 to 28 vdc.
- D. Refrigerant Sensors:
  1. Gas sensing module that holds fixed or replaceable refrigerant gas-sensor cartridge.
  2. Form Factor: IEC 60529, IP20 enclosure, single-gang electrical box mounted.
  3. Electromechanical sensor with 0 to 2,000 ppm measurement range.
  4. Accuracy: Plus/minus two percent of range with 1 ppm resolution.
  5. Hardwired Output: Three-wire, 4 to 20 mA, loop powered.
  6. Alarm: Auxiliary dry contact relay driven by setpoint adjustable between 100 to 500 ppm.

## 2.07 THERMOSTATS

- A. Freezestats:
  1. Configuration: Vapor-filled capillary.
  2. Probe Sensing Length: 20 feet (6.1 m).
  3. Setpoint Adjust Control: Screw with manual reset switch.
  4. Switch Type: SPDT, snap-action, form C in dust-protected enclosure.
  5. Mounting: Locate on cooling coil intake side.
  6. Field Interface: Connect load line-voltage to starter.
  7. Element shall respond to the lowest temperature sensed by any one foot section.
    - a. Low limit shall be manual reset only.



## 2.08 PIPE-MOUNTED SENSORS AND TRANSMITTERS

### A. Temperature Sensors:

1. Pipe-mounted temperature probe tied to weather-resistant enclosure for direct insertion into compatible liquids or gases or inserted into intermediary thermal grease-filled pipe-well compatible with interfaced fluid.
2. Sensor Type: 1,000 ohm Platinum RTD.

## 2.09 Relays

- A. Control relays shall be UL listed plug-in type with dust cover. Contact rating, configuration, and coil voltage suitable for application.
- B. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus or minus 200% (minimum) from set-point shown on plans. Contact rating, configuration, and coil voltage suitable for application. Provide NEMA 1 Type enclosure when not installed in local control panel.

## 2.10 Transformers and Power Supplies

- A. Control transformers shall be UL listed, Class 2 current-limiting type, or shall be furnished with over-current protection in both primary and secondary circuits for Class 2 service.
- B. Unit output shall match the required output current and voltage requirements. Current output shall allow for a 50% safety factor. Output ripple shall be 3.0 mV maximum Peak-to-Peak. Regulation shall be 0.10% line and load combined, with 50 microsecond response time for 50% load changes. Unit shall have built-in over-voltage protection.
- C. Unit shall operate between 0 C and 50 C.
- D. Unit shall be UL recognized.

## 2.11 Current Switches

- A. Current-operated switches shall be self-powered, solid state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. The project plans shall be thoroughly examined for control device and equipment locations, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.
- B. 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 Architect/Engineer for resolution before rough-in work is started.

- C. Verify existing conditions before starting work.
- D. Verify that systems are ready to receive work.
- E. Beginning of installation means installer accepts existing conditions.
- F. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
- G. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.
- H. Ensure installation of components is complementary to installation of similar components.
- I. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

### 3.02 INSTALLATION

- A. Install equipment, piping, wiring/conduit parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.
- B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- C. Install all equipment in readily accessible location as defined by chapter 1 article 100 part A of the NEC. Control panels shall be attached to structural walls unless mounted in equipment enclosure specifically designed for that purpose. Panels shall be mounted to allow for unobstructed access for service.
- D. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.
- E. Install in accordance with manufacturer's instructions.
- F. Check and verify location of thermostats with plans and room details before installation. Locate 48 inches (1200 mm) above floor. Align with lighting switches and humidistats; see Section 262726.
- G. Mount freeze protection thermostats using flanges and element holders.
- H. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.
- I. Provide separable sockets for liquids and flanges for air bulb elements.
- J. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.
- K. Provide conduit and electrical wiring in accordance with Section 260583. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

### 3.03 INSTALLATION OF SENSORS

- A. Install sensors in accordance with the manufacturer's recommendations.
- B. Mount sensors rigidly and adequate for the environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
- D. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor readings.
- E. Install duct static pressure tap with tube end facing directly down-stream of air flow.
- F. Sensors used in mixing plenums, and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.
- G. All pipe mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat conducting fluid in thermal wells.
- H. Wiring for space sensors shall be concealed in building walls. EMT conduit is acceptable within mechanical and service rooms.
- I. Install outdoor air temperature sensors on north wall complete with sun shield at designated location.

### 3.04 ACTUATORS

- A. Mount and link control damper actuators per manufacturer's instructions.
- B. To compress seals when spring return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.
- C. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
- D. Valves - Actuators shall be mounted on valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following manufacturer's recommendations.

### 3.05 WARNING LABELS

- A. Affix plastic labels on each starter and equipment automatically controlled through the Control System. Label shall indicate the following:
  - 1. CAUTION: This equipment is operating under automatic control and may start at any time without warning.

3.06 CLEANING

- A. This contractor shall clean up all debris resulting from his or her activities daily. The contractor shall remove all cartons, containers, crates, etc. under his 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 dust, 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.

3.07 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.

3.08 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.

3.09 MAINTENANCE

- A. Provide service and maintenance of control system for one year from Date of Substantial Completion.
- B. Provide complete service of controls systems, including call backs, and submit written report of each service call.

END OF SECTION

## SECTION 230923 - DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. System description.
- B. Operator interface.
- C. Controllers.
- D. Power supplies and line filtering.
- E. System software.
- F. Controller software.
- G. HVAC control programs.

#### 1.02 RELATED REQUIREMENTS

- A. Section 230913 - Instrumentation and Control Devices for HVAC.
- B. Section 230993 - Sequence of Operations for HVAC Controls.
- C. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

#### 1.03 REFERENCE STANDARDS

- A. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks; 2020, with Addendum (2024).
- B. ASHRAE Std 147 - Reducing the Release of Halogenated Refrigerants from Refrigerating and Air-Conditioning Equipment and Systems; 2019, with Addendum (2024).
- C. MIL-STD-810 - Environmental Engineering Considerations and Laboratory Tests; 2022h, with Editorial Revision.
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. UL (DIR) - Online Certifications Directory; Current Edition.

#### 1.04 RELATED SECTIONS

- A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are a part of these Specifications and shall be used in conjunction with this Section as a part of

the Contract Documents. Consult them for further instructions pertaining to this work. The Contractor is bound by the provisions of other Divisions.

- B. Refer to other Division 23 Sections for related work.

#### 1.05 SUBMITTALS

- A. Product Data: Provide data for each system component and software module.
- B. Contractor shall provide shop drawings and manufacturers' standard specification data sheets on all hardware and software to be provided. No work may begin on any segment of this project until submittals have been reviewed by the Engineer and Owner for conformity with the plan and specifications. PDF copies are required. All shop drawings shall be done on AutoCAD, and provided to the Owner on a flash drive.
- C. Quantities of items submitted shall be reviewed by the Engineer and Owner. Such review shall not relieve the contractor from furnishing quantities and specified functionality required for completion.
- D. Provide the Engineer and Owner, any additional information or data which is deemed necessary to determine compliance with these specifications or which is deemed valuable in documenting the system to be installed.
- E. Submit the following within 60 days of contract award:ings:
1. A complete bill of materials of equipment to be used indicating quantity, manufacturer and model number.
  2. A schedule of all control valves including the valve size, model number (including pattern and connections), flow, CV, pressure rating, and location.
  3. A schedule of all control dampers. This shall include the damper size, pressure drop, manufacturer and model number.
  4. Provide manufacturers cut sheets for major system components. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is being submitted to cover. Include:
    - a. Building Controllers
    - b. Custom Application Controllers
    - c. Application Specific Controllers
    - d. Operator Interface Computer
    - e. Auxiliary Control Devices
    - f. Detailed termination drawings showing all required field and factory terminations. Terminal numbers shall be clearly labeled.
    - g. Points list showing all system objects and the proposed English language object names.
    - h. Sequence of operations for each system under control. This sequence shall be specific for the use of the Control System being provided for this project.
    - i. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
    - j. List connected data points, including connected control unit and input device.

- k. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
  - l. Proposed control system riser diagram showing system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
  - m. Indicate description and sequence of operation of operating, user, and application software.
- F. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors. PDF copies are required
  - 1. Revise shop drawings to reflect actual installation and operating sequences.
  - 2. Include submittals data in final "Record Documents" form.
- G. Testing and Commissioning Reports and Checklists.
- H. Operation and Maintenance Data: These shall be as-built versions of the submittal product data. In addition to that required for the submittals, the O & M manual shall include:
  - 1. Names, address and 24-hour telephone numbers of Contractors installing equipment, and the control systems and service representative of each.
  - 2. Operators Manual with procedures of operating the control systems including logging on/off, alarm handling, producing point reports, trending data, overriding computer control, and changing set points and other variables.
  - 3. Programming Manual with a description of the programming language including syntax, statement descriptions including algorithms and calculations used, point database creation and modification, program creation and modification, and use of the editor.
  - 4. Engineering, Installation and Maintenance Manuals that explains how to design and install new points, panels, and other hardware; preventative maintenance and calibration procedures; how to debug hardware problems; and how to repair or replace hardware.
  - 5. A listing and documentation of all custom software created using the programming language including the point database. One set of electronic files containing the software and database shall also be provided
  - 6. One set of electronic files of all color-graphic screens created for the project.
  - 7. A list of recommended spare parts with part numbers and supplier.
  - 8. Complete original issue documentation, installation and maintenance information for all third party hardware provided including computer equipment and sensors.
  - 9. Complete electronic files for all software provided including operating systems, programming language, operator work-station software, and graphics software.
  - 10. Licenses, Guarantee, and Warranty documents for all equipment and systems.
    - a. Recommended preventive maintenance procedures for all system components including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions.
  - 11. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
  - 12. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
  - 13. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

- I. Training Manuals: The Contractor shall provide a course outline and training manuals for all training classes at least six weeks prior to the first class. The Owner reserves the right to modify any or all of the training course outline and training materials. Review and approval by Owner and Engineer and shall be completed at least 3 weeks prior to first class.

#### 1.06 QUALITY ASSURANCE

- A. Perform work in accordance with NFPA 70.
- B. System Installer Qualifications
  1. The Installer shall have an established working relationship with the Control System Manufacturer of not less than three years.
  2. The Installer shall have successfully completed Control System Manufacturer's classes on the control system and have a minimum of three years experience in the design and installation of control systems. The Installer shall present for review the certification of completed training, including the hours of instruction and course outlines upon request.
  3. The installer shall have an office within 75 miles of the project site and provide 24 hour response in the event of a customer call.
- C. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for purpose specified and indicated.
- D. All products used in this installation shall be new, currently under manufacture, and shall be applied in similar installations for a minimum of 2 years. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner's representative in writing prior to bid date. Spare parts shall be available for at least 5 years after completion of this contract.
- E. Codes and Standards: Meet requirements of all applicable standards and codes, except when more detailed or stringent requirements are indicated by the Contract Documents, including requirements of this Section.

#### 1.07 SYSTEM PERFORMANCE

- A. Performance Standards. The system shall conform to the following:
  1. Graphic Display. The system shall display a graphic with a minimum of 20 dynamic points. All current data shall be displayed within 20 seconds of the request.
  2. Graphic Refresh. The system shall update all dynamic points with current data within 30 seconds.
  3. Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be 10 seconds. Analog objects shall start to adjust within 10 seconds.
  4. Object Scan. All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or work-station will be current, within the prior 60 seconds.
  5. Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the work-station shall not exceed 45 seconds.
  6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.



7. Performance. Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every 5 seconds. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
8. Multiple Alarm Annunciation. All work-stations on the network shall receive alarms within 5 seconds of each other.
9. Reporting Accuracy. Minimum acceptable reporting accuracies for all values reported by the specified system shall be as follows:
  - a. Space temperature:  $\pm 0.5^{\circ}\text{C}$  ( $\pm 1^{\circ}\text{F}$ )
  - b. Ducted air:  $\pm 1.0^{\circ}\text{C}$  ( $\pm 2^{\circ}\text{F}$ )
  - c. Outside air:  $\pm 1.0^{\circ}\text{C}$  ( $\pm 2^{\circ}\text{F}$ )
  - d. Water Temperature:  $\pm 0.5^{\circ}\text{C}$  ( $\pm 1^{\circ}\text{F}$ )
  - e. Delta-T:  $\pm 0.15^{\circ}\text{C}$  ( $\pm 0.25^{\circ}\text{F}$ )
  - f. Relative humidity:  $\pm 5\%$  RH
  - g. Water flow:  $\pm 5\%$  of full scale
  - h. Air flow (terminal):  $\pm 10\%$  of reading \*Note 1
  - i. Air flow (measuring stations):  $\pm 5\%$  of reading
  - j. Air pressure (ducts):  $\pm 25$  Pa ( $\pm 0.1$  "W.G.)
  - k. Air pressure (space):  $\pm 3$  Pa ( $\pm 0.01$  "W.G.)
  - l. Water pressure:  $\pm 2\%$  of full scale \*Note 2
  - m. Electrical Power: 5% of reading \*Note 3
  - n. Carbon Monoxide (CO):  $\pm 50$  PPM
  - o. Carbon Dioxide (CO<sub>2</sub>):  $\pm 50$  PPM
    - 1) Note 1: (10%-100% of scale) (cannot read accurately below 10%)
    - 2) Note 2: for both absolute and differential pressure
    - 3) Note 3: \* not including utility supplied meters

#### 1.08 WARRANTY

A. Warrant all work as follows:

1. Labor & materials for control system specified shall be warranted free from defects for a period of twelve (12) months after final completion acceptance by the Owner. Control System failures during the warranty period shall be adjusted, repaired, or replaced at no charge or reduction in service to the Owner. The Contractor shall respond to the Owner's request for warranty service within 24 hours during customary business hours.
2. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the Owner and Engineer, the Owner shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of warranty.
3. Operator work-station software, project specific software, graphics, database, and firmware updates shall be provided to the Owner at no charge during the warranty period. Written authorization by Owner must, however, be granted prior to the installation of such changes.

#### 1.09 OWNERSHIP OF PROPRIETARY MATERIAL

- A. All project developed hardware and software shall become the property of the Owner. These include but are not limited to:

1. Project graphic images,
2. Record drawings,
3. Project database,
4. Job-specific application programming code,
5. All documentation.

## PART 2 PRODUCTS

### 2.01 SUPPLIERS

- A. Provide a complete ccontrols system from the following approved supplier(s)
  1. SC Technologies, a division of Summit Contractors, Inc.

### 2.02 MANUFACTURERS

- A. Provide a control system from one of the following approved manufacturers:
  1. Delta Controls; \_\_\_\_\_: [www.deltacontrols.com/#sle](http://www.deltacontrols.com/#sle).
  2. Trane

### 2.03 SYSTEM DESCRIPTION

- A. General: The control system shall be as indicated on the drawings and described in the specifications.
- B. Direct Digital Control (DDC) technology shall be used to provide the functions necessary for control of mechanical systems on this project.
  1. Automatic temperature control field monitoring and control system using field programmable micro-processor based units.
- C. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
  1. The control system shall accommodate simultaneous multiple user operation. Access to the control system data should be limited only by operator password. Multiple users shall have access to all valid system data. An operator shall be able to log onto any work-station on the control system and have access to all appropriate data.
- D. The control system shall be designed such that each mechanical system will be able to operate under stand-alone control. As such, in the event of a network communication failure, or the loss of any other controller, the control system shall continue to independently operate under control.
- E. Communication between the control panels and all work-stations shall be over a high speed network. All nodes on this network shall be peers. The operator shall not have to know the panel identifier or location to view or control an object. Application Specific Controllers shall be constantly scanned by the network controllers to update point information and alarm information.

- F. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- G. Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 230913.
- H. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.
- I. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.
- J. The documentation is schematic in nature. The Contractor shall provide hardware and software necessary to implement the functions and sequences shown and operate the systems in a safe and stable manner.

## 2.04 OPERATOR INTERFACE

- A. PC Based Work Station:
  - 1. Resides on high speed network with building controllers.
  - 2. Connected to server for full access to all system information.
- B. Workstation, controllers, and control backbone to communicate using BACnet protocol and addressing.
- C. BACnet protocol to comply with ASHRAE Std 135.
- D. Hardware:
  - 1. Laptop:
    - a. Laptop(s) to be provided by DDC controls manufacturer.
    - b. Quantity: 1.
    - c. Minimum RAM: 32.0 GB.
    - d. Minimum Processing Speed: 2.20GHz.
    - e. Minimum Hard Drive Memory: 951 GB.
    - f. Drives: 1.
    - g. Ports: Qty (2) USB-A, Qty (1) SD, Qty (2) USB-C, Qty (1) 3.5 mm AUX, and Qty (1) HDMI.
    - h. Display: 16" Monitor, 1920x1080 Display Resolution.
    - i. Network Connection:
      - 1) Ethernet interface card.
    - j. The work-station shall be able to access all information in the system. The work-station shall reside on the same high speed network as the building controllers,

## 2.05 CONTROLLERS

- A. Building Controllers:
  - 1. General:

- a. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
  - b. Provide sufficient memory to support controller's operating system, database, and programming requirements.
  - c. Share data between networked controllers.
  - d. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
  - e. Utilize real-time clock for scheduling.
  - f. Continuously check processor status and memory circuits for abnormal operation.
  - g. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
  - h. Communication with other network devices to be based on assigned protocol.
2. Communication:
  - a. Controller to reside on a BACnet network using ISO 8802-3 (ETHERNET) Data Link/Physical layer protocol.
  - b. Perform routing when connected to a network of custom application and application specific controllers.
  - c. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
3. Anticipated Environmental Ambient Conditions:
  - a. Outdoors and/or in Wet Ambient Conditions:
    - 1) Mount within NEMA 4 waterproof enclosures.
    - 2) Rated for operation at -40 to 149 degrees F (-40 to 65 degrees C).
  - b. Conditioned Space:
    - 1) Mount within dustproof enclosures.
    - 2) Rated for operation at 32 to 120 degrees F (0 to 50 degrees C).
4. Local Keypad and Display for each Controller:
  - a. Use for interrogating and editing data.
  - b. System security password prevents unauthorized use.
  - c. A local keypad and display shall be provided where specified in the sequence of operations or points list.
5. Provisions for Serviceability:
  - a. Diagnostic LEDs for power, communication, and processor.
  - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
7. Power and Noise Immunity:
  - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
  - b. Perform orderly shutdown below 80 percent of nominal voltage.
  - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet (1 m).
- B. Custom Application Controller:
  1. General:
    - a. Provide sufficient memory to support controller's operating system, database, and programming requirements.

- b. Share data between networked, microprocessor based controllers.
- c. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
- d. Utilize real-time clock for scheduling.
- e. Continuously check processor status and memory circuits for abnormal operation.
- f. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
- g. Communication with other network devices to be based on assigned protocol.
- 2. Communication:
  - a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
  - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
- 3. Anticipated Environmental Ambient Conditions:
  - a. Outdoors and/or in Wet Ambient Conditions:
    - 1) Mount within NEMA 4 waterproof enclosures.
    - 2) Rated for operation at -40 to 149 degrees F. (-40 to 65 degrees C.).
  - b. Conditioned Space:
    - 1) Mount within dustproof enclosures.
    - 2) Rated for operation at 32 to 120 degrees F (0 to 50 degrees C).
- 4. Local Keypad and Display for each Controller:
  - a. Use for interrogating and editing data.
  - b. System security password prevents unauthorized use.
  - c. A local keypad and display shall be provided where specified in the sequence of operations or points list.
- 5. Provisions for Serviceability:
  - a. Diagnostic LED's for power, communication, and processor.
  - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
- 6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
- 7. Power and Noise Immunity:
  - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
  - b. Perform orderly shutdown below 80 percent of nominal voltage.
  - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet (1 m).
- C. Application Specific Controllers:
  - 1. General:
    - a. Not fully user programmable, microprocessor based controllers dedicated to control specific equipment.
    - b. Customized for operation within the confines of equipment served.
    - c. Communication with other network devices to be based on assigned protocol.
    - d. Each ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.
    - e. Each ASC will contain sufficient I/O capacity to control the target system.
  - 2. Communication:

- a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
    - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
  3. Anticipated Environmental Ambient Conditions:
    - a. Outdoors and/or in Wet Ambient Conditions:
      - 1) Mount within NEMA 4 waterproof enclosures.
      - 2) Rated for operation at -40 to 149 degrees F. (-40 to 65 degrees C.).
    - b. Conditioned Space:
      - 1) Mount within dustproof enclosures.
      - 2) Rated for operation at 32 to 120 degrees F (0 to 50 degrees C).
  4. Local Keypad and Display for each Controller:
    - a. Use for interrogating and editing data.
    - b. System security password prevents unauthorized use.
    - c. A local keypad and display shall be provided where specified in the sequence of operations or points list.
  5. Provisions for Serviceability:
    - a. Diagnostic LEDs for power, communication, and processor.
    - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
  6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 90 days.
  7. Power and Noise Immunity:
    - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
    - b. Perform orderly shutdown below 80 percent of nominal voltage.
    - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet (1 m).
    - d. Transformer. Power supply for the ASC must be rated at minimum of 125% of ASC power consumption, and shall be fused or current limiting type.
- D. Input/Output Interface:
  1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.
  2. All Input/Output Points:
    - a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
    - b. All input points and output points shall be protected such that shorting of the point to itself, another point, or ground will cause no damage to the controller.
    - c. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.
  3. Binary Inputs:
    - a. Allow monitoring of On/Off signals from remote devices.
    - b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
    - c. Sense dry contact closure with power provided only by the controller.

4. Pulse Accumulation Input Objects: Comply with all requirements of binary input objects and accept up to 2 pulses per second, and shall be protected against effects of contact bounce and noise.
5. Analog Inputs:
  - a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
  - b. Compatible with and field configurable to commonly available sensing devices.
6. Binary Outputs:
  - a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
  - b. Outputs provided with three position (On/Off/Auto) override switches.
  - c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
7. Analog Outputs:
  - a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
  - b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
  - c. Drift to not exceed 0.4 percent of range per year.
8. Tri State Outputs:
  - a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.
  - b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:
  - c. Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
9. System Object Capacity:
  - a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.
  - b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

## 2.06 POWER SUPPLIES AND LINE FILTERING

- A. Power Supplies:
1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
  2. Limit connected loads to 80 percent of rated capacity.
  3. Match DC power supply to current output and voltage requirements.
  4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
  5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
  6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
  7. Operational Ambient Conditions: 32 to 120 degrees F (0 to 50 degrees C).

8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD-810 for shock and vibration.
  9. Line voltage units UL recognized and CSA approved.
- B. Power Line Filtering:
1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.
  2. Minimum surge protection attributes:
    - a. Dielectric strength of 1000 volts minimum.
    - b. Response time of 10 nanoseconds or less.
    - c. Transverse mode noise attenuation of 65 dB or greater.
    - d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

## 2.07 SYSTEM SOFTWARE

- A. Operating System:
1. Concurrent, multi-tasking capability.
    - a. Common Software Applications Supported: Microsoft Excel.
    - b. Acceptable Operating Systems: Windows 11.
  2. System Graphics:
    - a. The Operator Work-station software shall be graphically oriented
    - b. Allow up to 10 graphic screens, simultaneously displayed for comparison and monitoring of system status.
    - c. Animation displayed by shifting image files based on object status.
    - d. Provide method for operator with password to perform the following:
      - 1) Move between, change size, and change location of graphic displays.
      - 2) Modify on-line.
      - 3) Add, delete, or change dynamic objects consisting of:
        - a) Analog and binary values.
        - b) Dynamic text.
        - c) Static text.
        - d) Animation files.
  3. Custom Graphics Generation Package:
    - a. Create, modify, and save graphic files and visio format graphics in PCX, TIFF, GEM, and .dwg formats.
    - b. HTML graphics to support web browser compatible formats.
    - c. Capture or convert graphics from AutoCAD.
  4. Standard HVAC Graphics Library:
    - a. HVAC Equipment:
      - 1) Chillers.
      - 2) Boilers.
      - 3) Air Handlers.
      - 4) Fan Coil Units.
      - 5) Unit Ventilators.
    - b. Ancillary Equipment:
      - 1) Fans.
      - 2) Pumps.



- 3) Coils.
      - 4) Valves.
      - 5) Piping.
      - 6) Dampers.
      - 7) Ductwork.
    - c. File Format Compatible with Graphics Generation Package Program.
  5. Engineering Units. Allow for selection of the desired engineering units (i.e. Inch pound or SI) in the system. Unit selection shall be able to be customized by locality to select the desired units for each measurement. Engineering units on this project shall be: Standard Inch Pound.
- B. Workstation System Applications:
1. Each work-station shall provide operator interface and off-line storage of system information.
  2. Automatic System Database Save and Restore Functions:
    - a. Current database copy of each Building Controller is automatically stored on hard disk.
    - b. Automatic update occurs upon change in any system panel.
    - c. In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.
  3. Manual System Database Save and Restore Functions by Operator with Password Clearance:
    - a. Save database from any system panel.
    - b. Clear a panel database.
    - c. Initiate a download of a specified database to any system panel.
  4. Software provided allows system configuration and future changes or additions by operators under proper password protection.
  5. On-line Help:
    - a. Context-sensitive system assists operator in operation and editing.
    - b. Available for all applications.
    - c. Relevant screen data provided for particular screen display.
    - d. Additional help available via hypertext.
  6. Security:
    - a. Operator log-on requires user name and password to view, edit, add, or delete data.
    - b. System security selectable for each operator.
    - c. System supervisor sets passwords and security levels for all other operators.
    - d. Operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.
    - e. Automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.
    - f. All system security data stored in encrypted format.
  7. System Diagnostics:
    - a. Operations Automatically Monitored:
      - 1) Workstations.
      - 2) Printers.
      - 3) Modems.
      - 4) Network connections.

- 5) Building management panels.
    - 6) Controllers.
  - b. Device failure is annunciated to the operator.
- 8. Alarm Processing:
  - a. All system objects are configurable to "alarm in" and "alarm out" of normal state.
  - b. Configurable Objects:
    - 1) Alarm limits.
    - 2) Alarm limit differentials.
    - 3) States.
    - 4) Reactions for each object.
  - c. An object in alarm that has not been acknowledged within an operator specified time period shall be re-routed to an alternate operator specified alarm receipt device.
  - d. Binary Alarms. Each binary object shall be set to alarm based on the operator specified state. Provide the capability to disable alarming when the associated equipment is turned off or is being serviced.
  - e. Analog Alarms. Each analog object shall have both high and low alarm limits and warning limits. Alarming must be able to be automatically and manually disabled.
- 9. Alarm Messages:
  - a. Descriptor: English language.
  - b. Recognizable Features:
    - 1) Source.
    - 2) Location.
    - 3) Nature.
- 10. Configurable Alarm Reactions by Workstation and Time of Day:
  - a. Logging.
  - b. Printing.
  - c. Starting programs.
  - d. Displaying messages.
  - e. Dialing out to remote locations.
  - f. Paging.
  - g. Providing audible annunciation.
  - h. Displaying specific system graphics.
- 11. Custom Trend Logs:
  - a. Definable for any data object in the system including interval, start time, and stop time.
  - b. Trend Data:
    - 1) Trend intervals of 1, 5, 15, 30, and 60 minutes as well as once a shift (8 hours), once a day, once a week, and once a month shall be selectable. All trends shall start based on the hour.
    - 2) Each trend shall accommodate up to 64 system objects.
    - 3) The system operator with proper password shall be able to determine how many samples are stored in each trend.
    - 4) Sampled and stored on the building controller panel.
    - 5) Archivable on hard disk.
    - 6) Retrievable for use in reports, spreadsheets and standard database programs.

- 7) Archival on LAN accessible storage media including hard disk, tape, Raid array drive, and virtual cloud environment.
- 8) Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.
12. Dynamic Graphical Charting:
  - a. The operator shall be able to select system values to be charted in real time.
  - b. Up to three values at one time can be selected for each chart.
  - c. The type of chart (bar, line, 3-D, etc.) shall be selectable.
13. Alarm and Event Log:
  - a. View all system alarms and change of states from any system location.
  - b. Events listed chronologically.
  - c. Operator with proper security acknowledges and clears alarms.
  - d. Alarms not cleared by operator are archived to the workstation hard disk.
14. Object, Property Status and Control:
  - a. Provide a method to view, edit if applicable, the status of any object and property in the system.
  - b. Status Available by the Following Methods:
    - 1) Menu.
    - 2) Graphics.
    - 3) Custom Programs.
15. Clock Synchronization:
  - a. The real time clocks in all building control panels and work-stations shall be synchronized on command of an operator.
  - b. The system shall also be able to automatically synchronize all system clocks, daily from any operator designated device in the system.
  - c. The system shall automatically adjust for daylight savings and standard time if applicable.
16. Reports and Logs:
  - a. Reporting Package:
    - 1) Allows operator to select, modify, or create reports.
    - 2) Definable as to data content, format, interval, and date.
    - 3) Archivable to hard disk.
  - b. Real-time logs available by type or status such as alarm, lockout, normal, etc.
  - c. Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.
  - d. Set to be printed on operator command or specific time(s).
17. Reports:
  - a. Standard:
    - 1) Objects with current values.
    - 2) Current alarms not locked out.
    - 3) Disabled and overridden objects, points and SNVTs.
    - 4) Objects in manual or automatic alarm lockout.
    - 5) Objects in alarm lockout currently in alarm.
    - 6) Logs:
      - a) Alarm History.
      - b) System messages.
      - c) System events.

- d) Trends.
- b. Custom:
  - 1) Daily.
  - 2) Weekly.
  - 3) Monthly.
  - 4) Annual.
  - 5) Time and date stamped.
  - 6) Title.
  - 7) Facility name.
- c. Tenant Override:
  - 1) Monthly report showing total, requested, after-hours HVAC and lighting services on a daily basis for each tenant.
  - 2) Annual report showing override usage on a monthly basis.
- d. Electrical, Fuel, and Weather:
  - 1) Electrical Meter(s):
    - a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
    - b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.
  - 2) Fuel Meter(s):
    - a) Monthly showing daily natural gas consumption for each meter.
    - b) Annual summary showing monthly consumption for each meter.
  - 3) Weather:
    - a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.
- e. Daily Operating Condition of Chiller(s) Based on ASHRAE Std 147:
  - 1) Chilled water inlet and outlet temperature.
  - 2) Chilled water flow.
  - 3) Chilled water inlet and outlet pressure.
  - 4) Evaporator refrigerant pressure and temperature.
  - 5) Condenser refrigerant pressure and temperature.
  - 6) Condenser refrigerant pressure and liquid temperature.
  - 7) Condenser water flow.
  - 8) Refrigerant levels.
  - 9) Oil pressure and temperature.
  - 10) Oil level.
  - 11) Compressor refrigerant discharge temperature.
  - 12) Refrigerant suction temperature.
  - 13) Addition of refrigerant.
  - 14) Addition of oil.
  - 15) Vibration levels or observation that vibration is not excessive.
  - 16) Motor amperes per phase.
  - 17) Motor volts per phase.
  - 18) PPM refrigerant monitor level.
  - 19) Purge exhaust time or discharge count.
  - 20) Ambient temperature (dry-bulb and wet-bulb).
  - 21) Date and time logged.

C. Workstation Applications Editors:

1. Provide editing software for each system application at PC workstation.
2. Downloaded application is executed at controller panel.
3. Full screen editor for each application allows operator to view and change:
  - a. Configuration.
  - b. Name.
  - c. Control parameters.
  - d. Set-points.
4. Scheduling:
  - a. Monthly calendar indicates schedules, holidays, and exceptions.
  - b. Allows several related objects to be scheduled and copied to other objects or dates.
  - c. Start and stop times adjustable from master schedule.
5. Equipment Coordination
  - a. Provide a full screen editor that allows equipment to be grouped for proper operation as specified in the sequence of operations. This shall include the coordination of VAV boxes with their associated Air Handling Equipment.
6. Chiller System
  - a. The chiller plant control application shall be configured using a full screen editor and shall provide operating status for the system. The display shall include:
    - 1) System mode of the chiller plant.
    - 2) Chiller enable/disable status.
    - 3) System supply water setpoint.
    - 4) System supply and return water temperature.
    - 5) System Chilled water pump status.
    - 6) System Chilled water flow.
    - 7) Bypass pipe flow rate (if applicable).
    - 8) Current chiller plant control operation.
    - 9) Add information.
    - 10) Subtract information.
    - 11) System failure information.
    - 12) Chiller failure information.
    - 13) Rotation information.
    - 14) Override capabilities to force an add control, subtract control, or change of sequence.
    - 15) Remove a chiller from a sequence temporarily for service purposes.
7. Custom Application Programming:
  - a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.
  - b. Programming Features:
    - 1) English oriented language, based on BASIC, FORTRAN, C, or PASCAL syntax allowing for free form programming.
    - 2) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.
    - 3) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.

- 4) Allows the development of independently, executing, program modules designed to enable and disable other modules.
- 5) Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.
- 6) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
- 7) Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.
- 8) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values can be used in IF/THEN comparisons, calculations, programming statement logic, etc.
- 9) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

## 2.08 CONTROLLER SOFTWARE

- A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.
- B. System Security:
  1. User access secured via user passwords and user names.
  2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
  3. User Log On/Log Off attempts are recorded.
  4. Automatic Log Off occurs following the last keystroke after a user defined delay time.
- C. Object or Object Group Scheduling:
  1. Weekly Schedules Based on Separate, Daily Schedules:
    - a. Include start, stop, optimal stop, and night economizer.
    - b. 10 events maximum per schedule.
    - c. Start/stop times adjustable for each group object.
  2. Exception Schedules:
    - a. Based on any day of the year.
    - b. Defined up to one year in advance.
    - c. Automatically discarded and replaced with standard schedule for that day of the week upon execution.
  3. Holiday or Special Schedules:
    - a. Capability to define up to 99 schedules.
    - b. Repeated annually.
    - c. Length of each period is operator defined.
- D. Provide standard application for equipment coordination and grouping based on function and location to be used for scheduling and other applications.
- E. Alarms:

1. Binary object is set to alarm based on the operator specified state.
  2. Analog object to have high/low alarm limits.
  3. All alarming is capable of being automatically and manually disabled.
  4. Alarm Reporting:
    - a. Operator determines action to be taken for alarm event.
    - b. Alarms to be routed to appropriate workstation.
    - c. Reporting Options:
      - 1) Start programs.
      - 2) Print.
      - 3) Logged.
      - 4) Custom messaging.
      - 5) Graphical displays.
      - 6) Dial out to workstation receivers via system protocol.
- F. Demand Limiting:
1. Building power consumption monitored from signals generated by a current transformer, attached to the building feeder lines.
  2. Demand limit controlled via load shedding or load restoration in a predetermined and predictive manner.
  3. Demand Reduction Methods:
    - a. Supply air temperature reset.
    - b. Space temperature set-point reset.
    - c. Equipment off/on prioritization.
  4. Relevant variables that influence demand limiting control are based on the power company methodology for computing demand charges.
  5. Operator On-Line Changes Allowed:
    - a. Addition and deletion of loads controlled.
    - b. Changes in demand intervals.
    - c. Changes in demand limit for meter(s).
    - d. Maximum equipment shutoff time.
    - e. Minimum equipment shutoff time.
    - f. Select rotational or sequential shedding and restoring.
    - g. Shed/restore priority.
  6. Information and Reports available Hourly, Daily, and Monthly:
    - a. Total electric consumption.
    - b. Peak demand.
    - c. Date and time of peak demand.
    - d. Daily peak demand.
- G. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.
- H. Sequencing: Application software based upon specified sequences of operation in Section 230993.
- I. PID Control Characteristics:
1. Direct or reverse action.
  2. Anti-windup.

3. Calculated, time-varying, analog value, positions an output or stages a series of outputs.
  4. User selectable controlled variable, set-point, and PID gains.
- J. Staggered Start Application:
1. Prevents all controlled equipment from simultaneously restarting after power outage.
  2. Order of equipment startup is user selectable.
- K. Energy Calculations:
1. Accumulated instantaneous power or flow rates are converted to energy use data.
  2. Algorithm calculates a rolling average and allows window of time to be user specified in minute intervals.
  3. Algorithm calculates a fixed window average with a digital input signal from a utility meter defining the start of the window period that in turn synchronizes the fixed-window average with that used by the power company.
- L. Anti-Short Cycling:
1. All binary output objects protected from short-cycling.
  2. Allows minimum on-time and off-time to be selected.
- M. On-Off Control with Differential:
1. Algorithm allows binary output to be cycled based on a controlled variable and set-point.
  2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.
- N. Run-Time Totalization:
1. Totalize run-times for all binary input objects.
  2. Provides operator with capability to assign high run-time alarm.

## 2.09 HVAC CONTROL PROGRAMS

- A. General:
1. Support Inch-pounds and SI (metric) units of measurement.
  2. Identify each HVAC Control system.
- B. Optimal Run Time:
1. Control start-up and shutdown times of HVAC equipment for both heating and cooling.
  2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.
  3. Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions.
  4. Use outside air temperature to determine early shut down with ventilation override.
  5. Analyze multiple building mass sensors to determine seasonal mode and worse case condition for each day.
- C. Supply Air Reset:
1. Monitor heating and cooling loads in building spaces, terminal reheat systems, both hot deck and cold deck temperatures on dual duct and multizone systems, single zone unit discharge temperatures.
  2. Adjust discharge temperatures to most energy efficient levels satisfying measured load by:



- a. Raising cooling temperatures to highest possible value.
- b. Reducing heating temperatures to lowest possible level.

## 2.10 CHILLER CONTROL PROGRAMS

- A. Control function of condenser water reset, chilled water reset, and chiller sequencing. Support inch-pounds and SI (metric) units of measurement.
- B. Condenser Water Reset: Automatically reset controlled condenser water temperature using measured outside wet bulb temperature and load being handled.
- C. Chilled Water Reset: Automatically reset controlled chilled water temperature satisfying cooling coil requiring greatest cooling.
- D. Chiller Sequencing: Determine which combination of chillers will most efficiently satisfy chilled water load, by cycling chillers, based on comparing load to switchover limits defined for each chiller.
  - 1. The chiller plant control application shall have the ability to control a maximum of 25 chillers of any type including centrifugal, helirotor, scroll, reciprocating and absorption machines as detailed in the sequence of operations.
  - 2. This application shall be able to control both constant and variable flow systems as well as parallel, series and decoupled piping configurations.
  - 3. The chiller plant control application shall be able to control multiple chiller plants per site.
  - 4. Diagnostics/Protection - The chiller plant application program shall be able to integrate individual chiller diagnostics into control action decisions.
  - 5. Event Processing - All chiller plant control and status events shall be recorded, at the operator's selection, in the building management system event log to facilitate troubleshooting.
  - 6. Alarm Indications - The chiller plant control status screens shall display chiller plant and individual chiller alarm messages.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. The project plans shall be thoroughly examined for control device and equipment locations, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.
- B. 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 Architect/Engineer for resolution before rough-in work is started.
- C. Verify existing conditions before starting work.
- D. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

### 3.02 INSTALLATION

- A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
- B. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 230993.
- C. Provide conduit and electrical wiring in accordance with Section 260583. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.
- D. Install equipment, piping, wiring/conduit parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.
- E. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- F. Install all equipment in readily accessible location as defined by chapter 1 article 100 part A of the NEC. Control panels shall be attached to structural walls unless mounted in equipment enclosure specifically designed for that purpose. Panels shall be mounted to allow for unobstructed access for service.
- G. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- H. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.
- I. The controls Contractor shall provide all communication media, connectors, repeaters, hubs, and routers necessary for the inter-network.
- J. The owner will provide all communication media, connectors, repeaters, hubs, and routers necessary for the inter-network. A network jack will be provided adjacent to each Building Control Panel and PC Workstation for connection to this network.

### 3.03 WIRING

- A. All control and interlock wiring shall comply with the national and local electrical codes and Division 26 of these specifications. Where the requirements of this section differ with those in Division 26, the requirements of this section shall take precedence.
- B. Install all Class 2 wires in conduit in the following locations:
  - 1. Mechanical spaces.
  - 2. Concealed inaccessible walls, chassis, ceiling, etc.
- C. 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.

- D. 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).
- E. Where class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it, and bundled, using approved wire ties at no greater than 10 ft intervals. Such bundled cable shall be fastened to the structure, using specified fasteners, at 5 ft intervals or more often to achieve a neat and workmanlike result.
- F. 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.
- G. Maximum allowable voltage for control wiring shall be 120V. If only higher voltages are available, the Control System Contractor shall provide step down transformers.
- H. All wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.
- I. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations in accordance with other sections of this specification and local codes.
- J. Size of conduit and size and type of wire shall be the design responsibility of the Control System Contractor, in keeping with the manufacturer's recommendation and NEC.
- K. Control and status relays are to be located in designated enclosures only. These relays may also be located within packaged equipment control panel enclosures. These relays shall not be located within Class 1 starter enclosures.
- L. Follow manufacturer's installation recommendations for all communication and network cabling. Network or communication cabling shall be run separately from other wiring.
- M. Adhere to Division 26 requirements for installation of raceway.
- N. This Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with termination's identified at the job site.
- O. Flexible metal conduits and liquid-tight, flexible metal conduits shall not exceed 3' in length and shall be supported at each end. Flexible metal conduit less than 1/2" electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.
- P. A power supply for all required transformers shall be included in the Controls Contractor's scope of work for a complete and operable system. Controls contractor is responsible for hiring the electrical contractor for all 120 VAC and power requirements.

### 3.04 FIBER OPTIC CABLING SYSTEMS

- A. All cabling shall be installed in a neat and workmanlike manner. Minimum cable and unjacketed fiber bend radii as specified by cable manufacturer shall be maintained.

- B. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post installation residual cable tension shall be within cable manufacture's specifications.
- C. Fiber optic cabinets, hardware, and cable entering the cabinet shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii as specified by cable manufacturer shall be maintained.

### 3.05 WARNING LABELS

- A. Affix plastic labels on each starter and equipment automatically controlled through the Control System. Label shall indicate, "CAUTION: This equipment is operating under automatic control and may start at any time without warning."

### 3.06 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 minimum 1 cm letters on laminated plastic nameplates.
- D. Identify all other control components with permanent labels. Identifiers shall match record documents. All plug-in components shall be labeled such that removal of the component does not remove the label.

### 3.07 CONTROLLERS

- A. Provide a separate Controller for each major piece of HVAC equipment. Points used for control loop reset such as outside air or space temperature are exempt from this requirement.
- B. Building Controllers and Custom Application Controllers shall be selected to provide a minimum of 15% spare I/O point capacity for each point type found at each location. If input points are not universal, 15% of each type is required. If outputs are not universal, 15% of each type is required. A minimum of one spare is required for each type of point used.
- C. Future use of spare capacity shall require providing the field device, field wiring, point database definition, and custom software. No additional Controller boards or point modules shall be required to implement use of these spare points.

### 3.08 PROGRAMMING

- A. Provide sufficient internal memory for the specified control sequences and trend logging. There shall be a minimum of 25% of available memory free for future use.
- B. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index.
- C. Software Programming

- D. Provide programming for the system as per specifications and adhere to the strategy algorithms provided. All other system programming necessary for the operation of the system but not specified in this document shall also be provided by the Control System Contractor. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequence of operations.
- E. Operators' Interface
  - 1. Standard Graphics. Provide graphics for each major piece of equipment and floor plan in the building. This includes each Chiller, Air Handler, HVAC Unit, VAV Terminal, Fan Coil, Boiler, Heat Exchanger and Cooling Tower. These standard graphics shall show all points dynamically as specified in the points list.
  - 2. The controls contractor shall provide all the labor necessary to install, initialize, start-up, and trouble-shoot all operator interface software and their functions as described in this section. This includes any operating system software, the operator interface data base, and any third party software installation and integration required for successful operation of the operator interface.
  - 3. As part of this execution phase, the controls contractor will perform a complete test of the operator interface. Test duration shall be a minimum of 16 hours on-site. Tests shall be made in the presence of the Owner or Owner's representative.
- F. Demonstration: A complete demonstration and readout of the capabilities of the monitoring and control system shall be performed. The contractor shall dedicate a minimum of 24 hours on-site with the Owner and his representatives for a complete functional demonstration of all the system requirements. This demonstration constitutes a joint acceptance inspection, and permits acceptance of the delivered system for on-line operation.
- G. Adjustments: Provide up to 4 additional site visits during the first year of operation to adjust systems and provide owner instruction as required for seasonal adjustments.

### 3.09 CLEANING

- A. This contractor shall clean up all debris resulting from his or her activities daily. The contractor shall remove all cartons, containers, crates, etc. under his 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 dust, 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 MANUFACTURER'S FIELD SERVICES

- A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.

### 3.12 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate complete and operating system to Owner.
- B. Provide a minimum of 3 classroom training sessions, 8 hours each, throughout the contract period for personnel designated by the Owner. Computer based training may be substituted for up to 24 hours of hands on training.
- C. Train the designated staff of Owner's representative and Owner to enable them to proficiently operate the system; create, modify and delete programming; add, remove and modify physical points for the system; add additional panels when required.
- D. These objectives will be divided into three logical groupings; participants may attend one or more of these, depending on level of knowledge required:
  - 1. Day-to-day Operators
  - 2. System Troubleshooter
  - 3. System Manager: parts
- E. Provide course outline and materials. The instructor(s) shall provide one copy of training material per student.
- F. The instructor(s) shall be factory-trained instructors experienced in presenting this material.
- G. Classroom training shall be done using a network of working controllers representative of the installed hardware or at the customers site.

### 3.13 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.

3.14 ACCEPTANCE

- A. 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. Such tests shall then be performed as part of the warranty.

END OF SECTION

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## SECTION 232113 - HYDRONIC PIPING

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Hydronic system requirements.
- B. Condenser water piping, buried.
- C. Condenser water piping, above grade.
- D. Pipe hangers and supports.
- E. Unions, flanges, mechanical couplings, and dielectric connections.
- F. Valves:

#### 1.02 RELATED REQUIREMENTS

- A. Section 230516 - Expansion Fittings and Loops for HVAC Piping.
- B. Section 230719 - HVAC Piping Insulation.
- C. Section 232500 - HVAC Water Treatment: Pipe cleaning.

#### 1.03 REFERENCE STANDARDS

- A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
- B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
- D. ASME B31.9 - Building Services Piping; 2020.
- A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2023.
- B. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.
- C. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2023a.
- D. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984, with Editorial Revision (2019).
- E. ASTM B32 - Standard Specification for Solder Metal; 2020.

- F. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
- G. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
- H. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets; 2020.
- I. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 2024.
- J. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007 (Reapproved 2024).
- K. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.
- L. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2018.
- M. AWWA C606 - Grooved and Shouldered Joints; 2022.
- N. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).

#### 1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data:
  - 1. Include data on pipe materials, pipe fittings, valves, and accessories.
  - 2. Provide manufacturers catalog information.
  - 3. Indicate valve data and ratings.
  - 4. Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.
- C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- D. Project Record Documents: Record actual locations of valves.
- E. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
- F. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.
  - 3. Failed test results and corrective action taken to achieve requirements.
- G. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable Victaulic style or series number.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.
- B. Provide all grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.
  - 1. All castings used for couplings housings, fittings, or valve and specialty bodies shall be date stamped for quality assurance and traceability.
- C. Coupling Manufacturer:
  - 1. Perform on-site training by factory-trained representative to the Contractor's field personnel in the proper use of grooving tools and installation of grooved joint products.
  - 2. Periodic job site visits by factory-trained representative to ensure best practices in grooved joint installation.
  - 3. A distributor's representative is not considered qualified to perform the training.
- D. Welder Qualifications: Certify in accordance with ASME BPVC-IX.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.07 COORDINATION

- A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate pipe sleeve installations for foundation wall penetrations.
- C. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations.
- D. Coordinate pipe fitting pressure classes with products specified in related Sections.
- E. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 3 Sections.
- F. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in other Divisions.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Grooved Mechanical-Joint Fittings and Couplings:
    - a. Victaulic Company of America.
  2. Calibrated Balancing Valves:
    - a. Flow Design, Inc.
    - b. Gerand Engineering Company.
    - c. Griswold Controls.
    - d. Tour and Andersson,
    - e. Victaulic Company of America.
  3. Grooved End Steel Pipe Expansion Joints:
    - a. Victaulic Company of America.
  4. Flexible-Hose Expansion Joints:
    - a. Metraflex, Inc.
    - b. Flex-Hose Co., Inc.
    - c. Flexicraft Industries.
    - d. Senior Flexonics, Inc.
  5. Hose Kits:
    - a. Metraflex, Inc.
    - b. Flex-Hose Co., Inc.
    - c. Flexicraft Industries.
    - d. Senior Flexonics, Inc.

### 2.02 HYDRONIC SYSTEM REQUIREMENTS

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
- B. Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:
1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
  2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
  3. Grooved mechanical joints may be used in accessible locations only.
    - a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Architect.
    - b. Grooved mechanical connections and joints comply with AWWA C606.
      - 1) Ductile Iron: Comply with ASTM A536, Grade 65-45-12.
    - c. Use rigid joints unless otherwise indicated.
  4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.
- C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.

1. Where grooved joints are used in piping, provide grooved valve/equipment connections if available; if not available, provide flanged ends and grooved flange adapters.
- D. Valves: Provide valves where indicated:
1. Provide drain valves where indicated, and if not indicated, provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch (20 mm) gate valves with cap; pipe to nearest floor drain.
  2. On discharge of pumps, use spring-loaded check valves.
  3. Isolate equipment using butterfly valves with lug end flanges or grooved mechanical couplings.
  4. For throttling, bypass, or manual flow control services, use globe, ball, or butterfly valves.
  5. For shut-off and to isolate parts of systems or vertical risers, use gate, ball, or butterfly valves.
- E. Welding Materials and Procedures: Comply with ASME BPVC-IX.

## 2.03 PIPING MATERIALS

- A. General: Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

## 2.04 STEEL PIPE AND FITTINGS

- A. Steel Pipe Sizes 2 Inches and Smaller: ASTM A53/A53M, Schedule 40, black, Type S (seamless) or Type F (furnace-butt welded), Grade B, plain ends, using one of the following joint types:
1. Threaded Joints: ASME B16.3, malleable iron fittings, Classes 150 and 300.
- B. Steel Pipe Sizes 2.5 Inches and Greater: ASTM A53/A53M, Schedule 40, black, Type E (electric-resistance welded), Grade B, plain ends, using one of the following joint types:
1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
    - a. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.
  2. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
    - a. Grooved Mechanical-Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 53, Type F, E, or S, Grade B factory-fabricated steel; or ASTM A 234, Grade WPB steel fittings with grooves or shoulders designed to accept Victaulic grooved end couplings.
      - 1) 2" through 12"; ASTM A536 Grade 65-45-12 ductile iron with Victaulic Original Grooved System (OGS) grooved ends, stiffening ribs, and alignment indicators, orange coated or hot dipped galvanized as per ASTM A123, working pressure 400-psi (2758-kPa). Victaulic QuickVic™ V10 (90-deg), V11 (45-deg), and V20 (tee).
    - b. Grooved Mechanical-Joint Couplings: Two ductile-iron housings and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking

pin, locking toggle, or lugs to secure grooved pipe and fittings. Comply with ASTM A 536 Grade 65-45-12, 65,000 PSI minimum tensile strength.

- 1) Key section designed to engage fully into the groove tying the joint integrally to the pipe.
  - 2) Gaskets shall be suitable for the temperature and fluid used in the system. Use Grade "EHP" EPDM gaskets with unique sealing design, rated for continuous use at 250 deg F or Grade "E" EPDM gaskets rated for continuous use at 230 deg F unless indicated otherwise.
  - 3) Use rigid "QuickVic" or "Zero-Flex" couplings unless flex couplings are indicated for vibration isolation or to accommodate seismic movement.
  - 4) "Installation Ready" couplings, 2" through 12", shall be designed for direct 'stab' installation onto grooved end pipe without prior field disassembly and no loose parts. Gasket shall be Grade "EHP" EPDM; center-leg gasket with pipe stop to ensure proper groove engagement, alignment, and pipe insertion depth.
    - a) Rigid Type: Housings cast with torque-absorber and shift-limiting slant bolt pad design to provide piping system rigidity and support and hanging in accordance with ANSI B31.1 and B31.9, and to prevent mis-assembly due to overshift. Housings cast with alignment indicator notch for visual proper alignment to adjoining fitting. Victaulic Style 107V QuickVic™.
    - b) Flexible Type, 2" through 8": For use in locations where vibration attenuation and stress relief are required. Victaulic Style 177.
  - 5) Standard coupling design, 10" and 12" sizes, with Grade "E" EPDM gasket. Victaulic Style 77 (flexible).
  - 6) AGS two-piece housing design, 14" through 60", shall fit into a deeper wedge-shaped groove, cast with a wide key profile and flat bolt pads for metal-to-metal contact. Wide-width FlushSeal® gasket (Grade "E" EPDM). Victaulic Style W07 (rigid) or Style W77 (flexible).
3. Flanged Joints:
- a. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced.
  - b. 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.
- C. Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure and 250 deg F maximum operating temperature. Connectors shall have flanged or threaded-end connections to match equipment connected and shall be capable of ¾-inch misalignment.
1. Victaulic Style 177, 77 or W77 flexible couplings may be used in lieu of flexible connectors for vibration isolation at equipment connections on applicable piping systems. Three (3) couplings, for each connector, shall be placed in close proximity to the source of vibration.

- D. Hose Kits: EPDM tube with braided stainless steel outer jacket; brass female pipe swivel, both ends with crimp stainless steel collar; 33 to 180 deg F. range; with fibrous flat washer; 255 psi working pressure at 70 deg F.
- E. Packed, Slip, Expansion Joints: 150-psig minimum working pressure, steel pipe fitting consisting of telescoping body and slip-pipe sections, packing ring, packing, limit rods, flanged ends, and chrome-plated finish on slip-pipe telescoping section.
- F. In Victaulic grooved piping system, expansion and contraction shall be accommodated by installing expansion loops or bends consisting of (8) Victaulic flexible couplings, (4) 90 degree elbows, and (3) grooved end pipe spools provided in water systems up to +230 degrees F in accordance with Victaulic recommendations for expansion compensation.
- G. Install Victaulic Style 150 or Style 155 in-line expansion joints in enclosures where loops or bends cannot be applied.
- H. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.
- I. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

## 2.05 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn, using one of the following joint types:
  - 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
    - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
    - b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
  - 2. Grooved Joints: AWWA C606 grooved tube, fittings of same material, and copper-tube-dimension mechanical couplings.
    - a. Grooved Mechanical-Joint Fittings: ASME B16.22 wrought copper or ASME B16.18 bronze casting with copper tubing sized grooved ends (flaring of tube and fitting ends to IPS dimensions is not permitted). Victaulic Copper Connection.
    - b. Grooved Mechanical-Joint Couplings: "Installation Ready" stab-on design, for direct 'stab' installation onto roll grooved copper tube without prior field disassembly and no loose parts. Housings shall be ductile iron cast with offsetting, angle-pattern bolt pads, coated with copper-colored enamel. Gasket shall be Grade "EHP" EPDM center-leg gasket with pipe stop to ensure proper groove engagement, alignment, and pipe insertion depth, with unique sealing design, suitable for temperatures up to 250 deg F and plated steel bolts and nuts. Victaulic Style 607 QuickVic™.
  - 3. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
  - 4. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.
  - 5. Wrought-Copper Fittings: ASME B16.22.
  - 6. Wrought-Copper Unions: ASME B16.22.

2.06 CHILLED WATER PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black; using one of the following joint types:
  - 1. Threaded Joints: ASME B16.3, malleable iron fittings.
  - 2. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), hard drawn; using one of the following joint types:
  - 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22, solder wrought copper fittings.
    - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
    - b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
  - 2. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.

2.07 CONDENSER WATER PIPING, BURIED

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black with AWWA C105/A21.5 polyethylene jacket, or double layer, half-lapped polyethylene tape.
  - 1. Fittings: ASTM A234/A234M, wrought steel welding type with double layer, half-lapped polyethylene tape.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A) annealed.
  - 1. Fittings: ASME B16.22, wrought copper.
  - 2. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.

2.08 CONDENSER WATER PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black.
  - 1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings with finish matching piping; AWS D1.1/D1.1M welded.
  - 2. Threaded Joints: ASME B16.3, malleable iron fittings with finish matching piping.
  - 3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn; using one of the following joint types:
  - 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.

2.09 EXPANSION FITTINGS AND LOOPS

- A. Flexible-Hose Expansion Joints for Copper Piping: Copper alloy fittings with solder- joint end connections. Flexible loops consist of two sections of flexible hose and braid, two 90 degree elbows and a 180 degree return assembly with center support nut.



1. NPS 2 and Smaller: Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
  2. NPS 2-1/2 to NPS 4: Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.
- B. Flexible-Hose Expansion Joints for Steel Piping: Carbon-steel fittings with threaded end connections for NPS 2 and smaller and grooved or flanged end connections for NPS 2-1/2 and larger. Flexible loops consist of two sections of flexible hose and braid, two 90 degree elbows and a 180 degree return assembly with center support nut.
1. NPS 2 and Smaller: Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
  2. NPS 2-1/2 to NPS 6: Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.
  3. NPS 8 to NPS 12: Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F and 90 psig at 600 deg F ratings.
- C. In Victaulic grooved piping system, expansion and contraction shall be accommodated by installing expansion loops or bends consisting of (8) Victaulic flexible couplings, (4) 90 degree elbows, and (3) grooved end pipe spools provided in water systems up to +250 degrees F in accordance with Victaulic recommendations for expansion compensation.
- D. Install Victaulic Style 150 or Style 155 in-line expansion joints in enclosures where loops or bends cannot be applied.
1. 2" through 6" Sizes: Packless, gasketed, slip-type expansion joint with PPS coated grooved end telescoping body providing up to 3" axial end movement and pressure rating up to 350 psig. Victaulic Style 150 Mover®
  2. 3/4" and Larger: Combination of grooved end short nipples and flexible couplings joined in tandem to provide increased expansion. Expansion capabilities determined by the number of couplings/nipples used in the joint. Pressure rating dependent on size and style of flexible couplings used. Victaulic Style 155.

## 2.10 ALIGNMENT GUIDES

- A. Description: Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Flex-Hose Co., Inc.
    - b. Flexicraft Industries.
    - c. Metraflex, Inc.
    - d. Senior Flexonics, Inc.; Pathway Division.

## 2.11 MATERIALS FOR ANCHORS

- A. Steel Shapes and Plates: ASTM A 36/A 36M.
- B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.
- C. Washers: ASTM F 844, steel, plain, flat washers.

- D. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, and tension and shear capacities appropriate for application.
  - 1. Stud: Threaded, zinc-coated carbon steel.
  - 2. Expansion Plug: Zinc-coated steel.
  - 3. Washer and Nut: Zinc-coated steel.
- E. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application.
  - 1. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
  - 2. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
  - 3. Washer and Nut: Zinc-coated steel.
- F. Concrete: Portland cement mix, 3000 psi minimum. Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.
- G. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink, nonmetallic grout; suitable for interior and exterior applications.
  - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.

## 2.12 PIPE HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with requirements below for maximum spacing of supports.
- B. Provide hangers and supports that comply with MSS SP-58.
  - 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
  - 2. Adjustable steel clevis hangers for individual horizontal piping runs less than 20 feet long.
  - 3. Adjustable roller hangers for individual horizontal piping runs 75 feet or longer.
  - 4. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 75 feet or longer, supported on a trapeze.
  - 5. Constant support hangers for vertical heating supply and return piping extending more than two floors.
  - 6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
  - 1. NPS ¾ and 1: Maximum span, 7 feet; minimum rod size, ¼ inch.
  - 2. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
  - 3. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
  - 4. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
  - 5. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
  - 6. NPS 4: Maximum span, 14 feet; minimum rod size, ½ inch.
  - 7. NPS 6: Maximum span, 17 feet; minimum rod size, ½ inch.

8. NPS 8: Maximum span, 19 feet; minimum rod size, 5/8 inch.
  9. NPS 10: Maximum span, 20 feet; minimum rod size, 3/4 inch.
  10. NPS 12: Maximum span, 23 feet; minimum rod size, 7/8 inch.
- 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 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
  4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
  5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
  6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
- E. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge-shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.
- F. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer have written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
- G. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.
- H. Victaulic Style 107V, 07, and W07 rigid couplings may be used with IPS steel piping systems, which meet the support and hanging requirements of ASME B31.1 and B31.9. An adequate number of Victaulic Style 177, 77, and W77 flexible couplings shall also be used to compensate for thermal expansion/contraction of the pipe.
- 2.13 JOINTS, UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS
- A. Refer to Division 23 Section "Common Work Results for HVAC" for joint construction requirements for soldered and brazed joints in copper tubing; threaded, welded, and flanged joints in steel piping; and solvent-welded joints for PVC and CPVC piping.
- B. Unions for Pipe of 2 Inches (50 mm, DN) and Less:
1. Ferrous Piping: 150 psi (1034 kPa) brass or malleable iron, threaded.
  2. Copper Pipe: Bronze, soldered joints.
- C. Flanges for Pipe 2 Inches (50 mm, DN) and Greater:
1. Ferrous Piping: 150 psig (1034 kPa) forged steel, slip-on.
  2. Copper Piping: Bronze.
  3. Gaskets: 1/16 inch (1.6 mm) thick, preformed neoprene.
- D. Mechanical Couplings for Grooved and Shouldered Joints: Two curved housing segments with continuous key to engage pipe groove, circular C-profile, center-leg, or FlushSeal® gasket, and bolts to secure and compress gasket.
1. Dimensions and Testing: In accordance with AWWA C606.
  2. Mechanical Couplings: Comply with ASTM F1476.
  3. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.

4. When pipe is field grooved, provide coupling manufacturer's grooving tools.
- E. Grooved joint piping systems shall be installed in accordance with the manufacturer's (Victaulic) guidelines and recommendations. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by Victaulic. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. A Victaulic factory-trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Factory-trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

## 2.14 VALVES

- A. Gate, globe, check, ball, and butterfly valves are specified in Division 23 Section "General-Duty Valves for HVAC Piping."
- B. Refer to Part 3 "Valve Applications" Article for applications of each valve.
- C. Calibrated Balancing Valves, NPS 2 and Smaller:
  1. Bronze body, ball type, 125-psig working pressure, 250 deg F maximum operating temperature, and having threaded ends. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.
  2. DZR brass body, y-pattern, globe type, 300 psig working pressure, 230 deg F maximum operating temperature and having soldered or threaded ends. Valve shall have 4-turn digital readout hand wheel and concealed memory feature with locking, tamper-proof setting. Built-in check valve provided for connecting a Series 73M portable differential pressure meter. Victaulic/Tour & Andersson Series 786, 787, or 78K.
    - a. Coil Components: Provide Victaulic Series 799 or 79V Koil-Kit™ consisting of a Series 78U union port fitting, Series 78Y strainer/ball valve or Series 78T union/ball valve combination to reduce space requirements and complete terminal hookup at coil outlet.
- D. Calibrated Balancing Valves, NPS 2-1/2 and Larger:
  1. Cast-iron or steel body, ball type, 125-psig working pressure, 250 deg F maximum operating temperature, and having flanged or grooved connections. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.
  2. Ductile iron body, y-pattern, globe type with Ametal® DZR brass internal components, 300 psig working pressure, 230 deg F maximum operating temperature and having flanged or grooved ends. Valve shall have multiple-turn digital readout hand wheel and concealed memory feature with locking, tamper-proof setting. Built-in check valve provided for connecting a Series 73M portable differential pressure meter. Victaulic/Tour & Andersson Series 788 or 789.
- E. Pressure-Reducing Valves: Diaphragm-operated, bronze or brass body with low inlet pressure check valve, inlet strainer removable without system shutdown, and noncorrosive valve seat and

stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory set at operating pressure and have capability for field adjustment.

1. Basis of Design: Bermad.
- F. Safety Valves: Diaphragm-operated, bronze or brass body with brass and rubber, wetted, internal working parts; shall suit system pressure and heat capacity and shall comply with the ASME Boiler and Pressure Vessel Code, Section IV.
- G. Automatic Flow-Control Valves: Gray-iron body, factory set to maintain constant flow with plus or minus 5 percent over system pressure fluctuations, and equipped with a readout kit including flow meter, probes, hoses, flow charts, and carrying case. Each valve shall have an identification tag attached by chain, and be factory marked with the zone identification, valve number, and flow rate. Valve shall be line size and one of the following designs:
1. Gray-iron or brass body, designed for 175 psig at 200 deg F with stainless-steel piston and spring.
  2. Brass or ferrous-metal body, designed for 300 psig at 250 deg F with corrosion-resistant, tamperproof, self-cleaning, piston-spring assembly easily removable for inspection or replacement.
  3. Combination assemblies, including bronze ball valve, Bronze Y-strainer with 304 SS Screen, brass alloy control valve, with stainless-steel piston and spring 4-57 PSID Range, fitted with pressure and temperature test valves, and stainless steel braided hoses, 24 inches long, EPDM flame retardant EPM inner tube. and designed for 300 psig at 250 deg F.
  4. Basis of Design: Victaulic Series 76.

### PART 3 EXECUTION

#### 3.01 PIPING APPLICATIONS

- A. Hot and Chilled Water, NPS 2 and Smaller: Aboveground, use Type L drawn-temper copper tubing with soldered joints or Schedule 40 steel pipe with threaded joints. Belowground or within slabs, use Type K annealed-temper copper tubing with soldered joints. Use the fewest possible joints belowground and within floor slabs.
- B. Hot and Chilled Water, NPS 2-1/2 and Larger: Schedule 40 steel pipe with welded, flanged, or grooved mechanical-joints.
- C. Condenser Water, NPS 2 and Smaller: Aboveground, use Type L drawn-temper copper tubing with soldered joints or Schedule 40 steel pipe with threaded joints. Below ground or within slabs, use Type K annealed-temper copper tubing with brazed joints.
- D. Condenser Water: NPS 2 ½ and Larger: Schedule 40 steel pipe with welded, flanged, or grooved mechanical-joints.
- E. Condensate Drain Lines: Type L drawn-temper copper tubing with soldered joints or Schedule 40, PVC pipe with solvent-welded joints (PVC not permitted in air plenums, schools or hospitals).

### 3.02 VALVE APPLICATIONS

- A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:
  - 1. Shutoff Duty: Gate, ball, and butterfly valves.
  - 2. Throttling Duty: Globe, ball, and butterfly valves.
- B. Install shutoff duty valves at supply connection to each piece of equipment and elsewhere as indicated.
- C. Install calibrated balancing valves in the return water line of each heating or cooling element and elsewhere as required to facilitate system balancing.
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install safety valves on hot-water generators and elsewhere as required by the ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to floor. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.
- F. Install pressure-reducing valves on hot-water generators and elsewhere as required to regulate system pressure.

### 3.03 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel or groove plain end ferrous pipe.
- B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.
- C. Remove scale and dirt on inside and outside before assembly.
- D. Prepare piping connections to equipment using jointing system specified.
- E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- F. After completion, fill, clean, and treat systems. See Section 232500 for additional requirements.

### 3.04 INSTALLATION

- A. Refer to Division 23 Section "Common Work Results for HVAC" for basic piping installation requirements.
- B. Install in accordance with manufacturer's instructions.
  - 1. Install grooved fittings in strict accordance with the manufacturer's written installation instructions.
- C. Install heating water, glycol, chilled water, condenser water, and engine exhaust piping to ASME B31.9 requirements.
- D. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
- E. Route piping in orderly manner, parallel to building structure, and maintain gradient.

- F. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- G. Install piping to conserve building space and to avoid interference with use of space.
- H. Group piping whenever practical at common elevations.
- I. Sleeve pipe passing through partitions, walls, and floors.
- J. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specif.
- K. Slope piping and arrange to drain at low points.
- L. Install drains, consisting of a tee fitting, NPS  $\frac{3}{4}$  ball valve, and short NPS  $\frac{3}{4}$  threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.
- N. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- O. Anchor piping for proper direction of expansion and contraction.
- P. Grooved Joints:
  - 1. Install in accordance with the manufacturer's latest published installation instructions.
  - 2. Gaskets to be suitable for the intended service, molded, and produced by the coupling manufacturer.
- Q. Inserts:
  - 1. Provide inserts for placement in concrete formwork.
  - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches (100 mm).
  - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
  - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- R. Pipe Hangers and Supports:
  - 1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
  - 2. Support horizontal piping as scheduled.
  - 3. Install hangers to provide minimum 1/2-inch (13 mm) space between finished covering and adjacent work.
  - 4. Place hangers within 12 inches (300 mm) of each horizontal elbow.
  - 5. Use hangers with 1-1/2 inches (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
  - 6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.

- 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
  - 8. Prime coat exposed steel hangers and supports. See Section 09 9123. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
  - S. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
  - T. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 083100 .
  - U. Use eccentric reducers to maintain top of pipe level.
  - V. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds.
  - W. Install valves with stems upright or horizontal, not inverted.
  - X. Bolted mechanical saddle tee branch outlets are prohibited.
- 3.05 terminal equipment connections
- A. Size for supply and return piping connections shall be same as for equipment connections. Where piping is indicated to be larger than connection size, maintain larger pipe size through isolation valves and strainers.
  - B. Install control valves in accessible locations close to connected equipment.
- 3.06 PIPE BEND AND LOOP INSTALLATION
- A. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
  - B. Attach pipe bends and loops to anchors.
  - C. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
    - 1. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.
    - 2. Install flexible loops in accordance with manufacturer's installation instructions.
  - D. For water systems, Victaulic flexible couplings may be used to accommodate thermal growth and contraction, and for the elimination of expansion loops (as approved by the engineer). If loops are required, use flexible couplings on the loop.
- 3.07 SWING CONNECTIONS
- A. Connect risers and branch connections to mains and terminals with at least four pipe fittings, including tee in main.



- B. In Victaulic grooved piping systems, seismic motion shall be accommodated by installing swing joints consisting of flexible couplings, pipe nipples and elbows that provide simultaneous movement in all directions, or other seismic movement compensation devices such as loops, offsets, or Style 155 expansion joints (when an in-line device is required) to provide flexibility to the system and help reduce pipe stresses. Refer to Victaulic design submittal #26.12.

### 3.08 ALIGNMENT-GUIDE INSTALLATION

- A. Install guides on piping adjoining pipe expansion fittings and loops.
- B. Attach guides to pipe and secure to building structure.

### 3.09 ANCHOR INSTALLATION

- A. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.
- C. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.
- D. Install pipe anchors according to expansion-joint manufacturer's written instructions if expansion joints or compensators are indicated.
- E. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

### 3.10 CHEMICAL TREATMENT

- A. Perform an analysis of supply water to determine the type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling.
- B. Fill system and perform initial chemical treatment.

### 3.11 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 system with clean water. Clean strainers.
  - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install 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 trapped air. Use drains installed at low points for complete draining of liquid.
3. Check expansion tanks to determine that they are not air bound and that system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design 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 either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of 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.

### 3.12 ADJUSTING

- A. Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.
- B. Perform these adjustments before operating the system:
  1. Open valves to fully open position. Close coil bypass valves.
  2. Check pump for proper direction of rotation.
  3. Set automatic fill valves for required system pressure.
  4. Check air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
  5. Set temperature controls so all coils are calling for full flow.
  6. Check operation of automatic bypass valves.
  7. Check and set operating temperatures of boilers, chillers, and cooling towers to design requirements.
  8. Lubricate motors and bearings.

### 3.13 CLEANING

- A. Flush hydronic piping systems with clean water. Remove and clean or replace strainer screens. After cleaning and flushing hydronic piping systems, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers.

END OF SECTION

## SECTION 232114 - HYDRONIC SPECIALTIES

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Air vents.
- B. Hydraulic separators.
- C. Strainers.
- D. Bypass Chemical Feeder
- E. Suction diffusers.
- F. Pump connectors.
- G. Combination pump discharge valves.
- H. Balancing valves.
- I. Automatic flow control valves.
- J. Pressure reducing valves.

#### 1.02 RELATED REQUIREMENTS

- A. Section 232113 - Hydronic Piping.

#### 1.03 SUBMITTALS

- A. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model.
- B. Certificates: Inspection certificates for pressure vessels from authority having jurisdiction.
- C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- D. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. See Section 016000 - Product Requirements for additional provisions.
  - 2. Extra Glycol Solution: One container, 1 gallon (4 L) size.

#### 1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

#### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

### PART 2 PRODUCTS

#### 2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Hose Kits:
    - a. Metraflex, Inc.
    - b. Flex-Hose Co., Inc.
    - c. Flexicraft Industries.
    - d. Senior Flexonics, Inc.

#### 2.02 AIR VENTS

- A. Manual Air Vent: Short vertical sections of 1/2-inch (13 mm, DN) diameter pipe to form air chamber, with 1/8 inch (6 mm, DN) brass needle valve at top of chamber. Bronze body and nonferrous internal parts; 150-psig working pressure; 225 deg F operating temperature; manually operated with screwdriver or thumbscrew.
- B. Float Air Vent:
  - 1. 150-psig working pressure; 250 deg F operating temperature; with NPS ¼ discharge connection and NPS ½ inlet connection.
  - 2. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve. Designed to vent automatically with float principle.

#### 2.03 STRAINERS

- A. Size 2 inch (50 mm, DN) and Under:

1. Provide threaded brass or iron body for up to 175 psi (1,200 kPa) working pressure, Y-pattern strainer with bolted cover, 1/32 inch (0.8 mm) stainless steel perforated screen, and bottom drain connection.
  2. Body Material by Fluid Service:
    - a. Cast Iron or Brass:
      - 1) Liquids: Up to 125 psi
- B. Size 2-1/2 inch (65 mm, DN) to 4 inch (100 mm, DN):
1. Provide flanged or grooved iron body for up to 175 psi (1,200 kPa) working pressure, up to 250 degrees F (121.1 degrees C) working temperature, Y-pattern strainer with bolted cover, 3/64 inch (1.2 mm) stainless steel perforated screen, and bottom drain connection.
  2. Body Material by Fluid Service:
    - a. Cast Iron:
      - 1) Liquids: Up to 125 psi.
- C. Size 5 inch (125 mm, DN) and Larger:
1. Provide flanged or grooved iron body for up to 175 psi (1200 kPa) working pressure, basket pattern with bolted, cover, 1/8 inch (3.2 mm) stainless steel perforated screen, and bottom drain connection.
  2. Liquid Fluid Service: Up to 125 psi
- D. Basket-Type, Size 1 to 30 inch (25 to 750 mm, DN) for Liquid Service:
1. Flanged carbon steel body with 1/8 inch (3.2 mm) stainless steel perforated basket screen, flanged-end connections, bolted cover, bottom drain and capped air vent.
  2. Fluid Service: Up to 125 psi.
- E. Grooved-End Y-Pattern Strainers: 300-psig working pressure; ductile-iron body, grooved end connections, NPS 2 through NPS 18, Type 304/304L stainless steel metal removable basket with 0.125" diameter perforations, blow-down port fitted with pipe plug. Victaulic Style 732 and W732.
- 2.04 BYPASS CHEMICAL FEEDER
- A. Bypass Chemical Feeder: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.
1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.
- 2.05 PUMP CONNECTORS
- A. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.
1. Maximum Operating Service: 150 psi (1030 kPa) at 120 degrees F (49 degrees C).
  2. Accommodate the Following:
    - a. Axial Deflection in Compression and Expansion: \_\_\_\_\_ inch (\_\_\_\_\_ mm).
    - b. Lateral Movement: \_\_\_\_\_ inch (\_\_\_\_\_ mm).
    - c. Angular Rotation: 15 degrees.
    - d. Force developed by 1.5 times specified maximum allowable operating pressure.
  3. End Connections: Same as specified for pipe jointing.

4. Provide necessary accessories including, but not limited to, swivel joints.

## 2.06 BALANCING VALVES

### A. Manufacturers:

1. American Wheatley, a company of Global Flow Products, LLC: [www.wheatleyhvac.com/#sle](http://www.wheatleyhvac.com/#sle).
2. Armstrong International, Inc: [www.armstronginternational.com/#sle](http://www.armstronginternational.com/#sle).
3. Bell & Gossett, a brand of Xylem, Inc: [www.bellgossett.com/#sle](http://www.bellgossett.com/#sle).
4. Bell & Gossett, a brand of Xylem, Inc: [www.bellgossett.com/#sle](http://www.bellgossett.com/#sle).
5. FNW: [www.fnw.com/#sle](http://www.fnw.com/#sle).
6. Hays Fluid Controls: [www.haysfluidcontrols.com/#sle](http://www.haysfluidcontrols.com/#sle).
7. Nexus Valve, Inc: [www.nexusvalve.com/#sle](http://www.nexusvalve.com/#sle).
8. Oventrop Corporation; Hydrocontrol F: [www.ventrop.com/#sle](http://www.ventrop.com/#sle).
9. Taco, Inc: [www.taco-hvac.com/#sle](http://www.taco-hvac.com/#sle).

### B. Size 2 inch (50 mm, DN) and Smaller:

1. Provide ball or globe style with flow balancing, shut-off capabilities, memory stops, and minimum of two metering ports and female sweat, NPT threaded, press, or soldered connections.
2. Metal construction materials consist of bronze or brass.
3. Non-metal construction materials consist of Teflon, EPDM, or engineered resin.
4. Maximum Service Operation: 300 psi at 250 degrees F (2,068 kPa at 121.1 degrees C).

### C. Size 2-1/2 inch (65 mm, DN) and Larger:

1. Provide ball, globe, or butterfly style with flow balancing, shut-off capabilities, memory stops, and minimum of two metering ports and flanged, grooved, or weld-end connections.
2. Valve body construction materials consist of cast iron, carbon steel, or ductile iron.
3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, NORYL, or engineered resin.
4. Maximum Service Operation: 175 psi at 250 degrees F (1,200 kPa at 121.1 degrees C).

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Provide manual air vents at system high points, at heat-transfer coils, and elsewhere as required for system air venting.
- C. Install automatic air vents in mechanical equipment rooms only at high points of system piping, at heat-transfer coils, and elsewhere as required for system air venting.
- D. Provide air separator on suction side of system circulation pump and connect to expansion tank.
- E. Install air separators in pump suction lines. Install piping to automatic air vent with a 2 percent upward slope toward air vent. Install drain valve on units NPS 2 and larger.

- F. Provide valved drain and hose connection on strainer blowdown connection.
- G. Provide pump suction fitting on suction side of base-mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.
- H. Support pump fittings with floor-mounted pipe and flange supports.
- I. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.
- J. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- K. Pipe relief valve outlet to nearest floor drain.
- L. Where one line vents several relief valves, make cross-sectional area equal to sum of individual vent areas.
- M. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above floor. Install feeder in bypass line, off main, using globe valves on each side of feeder and ball or butterfly valve in the main between bypass connections. Pipe drain, with ball valve, to nearest equipment drain.
- N. Install bladder type expansion tanks on floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system design requirements.
  - 1. Support tank from floor with sufficient strength to carry weight of tank, piping connections, and fittings, plus weight of a full tank of water. Do not overload building components and structural members.

END OF SECTION

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## SECTION 232123 - HYDRONIC PUMPS

### PART 1 GENERAL

#### 1.01 RELATED DOCUMENTS

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

#### 1.02 DEFINITIONS

- A. ECM: Electronically commutated motor.
- B. EPDM: Ethylene propylene diene monomer.
- C. EPR: Ethylene propylene rubber.
- D. FKM: Fluoroelastomer polymer.
- E. HI: Hydraulic Institute.
- F. NBR: Nitrile rubber or Buna-N.

#### 1.03 SECTION INCLUDES

- A. Close-coupled, in-line centrifugal pumps.
- B. Separately coupled, base-mounted, end-suction centrifugal pumps.
- C. Separately coupled, base-mounted, double-suction centrifugal pumps.
- D. Wet-rotor pumps
- E. Dry-rotor pumps
- F. Automatic condensate pump units
- G. Pump specialty fittings
- H. Integral pump motor variable-speed controllers
- I. Electronically Communicated Motor (ECM)

#### 1.04 REFERENCE STANDARDS

- A. UL 778 - Standard for Motor-Operated Water Pumps; Current Edition, Including All Revisions.

#### 1.05 SUBMITTALS

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

1. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated.
  2. 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.

#### 1.06 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

#### 1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

#### 1.08 MAINTENANCE MATERIAL SUBMITTALS

- A. Maintenance Materials: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. See Section 016000 - Product Requirements, for additional provisions.
  2. Extra Pump Seals: One set for each type and size of pump.

#### 1.09 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacture, assembly, and field performance of pumps, with minimum three years of documented experience.

### PART 2 PRODUCTS

#### 2.01 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

- A. Acceptable Manufacturers:
1. Armstrong Pumps Inc.
  2. Bell & Gossett; Div. of ITT Industries.
  3. Taco, Inc.
- B. Source Limitations: Obtain pumps from single source from single manufacturer.
- C. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-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 or vertically.
- D. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gauge tappings at inlet and outlet and threaded companion-flange connections.
  2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
  3. Pump Shaft Sleeve: Bronze.
  4. Pump Stub Shaft: Type 304 stainless steel.
  5. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and EPR/Carbon/Silicon-Carbide rubber bellows and gasket. Include water slinger on shaft between motor and seal.
  6. Seal Flushing: Flush, cool, and lubricate pump seal by directing pump discharge water to flow over the seal.
- E. Shaft Coupling: Rigid, axially-split spacer coupling to allow service of pump seal without disturbing pump or motor.
- F. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
1. Enclosure : Totally enclosed, fan cooled.
  2. NEMA Premium Efficient motors as defined in NEMA MG 1.
  3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
  4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
  5. Variable-speed motor.
  6. Provide integral pump motor variable-speed controller.
- G. Basis of Design: Bell and Gossett e-90.
- H. Capacities and Characteristics: Refer to Drawings.
- 2.02 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS
- A. Acceptable Manufacturers:
1. Armstrong Pumps Inc.
  2. Bell & Gossett; Div. of ITT Industries.
  3. Taco, Inc.
- B. Source Limitations: Obtain pumps from single source from single manufacturer.
- C. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump with flexible shaft coupling as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.
- D. Pump Construction:
1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gauge tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing, and provide

- attached piping to allow removal and replacement of impeller without disconnecting piping or requiring realignment of pump and motor shaft.
  - 2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps that are not frequency-drive controlled, trim impeller to match specified performance.
  - 3. Pump Shaft: Carbon steel, with copper-alloy shaft sleeve.
  - 4. Seal, Mechanical Type: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and Buna bellows and gasket.
  - 5. Seal, Packing Type: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
  - 6. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.
  - E. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor.
  - F. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
  - G. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A36/A36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
  - H. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
    - 1. Enclosure: Totally enclosed, fan cooled.
    - 2. NEMA Premium Efficient motors as defined in NEMA MG 1.
    - 3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
    - 4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
    - 5. Variable-speed motor.
    - 6. Provide integral pump motor variable-speed controller.
  - I. Basis of Design: Bell and Gossett e-1510.
  - J. Capacities and Characteristics: Refer to Drawings.
- 2.03 PUMP SPECIALTY FITTINGS
- A. Suction Diffuser:
    - 1. Angle pattern.
    - 2. 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting.
    - 3. Bronze 16-mesh wire startup and Type 304 stainless steel permanent strainers with 3/16-inch.
    - 4. Type 304 stainless steel straightening vanes.
    - 5. Drain plug.
    - 6. Factory-fabricated support.

- B. Triple-Duty Valve:
  - 1. Angle or straight pattern.
  - 2. 175-psig pressure rating, cast-iron body, pump-discharge fitting.
  - 3. Valve with multi-turn stem and memory stop to allow valve to be returned to its original position after shutoff.
  - 4. Brass valve disc with EPDM rubber seat.
  - 5. Type 304 stainless steel valve stem.
  - 6. Drain plug and bronze-fitted shutoff, balancing, and check valve features.
  - 7. Brass gauge ports with integral check valve and orifice for flow measurement.

#### 2.04 ELECTRONICALLY COMMUTATED MOTOR (ECM)

- A. Provide pumps so they are specified or scheduled with ECM.
  - 1. Synchronous, constant torque, ECM with permanent magnet rotor. Rotor magnets to be time-stable, nontoxic ceramic magnets (Sr-Fe).
  - 2. Driven by a frequency converter with an integrated power factor correction filter. Conventional induction motors will not be acceptable.
  - 3. Each motor with an integrated variable-frequency drive, tested as one unit by manufacturer.
  - 4. Motor speed adjustable over full range from 0 rpm to maximum scheduled speed.
  - 5. Variable motor speed to be controlled by a 0- to 10 V-dc or 4- to 20-mA input.
  - 6. Integrated motor protection verified by UL to protect the pump against over-/undervoltage, overtemperature of motor and/or electronics, overcurrent, locked rotor, and dry run (no-load condition).

#### 2.05 GENERAL

- A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- B. Minimum Quality Standard: UL 778.
- C. Base Mounted Pumps: Aligned by qualified millwright.
- D. Electrical Requirements:
  - 1. Listed and classified by UL or testing agency acceptable to authority having jurisdiction as suitable for the purpose specified and indicated.

### PART 3 EXECUTION

#### 3.01 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.
- B. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- C. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- D. Examine foundations and inertia bases for suitable conditions where pumps will be installed.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide access space around pumps for periodic maintenance including removing motors, impellers, couplings, and accessories. Provide no less than minimum space recommended by manufacturer.
- C. Comply with HI 1.4 and HI 2.4.
- D. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- E. Equipment Mounting:
  - 1. Install base-mounted pumps on cast-in-place concrete equipment bases with anchor bolts, set and level, and grout in place.
- F. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and elastomeric hangers of size required to support weight of in-line pumps.
  - 1. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- G. Provide drains for bases and seals, piped to and discharging into floor drains.
- H. Check, align, and certify alignment of base-mounted pumps prior to start-up.
- I. Lubricate pumps before start-up.

### 3.03 ALIGNMENT

- A. Perform alignment service. When required by manufacturer to maintain warranty coverage, engage a factory-authorized service representative to perform it.
- B. Comply with requirements in HI standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.
- C. Comply with pump and coupling manufacturers' written instructions.
- D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

### 3.04 PIPING 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, shutoff, and throttling valves on discharge side of pumps.
- E. Install Y-type strainer and suction diffuser and shutoff valve on suction side of pumps.
  - 1. Use startup strainer for initial system startup. Install permanent strainer element before turnover of system to Owner.
- F. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
- G. Install pressure gauges on pump suction and discharge or at integral pressure-gauge tapping, or install single gauge with multiple-input selector valve.

### 3.05 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

### 3.06 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.

### 3.07 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
  - 2. Check piping connections for tightness.
  - 3. Clean strainers on suction piping. Use startup strainer for initial startup.
  - 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 correct direction.
  - 5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
  - 6. Start motor.

7. Open discharge valve slowly.

3.08 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 232500 - HVAC WATER TREATMENT

### PART 1 GENERAL

#### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Refer to Section 236500 "Cooling Towers", for non-chemical treatment systems and related controls.

#### 1.02 DEFINITIONS

- A. EEPROM: Electrically erasable, programmable read-only memory.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- C. TDS: Total dissolved solids.

#### 1.03 SECTION INCLUDES

- A. Bypass chemical-feed equipment and controls.
- B. Biocide chemical-feed equipment and controls.
- C. Chemical treatment test equipment.
- D. HVAC water-treatment chemicals.
- E. Makeup water softeners.
- F. Water filtration units for HVAC makeup water.

#### 1.04 PERFORMANCE REQUIREMENTS

- A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.
- B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
- C. Closed hydronic systems, including **hot-water heating, chilled water, dual-temperature water, condenser loop, and glycol cooling**, shall have the following water qualities:
  - 1. pH: Maintain a value within 9.0 to 10.5.
  - 2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.

3. Boron: Maintain a value within 100 to 200 ppm.
  4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
  5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
  6. TDS: Maintain a maximum value of 10 ppm.
  7. Ammonia: Maintain a maximum value of 20 ppm.
  8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
  9. Microbiological Limits:
    - a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
    - b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
    - c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
    - d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
    - e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.
- D. Steam Boiler and Steam Condensate:
1. Steam Condensate:
    - a. pH: Maintain a value within 7.8 to 8.4.
    - b. Total Alkalinity: Maintain a value within 5 to 50 ppm.
    - c. Chemical Oxygen Demand: Maintain a maximum value of 15 ppm.
    - d. Soluble Copper: Maintain a maximum value of 0.20 ppm.
    - e. TDS: Maintain a maximum value of 10 ppm.
    - f. Ammonia: Maintain a maximum value of 20 ppm.
    - g. Total Hardness: Maintain a maximum value of 2 ppm.
  2. Steam boiler operating at 15 psig and less shall have the following water qualities:
    - a. "OH" Alkalinity: Maintain a value within 200 to 400 ppm.
    - b. TDS: Maintain a value within 600 to 3000 ppm.
  3. Steam boiler operating at more than 15 psig shall have the following water qualities:
    - a. "OH" Alkalinity: 200 to 400 ppm.
    - b. TDS: Maintain a value within 600 to 1200 ppm to maximum 30 times RO water TDS.
- E. Open hydronic systems, including **condenser and fluid-cooler spray water**, shall have the following water qualities:
1. pH: Maintain a value within 8.0 to 9.1.
  2. "P" Alkalinity: Maintain a maximum value of 100 ppm.
  3. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
  4. Soluble Copper: Maintain a maximum value of 0.20 ppm.
  5. TDS: Maintain a maximum value of 10 ppm.
  6. Ammonia: Maintain a maximum value of 20 ppm.
  7. Free "OH" Alkalinity: Maintain a maximum value of 0 ppm
  8. Microbiological Limits:
    - a. Total Aerobic Plate Count: Maintain a maximum value of 10,000 organisms/ml.
    - b. Total Anaerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
    - c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
    - d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
    - e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.
  9. Polymer Testable: Maintain a minimum value within 10 to 40.
- F. Passivation for Galvanized Steel: For the first 60 days of operation.

1. pH: Maintain a value within 7 to 8.
2. Calcium Carbonate Hardness: Maintain a value within 100 to 300 ppm.
3. Calcium Carbonate Alkalinity: Maintain a value within 100 to 300 ppm.

G. By-pass (pot) feeder.

#### 1.05 REFERENCE STANDARDS

A. UL (DIR) - Online Certifications Directory; Current Edition.

#### 1.06 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:
1. Bypass feeders.
  2. Water meters.
  3. Inhibitor injection timers.
  4. pH controllers.
  5. TDS controllers.
  6. Biocide feeder timers.
  7. Chemical solution tanks.
  8. Injection pumps.
  9. Chemical test equipment.
  10. Chemical material safety data sheets.
  11. Water softeners.
  12. Multimedia filters.
  13. Self-cleaning strainers.
  14. Bag- or cartridge-type filters.
  15. Centrifugal separators.
- B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.
1. Wiring Diagrams: Power and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For sensors, injection pumps, water softeners, water filtration units, and controllers to include in emergency, operation, and maintenance manuals.
- E. Other Informational Submittals:
1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.
  2. Water Analysis: Illustrate water quality available at Project site.
  3. Passivation Confirmation Report: Verify passivation of galvanized-steel surfaces, and confirm this observation in a letter to Architect.

- F. Project Record Documents: Record actual locations of equipment and piping, including sampling points and location of chemical injectors.

#### 1.07 QUALITY ASSURANCE

- A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.
- 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.

#### 1.08 MAINTENANCE SERVICE

- A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for ,chilled-water piping, hot-water piping, steam and condensate piping, steam and condensate system for humidifier and cooking appliance applications, and closed loop condenser-water piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, and shall include the following:
  - 1. Initial water analysis and HVAC water-treatment recommendations.
  - 2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
  - 3. Periodic field service and consultation.
  - 4. Customer report charts and log sheets.
  - 5. Laboratory technical analysis.
  - 6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.
- B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum 3 years of experience and approved by manufacturer.

### PART 2 PRODUCTS

#### 2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Ampion Corp.
  - 2. Anderson Chemical Co, Inc.
  - 3. Aqua-Chem, Inc.; Cleaver-Brooks Div.
  - 4. Barclay Chemical Co.; Water Management, Inc.
  - 5. Boland Trane Services
  - 6. Enerco Corporation
  - 7. GE Betz.
  - 8. GE Osmonics.
  - 9. H-O-H Chemicals, Inc.

10. Metro Group, Inc. (The); Metropolitan Refining Div.
11. ONDEO Nalco Company.
12. Watcon, Inc.

## 2.02 MANUAL CHEMICAL-FEED EQUIPMENT

- A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
1. Capacity: 2 gal. or 5 gal. as required for the system.
  2. Minimum Working Pressure: 125 psig.

## 2.03 AUTOMATIC CHEMICAL-FEED EQUIPMENT

- A. Water Meter:
1. AWWA C700, oscillating-piston, magnetic-drive, totalization meter.
  2. Body: Bronze.
  3. Minimum Working-Pressure Rating: 150 psig.
  4. Maximum Pressure Loss at Design Flow: 3 psig.
  5. Registration: Gallons or cubic feet.
  6. End Connections: Threaded.
  7. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac; and that will close at adjustable increments of total flow.
- B. Inhibitor Injection Timers:
1. Microprocessor-based controller with LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door.
  2. Programmable timers with infinite adjustment over full range, and mounted in cabinet with hand-off-auto switches and status lights.
  3. Test switch.
  4. Hand-off-auto switch for chemical pump.
  5. Illuminated legend to indicate feed when pump is activated.
  6. Programmable lockout timer with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.
  7. LCD makeup totalizer to measure amount of makeup and bleed-off water from two water meter inputs.
- C. pH Controller:
1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 14 units. Incorporate solid-state integrated circuits and digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door.
  2. Digital display and touch pad for input.
  3. Sensor probe adaptable to sample stream manifold.
  4. High, low, and normal pH indication.
  5. High or low pH alarm light, trip points field adjustable; with silence switch.
  6. Hand-off-auto switch for acid pump.
  7. Internal adjustable hysteresis or deadband.

- D. TDS Controller:
1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 5000 micromhos. Incorporate solid-state integrated circuits and digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door.
  2. Digital display and touch pad for input.
  3. Sensor probe adaptable to sample stream manifold.
  4. High, low, and normal conductance indication.
  5. High or low conductance alarm light, trip points field adjustable; with silence switch.
  6. Hand-off-auto switch for solenoid bleed-off valve.
  7. Bleed-off valve activated indication.
  8. Internal adjustable hysteresis or deadband.
  9. Bleed Valves:
    - a. Cooling Systems: Forged-brass body, globe pattern, general-purpose solenoid with continuous-duty coil, or motorized valve.
    - b. Steam Boilers: Motorized ball valve, steel body, and TFE seats and seals.
- E. Biocide Feeder Timer:
1. Microprocessor-based controller with digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door.
  2. 24-hour timer with 14-day skip feature to permit activation any hour of day.
  3. Precision, solid-state, bleed-off lockout timer and clock-controlled biocide pump timer. Prebleed and bleed lockout timers.
  4. Solid-state alternator to enable use of two different formulations.
  5. 24-hour display of time of day.
  6. 14-day display of day of week.
  7. Battery backup so clock is not disturbed by power outages.
  8. Hand-off-auto switches for biocide pumps.
  9. Biocide A and Biocide B pump running indication.
- F. Chemical Solution Tanks:
1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
  2. Molded cover with recess for mounting pump.
  3. Capacity: 30 gal., 50 gal., 120 gal., or as required.
- G. Chemical Solution Injection Pumps:
1. Self-priming, positive-displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
  2. Adjustable flow rate.
  3. Metal and thermoplastic construction.
  4. Built-in relief valve.
  5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- H. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.
- I. Injection Assembly:

1. Quill: Minimum NPS 1/2 with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
2. Ball Valve: Two-piece, stainless steel as described in "Stainless-Steel Pipes and Fittings" Article below; and selected to fit quill.
3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
4. Assembly Pressure/Temperature Rating: Minimum 600 psig at 200 deg F.

#### 2.04 STAINLESS-STEEL PIPES AND FITTINGS

- A. Stainless-Steel Tubing: Comply with ASTM A 269, Type 316.
- B. Stainless-Steel Fittings: Complying with ASTM A 815/A 815M, Type 316, Grade WP-S.
- C. Two-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, carbon-filled TFE seats, threaded body design with adjustable stem packing, threaded ends, and 250-psig SWP and 600-psig CWP ratings.
- D. Three-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, threaded body design with adjustable stem packing, threaded ends, and 150-psig SWP and 600-psig CWP rating.

#### 2.05 CHEMICAL TREATMENT TEST EQUIPMENT

- A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing pH, TDS, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure boilers, and oxidizing biocide test for open cooling systems.
- B. Sample Cooler:
  1. Tube: Sample.
    - a. Size: NPS 1/4 tubing.
    - b. Material: ASTM A 666, Type 316 stainless steel.
    - c. Pressure Rating: Minimum 2000 psig.
    - d. Temperature Rating: Minimum 850 deg F.
  2. Shell: Cooling water.
    - a. Material: ASTM A 666, Type 304 stainless steel.
    - b. Pressure Rating: Minimum 250 psig.
    - c. Temperature Rating: Minimum 450 deg F.
  3. Capacities and Characteristics:
    - a. Tube: Sample.
      - 1) Flow Rate: 0.25 gpm.
      - 2) Entering Temperature: 400 deg F.
      - 3) Leaving Temperature: 88 deg F.
      - 4) Pressure Loss: 6.5 psig.
    - b. Shell: Cooling water.
      - 1) Flow Rate: 3 gpm.
      - 2) Entering Temperature: 70 deg F.
      - 3) Pressure Loss: 1.0 psig.

- C. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.
  - 1. Two-station rack for closed-loop systems.
  - 2. Four-station rack for open systems.

## 2.06 CHEMICALS

- A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 "Performance Requirements" Article.
- B. Water Softener Chemicals:
  - 1. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock. Resin exchange capacity minimum 30,000 grains/cu. ft. of calcium carbonate of resin when regenerated with 15 lb of salt.
  - 2. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are not acceptable.

## 2.07 HVAC MAKEUP WATER SOFTENER

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Alamo Water Treatment; Ecodyne Water Treatment, Inc.
  - 2. Columbia Water Conditioning Systems, Inc.
  - 3. CSI; a division of Chandler Systems, Inc.
  - 4. Culligan International.
  - 5. CUNO Incorporated.
  - 6. Diamond Water Conditioning.
  - 7. Diamond Water Systems, Inc.
  - 8. Environmental Dynamics Corporation.
  - 9. Hungerford & Terry, Inc.
  - 10. Kinetico Incorporated.
  - 11. Marlo Incorporated.
  - 12. Parker Boiler Company.
  - 13. Plymouth Products, Inc.
  - 14. Rainsoft Div.; Aquion Partners L. P.
  - 15. Water King.
- B. Description: Twin mineral tanks and one brine tank, factory mounted on skid.
- C. Fabricate supports and attachments to tanks with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure as recommended in writing by manufacturer.
- D. Mineral Tanks:
  - 1. Fabricate and label steel filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.



2. Fabricate and label FRP filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, if indicated.
  3. Pressure Rating: 125 psig minimum.
  4. Wetted Components: Suitable for water temperatures from 40 to at least 100 deg F.
  5. Freeboard: 50 percent, minimum, for backwash expansion above the normal resin bed level.
  6. Support Legs or Skirt: Constructed of structural steel, welded or bonded to tank before testing and labeling.
  7. Finish: Hot-dip galvanized on exterior and interior of tank after fabrication.
  8. Upper Distribution System: Single-point type, fabricated from galvanized-steel pipe and fittings.
  9. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from PVC pipe and fittings with individual, fine-slotted, nonclogging PE strainers; arranged for even-flow distribution through resin bed.
- E. Controls: Automatic; factory mounted on mineral tanks and factory wired.
1. Adjustable duration of regeneration steps.
  2. Push-button start and complete manual operation override.
  3. Pointer on pilot-control valve shall indicate cycle of operation.
  4. Means of manual operation of pilot-control valve if power fails.
  5. Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:
    - a. Slow opening and closing, nonslam operation.
    - b. Diaphragm guiding on full perimeter from fully open to fully closed.
    - c. Isolated dissimilar metals within valve.
    - d. Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
    - e. Float-operated brine valve to automatically measure the correct amount of brine to the softener and refill with fresh water.
    - f. Sampling cocks for soft water.
  6. Flow Control: Automatic control of backwash and flush rates over variations in operating pressures that do not require field adjustments. Equip mineral tanks with automatic-reset-head water meter that electrically activates cycle controller to initiate regeneration at preset total in gallons, and automatically resets after regeneration to preset total in gallons for next service run. Include alternator to regenerate one mineral tank with the other in service.
- F. Brine Tank: Combination measuring and wet-salt storing system.
1. Tank and Cover Material: Fiberglass a minimum of 3/16 inch thick; or molded PE a minimum of 3/8 inch thick.
  2. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.
  3. Size: Large enough for at least four regenerations at full salting.
- G. Factory-Installed Accessories:
1. Piping, valves, tubing, and drains.
  2. Sampling cocks.
  3. Main-operating-valve position indicators.
  4. Water meters.

- H. Water Test Kit: Include water test kit in wall-mounting enclosure for water softener.
- I. Capacities and Characteristics:
  - 1. Refer to drawings.

## 2.08 FILTRATION EQUIPMENT

- A. Multimedia Filters:
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Diamond Water Systems, Inc.
    - b. Everfilt.
    - c. LAKOS; a div. of Claude Laval Corporation.
    - d. Miami Filter LLC.
    - e. PEP Filters, Inc.
    - f. Puroflux Corporation.
    - g. United Industries, Inc.
  - 2. Description: Factory-fabricated and -tested, simplex, multimedia filter system of filter tank, media, strainer, circulating pump, piping, and controls for removing particles from water.
    - a. Filter Tank: Corrosion resistant with distribution system and media.
      - 1) Fabricate and label steel filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
      - 2) Fabricate and label FRP filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, if indicated.
      - 3) Pipe Connections NPS 2 and Smaller: Threaded according to ASME B1.20.1.
      - 4) Steel Tank Pipe Connections NPS 2-1/2 and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606.
      - 5) FRP Tank Pipe Connections NPS 2-1/2 and Larger: Type A, integral; Designation E, **125-psig or F, 150-psig pressure** category flanges of grade same as tank material according to ASTM D 5421.
    - b. Motorized Valves: Flanged or grooved-end, ductile-iron butterfly type with EPDM valve seat and stem seal; with ASTM B 148 aluminum bronze disc.
    - c. Strainer: Basket type mounted on pump suction.
    - d. Piping: ASTM A 53/A 53M, Type S, F, or E; Grade B, Schedule 40 black steel, with flanged, grooved, or threaded joints and malleable, steel welding, or ductile-iron fittings.
    - e. Piping: ASTM B 88, Type L copper water tube, copper-alloy solder-joint fittings, and brazed, flanged, or grooved joints.
    - f. Safety Valves: Automatic pressure relief.
    - g. Circulating Pump: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and with HI 1.1-1.2 and HI 1.3.
      - 1) Casing: Radially split, cast iron.
      - 2) Pressure Rating: 125 psig minimum.
      - 3) Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.

- 4) Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
      - 5) Seal: Mechanical.
      - 6) Motor: ODP motor supported on the pump-bearing frame. General requirements for motors are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
    - h. Controls: Automatic control of circulating pump and tank backwash; factory wired for single electrical connection.
      - 1) Panel: NEMA 250, Type 4 enclosure with time clock and pressure gages.
      - 2) Pump: Automatic and manual switching; manual switch position bypasses safeties and controls.
      - 3) Backwash: Automatic; with time clock and differential pressure switch.
      - 4) Backwash Valve: Tank mounted with valves interlocked to single actuator.
    - i. Support: Skid mounting.
  3. Capacities and Characteristics: As scheduled on the drawings.
- B. Bag-Type Filters:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Cycron Corporation.
    - b. Eden Equipment Company.
    - c. Filter Specialists, Inc.
    - d. Filtration Systems; division of Mechanical Mfg. Corporation.
    - e. Hayward Industrial Products, Inc.
    - f. Krystal Klear Filtration; a div. of Geyer's Mfr. & Design, Inc.
    - g. Parker Hannifin Corp.; Process Filtration Div.
    - h. PEP Filters, Inc.
    - i. Plymouth Products, Inc.
    - j. RainSoft Div.; Aquion Partners L. P.
    - k. Rosedale Products, Inc.
    - l. RPA Process Technologies.
    - m. Shelco Filters; division of Tinny Corp.
    - n. USFilter.
  2. Description: Floor-mounting housing with filter bags for removing particles from water.
    - a. Housing: Corrosion resistant; designed to separate inlet from outlet and to direct inlet through bag-type water filter; with bag support and base, feet, or skirt.
      - 1) Pipe Connections NPS 2 and Smaller: Threaded according to ASME B1.20.1.
      - 2) Steel Housing Pipe Connections NPS 2-1/2 and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606.
      - 3) Plastic Housing Pipe Connections NPS 2-1/2 and Larger: 150-psig plastic flanges.
    - b. Bag: Replaceable; of shape to fit housing.
  3. Capacities and Characteristics: As indicated on the drawings.
- C. Centrifugal Separators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Alamo Water Treatment; Ecodyne Water Treatment, Inc.
  - b. Culligan International.
  - c. Griswold Controls.
  - d. LAKOS; a div. of Claude Laval Corporation.
  - e. PEP Filters, Inc.
  - f. Puroflux Corporation.
  - g. Rosedale Products, Inc.
  - h. USFilter.
2. Description: Simplex separator housing with baffles and chambers for removing particles from water by centrifugal action and gravity.
3. Housing: With manufacturer's proprietary system of baffles and chambers.
  - a. Construction: Fabricate and label steel separator housing to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
  - b. Inlet: Designed with tangential entry to produce centrifugal flow of feedwater.
  - c. Vortex Chamber: Designed for downward vortex flow and gravity separation of particles.
  - d. Collection Chamber: Designed to hold separated particles.
  - e. Outlet: Near top of unit.
  - f. Purge: At bottom of collection chamber.
  - g. Pipe Connections NPS 2 and Smaller: Threaded according to ASME B1.20.1.
  - h. Pipe Connections NPS 2-1/2 and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606. Provide stainless-steel flanges if tank is stainless steel.
4. Motorized Purge Valve: Gate or plug pattern valve.
  - a. Motorized Valves: Butterfly-type, flanged or grooved-end, ductile-iron body, with EPDM valve seat and stem seal; with ASTM B 148 aluminum bronze disc.
5. Strainer: Stainless-steel basket type mounted on pump suction.
6. Piping: ASTM A 53/A 53M, Type S, F, or E; Grade B, Schedule 40 black steel, with flanged, grooved, or threaded joints and malleable, steel welding, or ductile-iron fittings.
7. Piping: ASTM B 88, Type L copper water tube, copper-alloy solder-joint fittings, and brazed, flanged, or grooved joints.
8. Circulating Pump: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and with HI 1.1-1.2 and HI 1.3.
  - a. Casing: Radially split, cast iron.
  - b. Pressure Rating: 125 psig minimum.
  - c. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
  - d. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
  - e. Seal: Mechanical.
  - f. Motor: ODP motor supported on the pump-bearing frame. General requirements for motors are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
9. Controls: Automatic control of circulating pump and separator purge; factory wired for single electrical connection.
  - a. Panel: NEMA 250, Type 4 enclosure.
  - b. Pump: Automatic and manual switching; manual switch position bypasses safeties and controls.

- c. Separator Purge: Automatic and manual.
- d. TDS Controller Interlock: Open separator purge valve with bleed-off control.
- 10. Support: Skid mounting.
- 11. Capacities and Characteristics: As indicated on the drawings.

## 2.09 REGULATORY REQUIREMENTS

- A. Comply with applicable codes for addition of non-potable chemicals to building mechanical systems and to public sewage systems.
- B. Comply with UL (DIR) requirements.
- C. Perform work in accordance with local health department regulations.
- D. Provide certificate of compliance from Authority Having Jurisdiction indicating approval of installation.

## 2.10 BY-PASS (POT) FEEDER

- A. Manufacturers:
- B. 2 quart (1.9 L) quick opening cap for working pressure of 175 psi (1200 kPa).

## PART 3 EXECUTION

### 3.01 PREPARATION

- A. Water Analysis
  - 1. Perform an analysis of supply water to determine quality of water available at Project site
- B. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
- C. Place terminal control valves in open position during cleaning.
- D. Verify that electric power is available and of the correct characteristics.

### 3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.
- C. Install water testing equipment on wall near water chemical application equipment.
- D. Install interconnecting control wiring for chemical treatment controls and sensors.
- E. Mount sensors and injectors in piping circuits.

- F. Bypass Feeders: Install in closed hydronic systems, including **hot-water heating, chilled water, dual-temperature water, closed-loop condenser, and glycol cooling**, and equipped with the following:
1. Install bypass feeder in a bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
  2. Install water meter in makeup water supply.
  3. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
  4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
- G. Install automatic chemical-feed equipment for steam boiler and steam condensate systems and include the following:
1. Install makeup water softener.
  2. Install water meter in makeup water supply.
  3. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.
    - a. Pumps shall operate for timed interval when contacts close at water meter in makeup water supply connection. Injection pump shall discharge into boiler feedwater tank or feedwater supply connection at boiler.
  4. Install test equipment and furnish test-kit to Owner.
  5. Install RO unit for makeup water.
  6. Install TDS controller with sensor and bleed valves.
    - a. Bleed valves shall cycle to maintain maximum TDS concentration.
  7. Install inhibitor injection timer with injection pumps and solution tanks.
    - a. Pumps shall operate for timed interval on contact closure at water meter in makeup water supply connection. Injection pump shall discharge into main steam supply header.
- H. Install automatic chemical-feed equipment for condenser and fluid-cooler spray water and include the following:
1. Install makeup water softener.
  2. Install water meter in makeup water supply.
  3. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.
    - a. Pumps shall operate for timed interval on contact closure at water meter in makeup water supply connection. Injection pump shall discharge into boiler feedwater tank or feedwater supply connection at boiler.
  4. Install test equipment and provide test-kit to Owner. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
  5. Install TDS controller with sensor and bleed valves.
    - a. Bleed valves shall cycle to maintain maximum TDS concentration.
  6. Install pH sensor and controller with injection pumps and solution tanks.
    - a. Injector pumps shall operate to maintain required pH.
  7. Install biocide feeder alternating timer with two sets of injection pumps and solution tanks.
    - a. Injection pumps shall operate to feed biocide on an alternating basis.
  8. Install ozone generator with diffusers in condenser-water piping.

- a. Ozone generator shall operate continuously with condenser-water flow.
- 9. Install UV-irradiation lamps in condenser-water piping.
  - a. UV lights shall operate continuously with condenser-water flow.

### 3.03 WATER SOFTENER INSTALLATION

- A. Install water softener equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.
- B. Install brine lines and fittings furnished by equipment manufacturer but not factory installed.
- C. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.
- D. Install water-testing sets on wall adjacent to water softeners.

### 3.04 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Division 23 Section "Common Work Results for HVAC."
- D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Division 23 Section "General-Duty Valves for HVAC Piping."
- E. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers required in makeup water connections to potable-water systems.
- F. Confirm applicable electrical requirements in Division 26 Sections for connecting electrical equipment.
- G. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- H. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### 3.05 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
  2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
  3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
  4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
  5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
  7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
  8. Repair leaks and defects with new materials and retest piping until no leaks exist.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare test report advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article for each required characteristic. Sample boiler water at four-week intervals following the testing noted above to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section.
- F. At four-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article.
- G. Comply with ASTM D 3370 and with the following standards:
1. Silica: ASTM D 859.
  2. Steam System: ASTM D 1066.
  3. Acidity and Alkalinity: ASTM D 1067.
  4. Iron: ASTM D 1068.
  5. Water Hardness: ASTM D 1126.

### 3.06 DEMONSTRATION



- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment. Refer to Division 01 Section "Demonstration and Training."
- B. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment.

3.07 CLOSED SYSTEM TREATMENT

- A. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.
- B. Introduce closed system treatment through bypass feeder when required or indicated by test.

3.08 CLOSEOUT ACTIVITIES

- A. Training: Train Owner's personnel on operation and maintenance of chemical treatment system.
  - 1. Provide minimum of two hours of instruction for two people.
  - 2. Have operation and maintenance data prepared and available for review during training.
  - 3. Conduct training using actual equipment after treated system has been put into full operation.

END OF SECTION

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## SECTION 233100 - HVAC DUCTS AND CASINGS

### PART 1 GENERAL

#### 1.01 related documents

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

#### 1.02 SECTION INCLUDES

- A. This Section includes metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2- to plus 10-inch wg. Metal ducts include the following:
  - 1. Rectangular ducts and fittings.
  - 2. Single-wall, round, and flat-oval spiral-seam ducts and formed fittings.
  - 3. Double-wall, round, and flat-oval spiral-seam ducts and formed fittings.
  - 4. Duct liner.

#### 1.03 RELATED REQUIREMENTS

- A. Section 233300 - Air Duct Accessories.

#### 1.04 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- B. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2024.

#### 1.05 System description

- A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Engineer. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.
- B. Drawings are diagrammatical and shall not be used as a shop drawing for fabrication. The contractor is responsible to coordinate with other trades and adjustments in elevation and routings as required to meet the project requirements.

#### 1.06 Submittals

- A. Shop Drawings: CAD-generated and drawn to 1/4 inch equals 1 foot (1:50) scale. Show fabrication and installation details for metal ducts.

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Duct layout indicating sizes and pressure classes.
3. Elevations of top and bottom of ducts.
4. Dimensions of main duct runs from building grid lines.
5. Fittings.
6. Reinforcement and spacing.
7. Seam and joint construction.
8. Penetrations through fire-rated and other partitions.
9. Equipment installation based on equipment being used on Project.
10. Duct accessories, including access doors and panels.
11. Hangers and supports, including methods for duct and building attachment and vibration isolation.

B. Field quality-control test reports.

C. Product Data: Provide data for duct materials.

D. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

#### 1.07 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," for hangers and supports.

B. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

C. Comply with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations," Ch. 3, "Duct System," for range hood ducts, and the Michigan Department of Public Health Manual of Ventilation Systems for Food Service Establishments.

#### 1.08 COORDINATION

A. The contractor is responsible for coordination with other trades and maintaining required clearances for access and servicing of equipment.

#### 1.09 FIELD CONDITIONS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures within acceptable range during and after installation of duct sealants.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

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

### 2.02 SHEET METAL MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 (Z275) coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. paPVC-Coated Galvanized Steel: Acceptable by authorities having jurisdiction for use in fabricating ducts with UL 181, Class 1 listing. Lock-forming-quality, galvanized sheet steel complying with ASTM A 653/A 653M and having G60 (Z180) coating designation. Factory-applied PVC coatings shall be 4 mils thick on sheet metal surfaces of ducts and fittings exposed to corrosive conditions and 2 mils thick on opposite surfaces.
- D. Carbon-Steel Sheets: ASTM A 366/A 366M, cold-rolled sheets; commercial quality; with oiled, matte finish for exposed ducts.
- E. Stainless Steel: ASTM A 480/A 480M, Type 316, and having a No. 2D finish for concealed ducts and for exposed ducts.
- F. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- G. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
- H. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

### 2.03 RECTANGULAR FITTING CONSTRUCTION

- A. General: Construct fittings in accordance with SMACNA HVAC Duct Construction Standards. Use low loss fittings.
- B. Elbows: Use full radius type with inside radius equal to the duct width except where space limits use. Where square elbows are shown or used, provide turning vanes. Use airfoil type vanes where duct velocities exceed 2000 fpm.

- C. Transitions: Construct transitions between duct sizes with tapered fittings. Use 22.5-degree maximum angle per side for diverging transitions and 30-degree maximum angle for converging transitions.
- D. Divided Flow Fittings: Use full radiused tees, square tees with turning vanes, or enlarged branch connections with 45-degree entry equal to  $\frac{1}{4}$  times the duct width. Round branch ducts to rectangular ducts may be conical or enlarged rectangular to round fittings with 45 degree enlarged entry. Round taps serving individual diffusers may be straight taps where branch duct velocities are less than 800 fpm.

## 2.04 DUCT LINER

- A. Fibrous-Glass Liner: Comply with NFPA 90A or NFPA 90B and with NAIMA AH124.
  - 1. Manufacturers:
    - a. CertainTeed Corp.; Insulation Group.
    - b. Johns Manville International, Inc.
    - c. Knauf Fiber Glass GmbH.
    - d. Owens Corning.
  - 2. Materials: ASTM C 1071; surfaces exposed to airstream shall be coated to prevent erosion of glass fibers.
    - a. Thickness: 1 inch unless otherwise indicated.
    - b. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
    - c. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
    - d. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
    - e. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.
  - 3. Tensile Strength: Indefinitely sustain a 50-lb- tensile, dead-load test perpendicular to duct wall.
  - 4. Fastener Pin Length: As required for thickness of insulation and without projecting more than  $\frac{1}{8}$  inch into airstream.
  - 5. Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.

## 2.05 SEALANT MATERIALS

- A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.
- B. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.
- C. Solvent-Based Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75 percent solids.
- D. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

- E. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

## 2.06 HANGERS AND SUPPORTS

- A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  - 1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
  - 2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
  - 1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
  - 2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
  - 3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.
- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.
  - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
  - 2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
  - 3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

## 2.07 RECTANGULAR DUCT FABRICATION

- A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
  - 1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
  - 2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.
  - 1. Manufacturers:
    - a. Ductmate Industries, Inc.
    - b. Nexus Inc.
    - c. Ward Industries, Inc.
- C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.

1. Manufacturers:
    - a. Ductmate Industries, Inc.
    - b. Lockformer.
  2. Duct Size: Maximum 30 inches wide and up to 2-inch wg pressure class.
  3. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.
- D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.

## 2.08 APPLICATION OF LINER IN RECTANGULAR DUCTS

- A. Use 1-inch thick liner on supply and return air ducts for a minimum distance of 10 ft from all air handling equipment or distance as noted on the plans. Increase the duct dimension as required to provide the internal clear dimensions shown on the drawings.
- B. Do not apply liner in supply, return, or exhaust ductwork serving Natatoriums.
- C. Outpatient and Hospitals (ASHRAE 170): Duct Lining shall not be used in ductwork located downstream of Filter Bank No 2, Duct lining with an impervious cover may be allowed in terminal units, sound attenuators, and air distribution devices downstream of Filter Bank No. 2. This lining and cover shall be factory installed.
- D. Outpatient and Hospitals (ASHRAE 170): Duct lining shall not be installed within 15 ft downstream of humidifiers
- E. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
- F. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
- G. Butt transverse joints without gaps and coat joint with adhesive.
- H. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
- I. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.
- J. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
- K. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
- L. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
  1. Fan discharges.
  2. Intervals of lined duct preceding unlined duct.



3. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm or where indicated.
- M. Where indicated on the drawings, secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
1. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
  2. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

## 2.09 ROUND AND FLAT-OVAL DUCT AND FITTING FABRICATION

- A. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.
- B. Round, Longitudinal- and Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- C. Flat-Oval, Spiral Lock-Seam Ducts: Fabricate supply ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible." Fabricate ducts larger than 72 inches in diameter with butt-welded longitudinal seams.
1. Manufacturers:
    - a. McGill AirFlow Corporation.
    - b. SEMCO Incorporated.
    - c. Dixie Sheet Metal Products.
    - d. Foremost.
    - e. Lindab.
- D. Duct Joints:
1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
  2. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
  3. Ducts Larger Than 72 Inches in Diameter: Companion angle flanged joints per SMACNA "HVAC Duct Construction Standards--Metal and Flexible," Figure 3-2.
  4. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.
    - a. Manufacturers:
      - 1) Lindab Inc.
  5. Flat-Oval Ducts: Prefabricated connection system consisting of two flanges and one synthetic rubber gasket.
    - a. Manufacturers:
      - 1) Ductmate Industries, Inc.
      - 2) McGill AirFlow Corporation.
      - 3) SEMCO Incorporated.

- E. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.
- F. Diverging-Flow Fittings: Fabricate with reducing entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.
- G. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:
  - 1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
  - 2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg:
    - a. Ducts 3 to 36 Inches in Diameter: 0.034 inch.
    - b. Ducts 37 to 50 Inches in Diameter: 0.040 inch.
    - c. Ducts 52 to 60 Inches in Diameter: 0.052 inch.
    - d. Ducts 62 to 84 Inches in Diameter: 0.064 inch.
  - 3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg:
    - a. Ducts 3 to 26 Inches in Diameter: 0.034 inch.
    - b. Ducts 27 to 50 Inches in Diameter: 0.040 inch.
    - c. Ducts 52 to 60 Inches in Diameter: 0.052 inch.
    - d. Ducts 62 to 84 Inches in Diameter: 0.064 inch.
  - 4. Flat-Oval Mitered Elbows: Welded construction with same metal thickness as longitudinal-seam flat-oval duct.
  - 5. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.
  - 6. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
  - 7. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
  - 8. Round Elbows Larger Than 14 Inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.
  - 9. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick with 2-piece welded construction.
  - 10. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.
  - 11. Flat-Oval Elbow Metal Thickness: Same as longitudinal-seam flat-oval duct specified above.
  - 12. Pleated Elbows for Sizes through 14 Inches in Diameter and Pressures through 10-Inch wg: 0.022 inch.

## PART 3 EXECUTION

### 3.01 DUCT APPLICATIONS

- A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:
  - 1. Supply Ducts: 2-inch wg.
  - 2. Supply Ducts (before Air Terminal Units): 6-inch wg.
  - 3. Supply Ducts (after Air Terminal Units): 1-inch wg.
  - 4. Exhaust Ducts (Negative Pressure): 2-inch wg.
- B. All ducts shall be galvanized steel except as follows:
  - 1. All indoor supply, return, and exhaust air ductwork serving Natatoriums: Aluminum construction.
  - 2. Range Hood Exhaust Ducts: Comply with NFPA 96.
    - a. Concealed: Carbon-steel sheet.
    - b. Exposed: Type 304, stainless steel with finish to match kitchen equipment and range hood.
    - c. Weld and flange seams and joints.
  - 3. Dishwasher Hood Exhaust Ducts:
    - a. Type 304, stainless steel with finish to match kitchen equipment and range hood. Weld and flange seams and joints.
    - b. Aluminum, with seams and laps arranged on top of duct.
  - 4. Acid-Resistant (Fume-Handling) Ducts: PVC-coated galvanized steel with thicker coating on duct interior.
  - 5. Underground Ducts: PVC-coated galvanized steel with thicker coating on duct exterior.

### 3.02 INSTALLATION

- A. Install round and flat-oval ducts in lengths not less than 12 feet unless interrupted by fittings.
- B. Install ducts with fewest possible joints.
- C. Install fabricated fittings for changes in directions, size, and shape and for connections.
- D. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.
- E. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
  - 1. Offsets and transitions as required to coordinate with other trades and equipment are the responsibility of the contractor.
- G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- H. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

- I. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.
  - 1. Where ducts pass over light fixtures, maintain a minimum elevation of 6-inches above finish ceiling, or more as required by the light fixtures.
- J. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
- K. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- L. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches. Provide sheet metal flanges on both sides of walls, exposed or concealed for sound sensitive walls.
- M. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 7 Section "Through-Penetration Firestop Systems."
- N. Paint interiors of metal ducts, that do not have duct liner, for 24 inches upstream of registers and grilles where line of sight permits view of ducts. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 9 painting Sections.
- O. Connections to existing equipment: Duct connections to equipment shall be full size to match the specific equipment used.
  - 1. Provide tapered transitions to equipment.
  - 2. Adjust ductwork configuration to match equipment used on project.
- P. Install products following the manufacturer's instructions.
- Q. Comply with safety standards NFPA 90A and NFPA 90B.
- R. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering the ductwork system.
- S. Protect duct interiors from the elements and foreign materials until building is enclosed.
- T. Duct sizes indicated are precise inside dimensions. For lined ducts, maintain sizes inside lining.
- U. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

### 3.03 SEAM AND JOINT SEALING

- A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.
  - 1. For pressure classes lower than 2-inch wg, seal transverse joints.

- B. Seal ducts before external insulation is applied.

### 3.04 HANGING AND SUPPORTING

- A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
- B. Support vertical ducts at maximum intervals of 16 feet and at each floor.
- C. Install concrete inserts before placing concrete.
- D. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  - 1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

### 3.05 CONNECTIONS

- A. Make connections to equipment with flexible connectors according to Division 23 Section "Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

### 3.06 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:
  - 1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
  - 2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
  - 3. Determine leakage from entire system or section of system by relating leakage to surface area of test section.
    - a. Allowable Leakage, Supply Duct Systems: 1 percent of design airflow.
    - b. Allowable Leakage, Return Duct Systems: 2 percent of design airflow.
    - c. Allowable Leakage, Exhaust Supply Duct Systems: 2 percent of design airflow.
    - d. Allowable Leakage, Supply Duct Systems, Terminals to Air Outlets: 2 percent of design airflow.
  - 4. Maximum Allowable Leakage: Comply with requirements for Leakage Class 3 for round and flat-oval ducts, Leakage Class 12 for rectangular ducts in pressure classes lower than and equal to 2-inch wg (both positive and negative pressures), and Leakage Class 6 for pressure classes from 2- to 10-inch wg.
  - 5. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

3.07 CLEANING

- A. Use service openings, as required, for physical and mechanical entry and for inspection.
  - 1. Use existing service openings where possible.
  - 2. Create other openings to comply with duct standards.
  - 3. Disconnect flexible ducts as needed for cleaning and inspection.
  - 4. Remove and reinstall ceiling sections to gain access during the cleaning process.
- B. Mark position of dampers and air-directional mechanical devices before cleaning, and restore to their marked position on completion.
- C. Particulate Collection and Odor Control:
  - 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron size (or larger) particles.
  - 2. When venting vacuuming system to the outside, use filtration to contain debris removed from HVAC system, and locate exhaust down wind and away from air intakes and other points of entry into building.
- D. Clean the following metal duct systems by removing surface contaminants and deposits:
  - 1. Air outlets and inlets (registers, grilles, and diffusers).
  - 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
  - 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
  - 4. Coils and related components.
  - 5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
  - 6. Supply-air ducts, dampers, actuators, and turning vanes.
  - 7. Dedicated ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:
  - 1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
  - 2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
  - 3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
  - 4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Report areas where fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth to the Engineer.
  - 5. 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.
  - 6. Provide operative drainage system for washdown procedures.
  - 7. Biocidal Agents and Coatings: Apply biocidal agents if fungus is present. Apply biocidal agents according to manufacturer's written instructions after removal of surface deposits and debris.

F. Cleanliness Verification:

1. Verify cleanliness after mechanical cleaning and before application of treatment, including biocidal agents and protective coatings.
2. Visually inspect metal ducts for contaminants.
3. Where contaminants are discovered, re-clean and reinspect ducts.

END OF SECTION

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## SECTION 233300 - AIR DUCT ACCESSORIES

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Air turning devices/extractors.
- B. Backdraft dampers - metal.
- C. Combination fire and smoke dampers.
- D. Duct access doors.
- E. Duct test holes.
- F. Fire dampers.
- G. Flexible duct connectors.
- H. Flexible ducts.
- I. Duct accessory hardware.
- J. Smoke dampers.
- K. Volume control dampers.
- L. Roof exhaust/intake hoods.
- M. Louvers and Vents.
- N. Motorized Control Dampers.

#### 1.02 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section 230548 - Vibration and Seismic Controls for HVAC.
- C. Section 233100 - HVAC Ducts and Casings.
- D. Section 233600 - Air Terminal Units: Pressure regulating damper assemblies.
- E. Section 253513 - Integrated Automation Actuators and Operators: Damper operators.
- F. Section 253516 - Integrated Automation Sensors and Transmitters: Damper position switch.
- G. Section 253523 - Integrated Automation Control Dampers: Product furnishing.
- H. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- B. NFPA 92 - Standard for Smoke Control Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.
- D. UL 33 - Safety Heat Responsive Links for Fire-Protection Service; Current Edition, Including All Revisions.
- E. UL 555 - Standard for Fire Dampers; Current Edition, Including All Revisions.
- F. UL 555C - Standard for Safety Ceiling Dampers; Current Edition, Including All Revisions.
- G. UL 555S - Standard for Smoke Dampers; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. Product Data: Provide for shop-fabricated assemblies including volume control dampers, duct access doors, duct test holes, and hardware used. Include electrical characteristics and connection requirements. For each manufacturer product; indicate dimensions, required clearances, method of field assembly, components, location, and size of each field connection.
- B. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers, backdraft damper, fire and smoke-damper installations, including sleeves and duct-mounted access doors, roof hoods, louvers.
- C. Manufacturer's Installation Instructions: Provide instructions for fire dampers.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. NFPA Compliance:
  - 1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
  - 2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect dampers from damage to operating linkages and blades.

## PART 2 PRODUCTS

### 2.01 MATERIALS

- A. Galvanized, Sheet Steel: Lock-forming quality; ASTM A 653/A 653M, G90 coating designation; mill-phosphatized finish for surfaces of ducts exposed to view.
- B. Reinforcement Shapes and Plates: Galvanized steel reinforcement where installed on galvanized, sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

### 2.02 AIR TURNING DEVICES/EXTRACTORS

- A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Manufactured Turning Vanes: Fabricate of 1-1/2-inch- wide, curved blades set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into side strips suitable for mounting in ducts.

### 2.03 BACKDRAFT DAMPERS - METAL

- A. Backdraft Dampers: Suitable for horizontal or vertical installations.
- B. Construction:
  - 1. Frame: 0.052-inch- thick, galvanized, sheet steel, with welded corners and mounting flange.
  - 2. Blades: 0.025-inch- thick, roll-formed aluminum.
  - 3. Blade Seals: Felt, vinyl, or neoprene.
  - 4. Blade Axles: Galvanized steel.
  - 5. Tie Bars and Brackets: Galvanized steel.
  - 6. Return: Counter-weighted, adjustable.

### 2.04 COMBINATION FIRE AND SMOKE DAMPERS

- A. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.
- B. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized, sheet steel; length to suit wall or floor application.
- C. Damper Motors: Provide for modulating or two-position action.
  - 1. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
  - 2. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.

3. Outdoor Motors and Motors in Outside-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
  4. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
  5. Two-Position Motor: 120 VAC.
  6. Auxiliary end switch for monitoring damper position.
- D. Combination fire and smoke dampers shall be labeled for a minimum of one-and-one-half-hour rating to UL 555 or as indicated on the drawings. Dampers shall be Class 2 leakage designed for dynamic systems and rated for a minimum of 250 degrees F.
- E. Multiple Blade Dampers: Fabricate with 16 gauge, 0.0598 inch (1.52 mm) galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8 by 1/2 inch (3.2 by 12.7 mm) plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch (12.7 mm) actuator shaft.
- F. Operators: UL listed and labeled; spring-return, electric-type suitable for 120 volts, single phase, 60 Hz. Provide end switches to indicate damper position. Locate damper operator on interior of duct and link to damper operating shaft.

## 2.05 DUCT ACCESS DOORS

- A. Fabricate in accordance with SMACNA (DCS) and as indicated.
- B. Fabricate doors and panels airtight and suitable for duct pressure class.
1. Frame: Galvanized, sheet steel, with bend-over tabs and foam gaskets.
  2. Door: Double-wall, galvanized, sheet metal construction with insulation fill and thickness, and number of hinges and locks as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.
  3. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.
  4. Insulation: 1-inch- thick, fibrous-glass or polystyrene-foam board.

## 2.06 DUCT TEST HOLES

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments, and length to suit duct insulation thickness.

## 2.07 FIRE DAMPERS

- A. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.
- B. Ceiling (Radiation) Dampers: Galvanized steel, 22-gauge, 0.0299-inch (0.76 mm) frame and 16-gauge, 0.0598-inch (1.52 mm) flap, two layers of 0.125-inch (3.2 mm) thick ceramic fiber on top side and one layer on bottom side for round flaps, with locking clip.
1. Rated for three hour service in compliance with UL 555C.

- C. Horizontal Dampers: Galvanized steel, 22-gauge, 0.0299-inch (0.76 mm) frame, stainless steel closure spring, and lightweight, heat-retardant, non-asbestos fabric blanket. Include a blade lock and stainless-steel negator closure spring.
- D. Fusible Links: Replaceable, UL 33, separate at 160 degrees F (71 degrees C) with adjustable link straps for combination fire/balancing dampers.
- E. Mounting Sleeve: Factory- or field-installed galvanized, sheet steel with minimum thickness of 0.052 inch or 0.138 inch thick as indicated, and length to suit application.
- F. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized, sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized steel blade connectors.
- G. Configuration: Type B with blades out of air stream.

## 2.08 FLEXIBLE DUCT CONNECTORS

- A. Fabricate in accordance with SMACNA (DCS) and as indicated.
- B. Flexible Duct Connections: Fabric crimped into metal edging strip.
  - 1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz/sq yd (1.0 kg/sq m).
    - a. Net Fabric Width: Approximately 3 inches (75 mm) wide.
  - 2. Metal: 3 inches (75 mm) wide, 24 gauge, 0.0239 inch (0.61 mm) thick galvanized steel.
  - 3. Conventional, Indoor System Flexible Connector Fabric: Glass fabric double coated with polychloroprene.
    - a. Minimum Weight: 26 oz./sq. yd..
    - b. Tensile Strength: 480 lbf/inch in the warp, and 360 lbf/inch in the filling.
- C. Maximum Installed Length: 14 inch (356 mm).
- D. FLEXIBLE DUCTS
  - 1. Uninsulated: Comply with UL 181, Class 1, spiral-wound steel spring with flameproof vinyl sheathing or corrugated aluminum.
    - a. Pressure Rating: 6-inch wg positive, 1/2-inch wg negative.
  - 2. Insulated: Factory-fabricated, insulated, round duct, with an outer jacket enclosing 1-1/2-inch- thick, glass-fiber insulation around a continuous inner liner.
    - a. Reinforcement: Steel-wire helix encapsulated in inner liner.
    - b. Outer Jacket: Polyethylene film.
    - c. Inner Liner: Polyethylene film.
    - d. Pressure Rating: 6-inch wg positive, 1/2-inch wg negative.

## 2.09 ACCESSORY HARDWARE

- A. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 to 18 inches to suit duct size.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

## 2.10 SMOKE DAMPERS

- A. Fabricate in accordance with NFPA 90A and UL 555S, and as indicated.
- B. Frame and Blades: 0.064-inch- thick, galvanized, sheet steel.
- C. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized, sheet steel; length to suit wall or floor application.
- D. Damper Motors: Provide for modulating or two-position action.
  - 1. a. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
  - 2. b. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
  - 3. c. Outdoor Motors and Motors in Outside-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
  - 4. d. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
  - 5. e. Two-Position Motor: 120 VAC.
  - 6. f. Auxiliary end switch for monitoring damper position.
- E. Electro Thermal Link: Fusible link melting at 250 degrees F (121 degrees C); 120 volts, single phase, 60 Hz; UL listed and labeled. Replaceable.

## 2.11 VOLUME CONTROL DAMPERS

- A. Fabricate in accordance with SMACNA (DCS) and as indicated.
- B. Factory fabricated with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.
  - 1. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
  - 2. Steel Frames: Hat-shaped, galvanized, steel-sheet channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
  - 3. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized, sheet steel.
  - 4. Blade Axles: Galvanized steel.
  - 5. Tie Bars and Brackets: Galvanized steel.
  - 6. Jackshaft: 1-inch- diameter, galvanized steel pipe rotating within a pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
  - 7. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

## 2.12 ROOF INTAKE/RELIEF HOODS

### A. Rectangular Gravity Hoods

1. Housing: Minimum 18 gage galvanized steel, printed and painted, or minimum 16 gage anodized aluminum, constructed with hinged hoods and specifically designed for intake or exhaust.
  - a. All vertical seams continuously welded with lock form seams on hood ends.
  - b. Hood stress and sloped for drainage.
  - c. Opening with aluminum snow screen.
2. Outdoor opening shall be a minimum size as follows:
  - a. 2 times neck area for intake hoods.
  - b. 1 times neck area for relief and exhaust applications.
3. Airflow rating and pressure drop shall be as scheduled on the drawings. Select intake hoods with a maximum of 500 FPM inlet velocity and 0.2 inch pressure drop.
4. Insulation: Minimum of one-inch applied to the underside of hood to prevent condensation.
5. Curb: Prefabricated of heavy gage galvanized steel with integral fiberglass insulation with metal liner and wood nailer. Refer to drawings for roof slopes. Minimum curb height shall be as follows:
  - a. 24-inches high for intake hoods.
  - b. 18-inches high for exhaust of relief.
6. Dampers:
  - a. Automatic counterbalanced backdraft damper for relief and exhaust units constructed of tight fitting aluminum blades.
  - b. Motorized, low leak dampers, where indicated on the drawings with spring return, and oil immersed gear train, rated for minimum 22 to plus 250 deg F, 120V/1 phase.

### B. Spun Aluminum Gravity Ventilators

1. Heavy gage aluminum wind band with rolled bead.
2. Curb cap: Heavy gage aluminum with one piece spun venturi.
3. Galvanized bird screen.
4. 18-inch high insulated curb.

## 2.13 LOUVERS AND VENTS

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

1. American Warming and Ventilating, Inc.
2. Carnes Company, Inc.
3. Greenheck
4. Industrial Louvers
5. Louvers and Dampers
6. Ruskin Co.
7. Vent Products Co.

- B. General: Provide louvers and vents capable of withstanding the effects of gravity loads, wind loads and thermal movement. Wind loads shall be based on 30 pounds per square foot acting inward or outward.
  - 1. Provide frame types and extended sills compatible with construction details.
    - a. Provide flanged frame where indicated.
  - 2. Provide screen at interior face of each exterior louver.
  - 3. Louver Screen Frames: Same kind and form of metal as indicated for louver to which screens are attached.
- C. Materials:
  - 1. Aluminum Extrusions: ASTM B 221, alloy 6063-T5 or T-52.
  - 2. Aluminum Sheet: ASTM B 209, alloy 3003 or 5005.
  - 3. Galvanized Steel Sheet: ASTM A 653/A 653M, G 90 (Z275) zinc coating, mill phosphatized.
  - 4. Stainless-Steel Sheet: ASTM A 666, Type 304, with No. [4] [6] finish.
  - 5. Fasteners: Of same basic metal and alloy as fastened metal or 300 Series stainless steel.
  - 6. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- D. Fabrication, General:
  - 1. Fabricate frames to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
  - 2. Join frame members to each other and to louver blades with fillet welds concealed from view.
  - 3. Join frame members to each other and to louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer, concealed from view.
- E. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
- F. Extruded Aluminum Double Drainable Blade
  - 1. Frame: Four-inch deep .090 inch nominal wall thickness, 6064T5 extruded aluminum.
  - 2. Blades: 6063T5 extruded aluminum, .081 inch nominal wall thickness, double drainable blades at 45 deg. angle.
  - 3. Finish: Mill finish.
  - 4. Reference Product: Ruskin ELF811DD.
- G. Roll Formed Steel, Double Drainable Blade
  - 1. Frame: 6-inch deep, 18-gage galvanized steel.
  - 2. Blades: 18-gage galvanized steel, 37½ deg angle, and with drain gutters in each blade.
  - 3. Screen: ½-inch mesh x 19-gage galvanized bird screen in a removable frame.
  - 4. Finish: Baked enamel finish in standard color selected by Architect.
- H. Louver variations where scheduled on drawings:
  - 1. Hinged frame.
  - 2. Front or rear security bars.
  - 3. Filter Rack for 2-inch filters.



2.14 motorized control dampers

- A. Frame: 4x1 extruded aluminum hot section with 0.081-inch minimum wall thickness, and mounting flanges.
- B. Blades: 4-inch wide, 6063T5 heavy gage extruded aluminum, airfoil shaped, and with concealed linkage.
- C. Axles: ½-inch plated steel hex, molded synthetic bearings.
- D. Seals extruded TPR blade edge seal and flexible metal compression type jamb seals.
- E. Control Shaft: ½-inch diameter with jackshaft for field mounted actuator.
- F. Actuator: Belimo.
  - 1. Microprocessor-controlled brushless DC motor.
  - 2. Overload-proof.
  - 3. Built-in mechanical stops.
  - 4. Spring return.
  - 5. Auxiliary switch.
  - 6. Double-insulated, 120 VAC, max 27 VA.
  - 7. Select size and accessories per Belimo selection guide.
  - 8. Multi-function Control: On/off or floating point as required.
- G. Basis-of-Design: Ruskin Model CD40.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). See Section 233100 for duct construction and pressure class.
- B. Install volume dampers in lined duct; avoid damage to and erosion of duct liner.
- C. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- D. Install duct access panels for access to both sides of duct coils. Install duct access panels downstream from volume dampers, fire dampers, turning vanes, and equipment.
  - 1. Install duct access panels to allow access to interior of ducts for cleaning, inspecting, adjusting, and maintaining accessories and terminal units.
  - 2. Install access panels on side of duct where adequate clearance is available.
- E. Label access doors.
- F. Provide duct test holes where indicated and required for testing and balancing purposes.
- G. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire-rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

- H. Install fire and smoke dampers according to manufacturer's UL-approved written instructions. Install fusible links in fire dampers.
- I. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.
- J. Demonstrate re-setting of fire dampers to Owner's representative.
- K. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.
- L. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum two duct widths from duct take-off.
- M. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.
- N. Coordinate installation of roof curbs with general trades.

END OF SECTION

## SECTION 233423 - HVAC POWER VENTILATORS

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Inline centrifugal fans and blowers.

#### 1.02 RELATED REQUIREMENTS

- A. Section 230548 - Vibration and Seismic Controls for HVAC.
- B. Section 233100 - HVAC Ducts and Casings.
- C. Section 233300 - Air Duct Accessories: Backdraft dampers.

#### 1.03 REFERENCE STANDARDS

- A. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program; 2015.
- B. AMCA 99 - Standards Handbook; 2025.
- C. AMCA 204 - Balance Quality and Vibration Levels for Fans; 2020.
- D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2025.
- E. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans; 2024.
- F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.

#### 1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on fans and accessories, including fan curves with specified operating point plotted, power, rpm, sound power levels at rated capacity, and electrical characteristics and connection requirements.

### PART 2 PRODUCTS

#### 2.01 MANUFACTURERS

- A. Greenheck Fan Corporation; \_\_\_\_\_: [www.greenheck.com/#sle](http://www.greenheck.com/#sle).
- B. Loren Cook Company; \_\_\_\_\_: [www.lorencook.com/#sle](http://www.lorencook.com/#sle).

2.02 POWER VENTILATORS - GENERAL

- A. Static and Dynamically Balanced: Comply with AMCA 204.
- B. Performance Ratings: Comply with AMCA 210, bearing certified rating seal.
- C. Sound Ratings: Comply with AMCA 301, tested to AMCA 300, bearing certified sound ratings seal.
- D. Fabrication: Comply with AMCA 99.
- E. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.03 INLINE CENTRIFUGAL FANS AND BLOWERS

- A. Centrifugal Fan Unit: V-belt or direct driven, with galvanized steel housing lined with acoustic insulation, resiliently-mounted motor, gravity backdraft damper in discharge.
- B. Forward Curved Blower:
  - 1. Direct-driven, resiliently mounted motor, heavy-duty ball bearings, galvanized steel housing for indoor or outdoor service, and removable service panels.
  - 2. Accessories: Provide filter section, intake hood with bird screen, and MERV- \_\_ filters.
- C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm gets reached with sheaves set at mid-position; fan shaft with self-aligning prelubricated ball bearings.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Hung Cabinet Fans:
  - 1. Install fans with resilient mountings and flexible electrical leads, see Section 230548.
- C. Provide sheaves required for final air balance.

END OF SECTION

## SECTION 236426 - ROTARY-SCREW WATER CHILLERS

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Water-cooled rotary-screw chiller.
- B. Air-cooled rotary-screw chiller.

#### 1.02 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete housekeeping pads.
- B. Section 230553 - Identification for HVAC Piping and Equipment.
- C. Section 230593 - Testing, Adjusting, and Balancing for HVAC.
- D. Section 230800 - Commissioning of HVAC.
- E. Section 230923 - Direct-Digital Control System for HVAC.
- F. Section 230993 - Sequence of Operations for HVAC Controls.
- G. Section 232113 - Hydronic Piping.
- H. Section 232114 - Hydronic Specialties.
- I. Section 251500 - Integrated Automation Software.
- J. Section 253519 - Integrated Automation Control Valves.
- K. Section 260583 - Wiring Connections.

#### 1.03 REFERENCE STANDARDS

- A. AHRI 550/590 (I-P) - Performance Rating of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle; 2023.
- B. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2024, with Errata (2025).
- C. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks; 2020, with Addendum (2024).
- E. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2023, with Errata (2024).

- F. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2019.
- G. UL 984 - Hermetic Refrigerant Motor-Compressors; Current Edition, Including All Revisions.
- H. UL 1995 - Heating and Cooling Equipment; Current Edition, Including All Revisions.

#### 1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate physical size, weight and location of major pieces of equipment to be installed. Notify Architect of any major deviations from the equipment originally specified prior to ordering equipment.

#### 1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.
- C. Shop Drawings: Indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate equipment, piping and connections, valves, strainers, and thermostatic valves required for complete system.
- D. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

#### 1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

#### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's written installation instructions for rigging, unloading, and transporting units.
- B. Deliver units to the job site completely assembled and charged with refrigerant and oil by manufacturer.

#### 1.08 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer's Warranty: Provide minimum five year warranty to include coverage for materials only for compressor.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Trane Technologies, PLC; \_\_\_\_\_: [www.trane.com/#sle](http://www.trane.com/#sle).
- B. York, a brand of Johnson Controls International, PLC; \_\_\_\_\_: [www.york.com/#sle](http://www.york.com/#sle).
- C. Substitutions: See Section 016000 - Product Requirements.
  - 1. The chilled water system has been designed based on specific capacities and characteristics of equipment specified in this section and other sections.
  - 2. When substitution of a different manufacturer or model number is desired, submit sufficient information to demonstrate to Architect that the substitute will have the same or better performance as that specified AND that the related equipment in the system will perform acceptably with the substitute.
  - 3. If the related equipment must be modified to perform acceptably with the substitute, the entity proposing the substitution is responsible for all additional costs due to re-design and provision of different related equipment.

### 2.02 ROTARY-SCREW WATER CHILLER PERFORMANCE REQUIREMENTS

- A. Packaged Water-Cooled Chiller, CH-1:
  - 1. Refrigerant: R-513B, use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) no greater than that allowed by federal code.
  - 2. Evaporator:
    - a. Fouling Factor: 0.00010 sq ft-hr-degrees F/Btu (0.000018 sq m-hr-degrees C/W).
  - 3. Water-Cooled Condenser:
    - a. Fouling Factor: 0.00025 sq ft-hr-degrees F/Btu (0.000044 sq m-hr-degrees C/W).

### 2.03 WATER-COOLED, ROTARY-SCREW, WATER CHILLER CONSTRUCTION REQUIREMENTS

- A. Factory assembled and tested chiller consisting of compressor(s), compressor motor(s), motor starter(s) or variable frequency drives as indicated, evaporator, condenser, enclosure, refrigeration circuits(s) and specialties, interconnecting piping, microprocessor-based controls, readouts, and diagnostics.
  - 1. Rating: AHRI 550/590 (I-P).
  - 2. Safety: ASHRAE Std 15 and UL 1995.
  - 3. Construction and Testing: ASME BPVC-VIII-1.
  - 4. Energy Efficiency: ASHRAE Std 90.1.
  - 5. Enclosures:
    - a. Structural Framing: Mount structural steel on welded steel base with hot-dip galvanized finish.
    - b. Steel Cabinet:
      - 1) Factory apply baked on powder paint or corrosion resistant paint prior to assembly.
      - 2) Provide gasketing and weatherproofing to panels with fully opening doors containing starters or variable frequency drives, terminal blocks, through-

- the-door type disconnects and circuit breaker with lockable handles indicating "power-on" or "power-off".
    - 3) Provide door stays.
  - c. Perform 500-hour salt spray test in accordance with ASTM B117 for outdoor applications.
- B. Rotary-Screw Compressors:
  - 1. Unit: Semi-hermetic type with two, direct drive compressors with multiple independent refrigeration circuit(s), internal muffler, discharge, check, and suction service valves.
  - 2. Oil Lubrication System: Positive pressure system, oil heater, oil separator, check valves, solenoid valves, and filtration devices.
  - 3. Valves: Check valves in compressor discharge.
  - 4. Capacity Reduction System: Load/unload valve control down to 20 percent of full load without the activation of hot gas bypass.
  - 5. Motors: UL 984, 3,600 rpm, suction gas-cooled, hermetically sealed, squirrel cage induction with starter.
- C. Evaporator, Shell and Tube Type:
  - 1. ASME BPVC-VIII-1, three pass type, with three independent refrigeration circuits.
  - 2. Shell, Removable Heads and Tube Support Sheets: Carbon steel.
  - 3. Tubes: Mechanically treated copper tubes fixed and aligned into intermediate tube support sheets across the shell to maintain consistent spacing between tubes with the capability of being cleanable.
  - 4. Working Pressure Rating, Refrigerant-Side: 200 psi (1380 kPa).
  - 5. Working Pressure Rating, Water-Side: 150 psi (1035 kPa).
  - 6. Cold Surface Insulation:
    - a. Factory install on shell and all other cold surfaces.
    - b. 0.75-inch (20 mm) minimum thickness, closed cell, expanded polyvinyl chloride flexible foam insulation with a maximum K factor of 0.28.
- D. Provide vents and water drain connections.
- E. Provide fittings for temperature control sensors.
- F. Freeze Protection: Provide evaporator heater with thermostat to protect from freezing at ambient temperatures down to minus 20 degrees F (minus 28.9 degrees C).
- G. Refrigeration Circuits:
  - 1. Provide two independent refrigeration circuit(s) with two compressor(s) per circuit.
  - 2. Minimum Refrigerant Specialties per Circuit:
    - a. Isolation and service valves for refrigerant removal and charging.
    - b. Removable-core filter driers.
    - c. ASHRAE Std 15 compliant relief valves.
    - d. Liquid line sight glass with moisture indicator.
    - e. Refrigerant expansion valves or metering devices.
    - f. Complete operating charge of both refrigerant and oil.
- H. Starters and Drives:
- I. Controls Package:



1. Unit Controls: Factory-supplied DDC:
  - a. Control-panel mounted with required input-output expansions, power supply, fused disconnect, hand switches, knobs, and accessories required to control chiller unit to manufacturer required sequences to meet intended use with listed performance.
  - b. Factory configured to interface prewired sensors, switches, and safeties with allowance to add up to four chiller valves and flow sensors.
  - c. Graphic-based touchscreen to include unit operation controls and user filter based interface for faults, alarms, performance, unit diagnostics, and data recording up to 12 months.
  - d. BAS, SCADA, or other Integrated Automation Link: ASHRAE Std 135 BACnet MS/TP.
  - e. External Point Mapping: Provide mapping table for each parameter included in the local visual interface with software-toggle flag to allow reduced mapping of available points.
  - f. Isolation Valves: Field-installed, 2-position, butterfly type with position tracking; see Section 253519.
2. Control Components for Preventing Shutdown:
  - a. Provide high pressure limit with indicating light for each compressor, set lower than factory pressure switch to automatically unload compressor and prevent nuisance high pressure condenser control trip.
  - b. Provide one protector with indicating light for each compressor, with current limit setpoint of 120 percent of compressor running load amperage to automatically unload compressor preventing over-current trip.
  - c. Provide low refrigerant limit to automatically unload each compressor preventing a low evaporator temperature trip.
3. Chiller Operation in Abnormal Operating Conditions:
  - a. Unloaded Running: Adequate chilled water production.
  - b. Trip-out Limit Reached: Chiller goes off-line and manual reset is required for continued operation.
4. Control Panel Display:
  - a. Evaporator pressure.
  - b. Condenser refrigerant pressure.
  - c. Entering and leaving evaporator water temperature.
5. Points for Remote Monitoring and Control:
  - a. Entering and leaving condenser water temperature as applicable.
  - b. Chilled water setpoint.
  - c. Electrical 3 phase current limit and percent RLA setpoint.
  - d. Electrical 3 phase amp draw.
  - e. Chiller operating mode.
  - f. Condenser refrigerant temperature.
  - g. Elapsed time and number of starts counter.
  - h. Chiller compressor run status relay.
  - i. Minimum of 20 diagnostics with time and date stamp.
  - j. Identification of the fault, date, time and operating mode at time of occurrence, type of reset required, and help message.
  - k. Relay output energized upon detecting a fault requiring manual reset.

- l. Relay output energized whenever unit is operating in a limit mode for an extended period of time.
- m. Analog input to control leaving chilled water temperature setpoint based upon a 4-20ma or 0-10 VDC signal from the building automation system.
- n. Programmable soft during pull-down period via ramped current limit or fully adjustable, temperature pull-down rate.
- o. Leaving chilled water reset based upon return water temperature.
- p. Provide RS-232 for printer interface.

### PART 3 EXECUTION

#### 3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Align chiller package on steel or concrete foundations.
- C. Install units on vibration isolators.
- D. Connect to electrical service.
- E. Connect to chilled water piping.
- F. Arrange piping for easy dismantling to permit tube cleaning and removal.
- G. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front-end interface; see Section 251500.

#### 3.02 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.

#### 3.03 MANUFACTURER'S FIELD SERVICES

- A. Perform factory startup of the chiller by factory trained and authorized servicing technicians confirming equipment has been correctly installed prior to equipment becoming operational and covered under the manufacturer's warranty.
- B. Supply initial charge of refrigerant and oil if not completely factory charged.
- C. Demonstrate system operations and verify specified performance.

#### 3.04 CLOSEOUT ACTIVITIES

- A. Demonstrate proper operation of equipment to Owner's designated representative.
- B. Demonstration: Demonstrate operation of system to Owner's personnel.
  - 1. Use operation and maintenance data as reference during demonstration.
  - 2. Conduct walking tour of project.
  - 3. Briefly describe function, operation, and maintenance of each component.

- C. Training: Train Owner's personnel on operation and maintenance of system.
  - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
  - 2. Provide minimum of one day of training.
  - 3. Instructor: Manufacturer's training personnel.
  - 4. Location: At project site.
  - 5. Location: Owner's offsite classroom facilities may be used.

END OF SECTION

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## SECTION 238216 - AIR COILS

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Water heating coils.

#### 1.02 RELATED REQUIREMENTS

- A. Section 230719 - HVAC Piping Insulation.
- B. Section 232114 - Hydronic Specialties.
- C. Section 233100 - HVAC Ducts and Casings: Installation of duct coils.
- D. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

#### 1.03 REFERENCE STANDARDS

- A. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

#### 1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
- C. Shop Drawings: Indicate coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.

#### 1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors.
- B. Protect coils from entry of dirt and debris with pipe caps or plugs.

#### 1.07 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

- B. Provide five year manufacturer warranty for \_\_\_\_\_.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Aerofin Corporation; \_\_\_\_\_: [www.aerofin.com/#sle](http://www.aerofin.com/#sle).  
B. Trane Technologies, PLC; \_\_\_\_\_: [www.trane.com/#sle](http://www.trane.com/#sle).

### 2.02 WATER HEATING COILS

- A. Tubes: Seamless copper or brass arranged in parallel or staggered pattern, expanded into fins, silver brazed joints.  
B. Fins: Aluminum or copper continuous plate type with full fin collars.  
C. Casing: Die formed channel frame of 16 gauge, 0.0598 inch (1.52 mm) galvanized steel with mounting holes on 3 inch (75 mm) centers. Provide tube supports for coils longer than 36 inches (900 mm).  
D. Headers: Cast iron with tubes expanded into header.  
E. Testing: Air test under water to 200 psi (1380 kPa) for working pressure of 200 psi (1380 kPa) and 220 degrees F (104 degrees C).  
F. Configuration: Drainable, with threaded plugs for drain and vent.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Install in accordance with manufacturer's written instructions.  
B. Install in ducts and casings in accordance with SMACNA (DCS).  
C. Hydronic Coils:  
1. Hydronic Coils: Connect water supply to leaving air side of coil (counterflow arrangement).  
2. Ensure water coils are drainable and provide drain connection at low points.

END OF SECTION

## SECTION 260010 - BASIC ELECTRICAL REQUIREMENTS

### PART 1 GENERAL

#### 1.01 DESCRIPTION OF WORK

- A. Work includes all electrical items and systems shown on the contract drawings and specified herein.
- B. Unless specifically dimensioned, the work shown on the drawings is diagrammatic, and is intended only to show general arrangement.
- C. Include in the work all accessories and devices necessary for the intended operation of any system, whether or not specifically shown or specified.

#### 1.02 STANDARDS OF QUALITY

- A. The specifications establish the standard of quality required, either by description of by references to brand name, name of manufacturers or manufacturer's model number.
- B. Where one product only is specifically identified by name of manufacturer's model number, the Contractor shall base his bid on the use of the name product. Where multiple names are used, the Contractor shall base his bid on the use of any of those products named.
- C. The Contractor may submit with his bid, the names of products which are proposed as substitutions for products named in specifications. Each proposed substitution shall be accompanied by a written sum of money to be added or deducted from his bid. The Owner reserves the sole right to accept or reject said substitutions with or without cause.
- D. When equipment and/or materials are proposed to be purchased from a manufacturer other than those specified, the Contractor shall provide complete data adequate for the Engineer's evaluation of the proposed substitution.
- E. When the equipment other than that specified is used, the Contractor shall be responsible for any extra cost of required revisions such as structural steel, concrete, electrical, piping, etc. Such additional costs shall be identified at the time such substitutions are proposed.

#### 1.03 SUMMARY

- A. This Section includes general administrative and procedural requirements for electrical installations.
  - 1. Submittals
  - 2. Maintenance Manuals
  - 3. Rough-ins
  - 4. Electrical Installations

#### 1.04 SUBMITTALS

- A. The Contractor shall review, approve and submit shop drawings, with promptness so as to cause no delay in his work or in that of others. No submissions will be accepted by the Engineer without the signed review and approval of the Contractor.
- B. The Contractor shall check and verify pertinent field measurements, quantities of equipment and materials required.
- C. Submittals shall be identified by reference to project, the drawings, sections of specifications, or equipment symbols to which they relate.
- D. Shop drawings, when required, shall include:
  - 1. Verification of information given in Contract Documents such as performance, dimensions, weight, materials, construction, types, models, manufacturer, etc.
  - 2. Equipment layouts drawn to scale as may be required.
  - 3. Wiring diagrams and schematics for equipment.
  - 4. Any special construction conditions.
  - 5. Other information/data as may be requested.
- E. All submittals shall identify the specific details of the product or assembly. All optional features being proposed shall be so noted, or the submittal will be rejected.
- F. Review is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Any action shown is subject to the requirements of the plans and specification. Contractor is responsible for dimensions which shall be confirmed and correlated at the job site; fabrication processes and techniques of construction; coordination of his work with that of all other trades; and the satisfactory performance of his work.
- G. For items being resubmitted, clearly identify changes made from the initial submittal requested by the Engineer. The Engineer will review only those changes requested and identified by the Contractor.

#### 1.05 MAINTENANCE MANUALS

- A. Prepare maintenance manuals including the following information for equipment items:
  - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
  - 2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
  - 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
  - 4. Servicing instructions and lubrication charts and schedules.



1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.07 PERMITS, FEES, AND CERTIFICATES OF APPROVAL

- A. Contractor shall acquire all permits and certificates.
- B. Contractor shall provide all labor and instruments required for tests and cleaning of systems.
- C. Whenever tests are required, three (3) copies of the test reports shall be submitted to the Engineer and (1) electronic copy.
- D. Tests may be observed by the Engineer or his representative. Notify the Engineer a minimum of three weeks in advance of the test dates.

1.08 COMPLIANCE WITH CODES, STANDARDS AND REGULATIONS

- A. In the absence of specific instruction in the technical specifications, equipment and installation shall conform to the following applicable codes, standards and regulations, latest editions:
  - 1. American Society for Testing Materials (ASTM).
  - 2. American National Standard Institute (ANSI).
  - 3. Underwriter's Laboratories, Inc. (UL).
  - 4. American Welding Society Code (AWSC).
  - 5. Local Building, Electrical, and Fire Codes.
  - 6. National Electrical Code (NEC).
  - 7. Service Rules and Regulations of Local Electrical Utility Company.
  - 8. National Electrical Manufacturer's Association (NEMA).
  - 9. U.S. Department of Health & Human Services "HRS-M-HF" 84-1.
  - 10. Occupational Safety and Health Act (OSHA).
  - 11. National Fire Protection Association (NFPA).
  - 12. Americans with Disabilities Act (ADA).

PART 2 PRODUCTS - NOT USED.

PART 3 EXECUTION

3.01 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with requirements of the actual equipment to be connected.

3.02 ELECTRICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with other building components.
2. Verify all dimensions by field measurements.
3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building.
6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
7. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Engineer.
9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
10. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
11. Install access panel or doors where units are concealed behind finished surfaces.
12. Install systems, material, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
13. Coordinate all electrical requirements with other trades and their shop drawings prior to installing conduit, wire, switches and breakers. Notify engineer of any discrepancies between document and actual supplied equipment.

### 3.03 CUTTING AND PATCHING

- A. General: Performing cutting and patching in accordance with the following requirements:
  1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
    - a. Uncover work to provide for installation of ill-timed work.
    - b. Remove and replace defective work.
    - c. Remove and replace work not conforming to requirements of the contract documents.
    - d. Remove samples of installed work as specified for testing.
    - e. Upon written instruction from the Engineer, uncover and restore work to provide for Engineer observation of concealed work.

END OF SECTION

## SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

### PART 1 GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. Electrical equipment coordination and installation.
  - 2. Common electrical installation requirements.

#### 1.02 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
  - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
  - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
  - 3. To allow right of way for piping and conduit installed at required slope.
  - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.

### PART 2 PRODUCTS – NOT USED.

### PART 3 EXECUTION

#### 3.01 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

- E. Right of Way: Give to piping systems installed at a required slope.

END OF SECTION

## SECTION 260505 - SELECTIVE DEMOLITION FOR ELECTRICAL

### PART 1 GENERAL - NOT USED

### PART 2 PRODUCTS - NOT USED

### PART 3 EXECUTION

#### 3.01 EXAMINATION

- A. Verify field measurements and circuiting arrangements are as indicated.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition drawings are based on casual field observation and existing record documents.
- D. Report discrepancies to Architect before disturbing existing installation.
- E. Beginning of demolition means installer accepts existing conditions.

#### 3.02 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Coordinate utility service outages with utility company.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
  - 1. Obtain permission from Owner at least 24 hours before partially or completely disabling system.
  - 2. Make temporary connections to maintain service in areas adjacent to work area.

#### 3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:
  - 1. PCB-containing electrical equipment, including transformers, capacitors, and switches.
  - 2. PCB- and DEHP-containing lighting ballasts.

3. Mercury-containing lamps and tubes, including fluorescent lamps, high intensity discharge (HID), arc lamps, ultra-violet, high pressure sodium, mercury vapor, ignitron tubes, neon, and incandescent.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned wiring to source of supply.
- D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- F. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- G. Repair adjacent construction and finishes damaged during demolition and extension work.
- H. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

#### 3.04 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment that remain or that are to be reused.
- B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

END OF SECTION

## SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Single conductor building wire.
- B. Nonmetallic-sheathed cable.
- C. Underground feeder and branch-circuit cable.
- D. Wiring connectors.
- E. Electrical tape.
- F. Oxide inhibiting compound.
- G. Wire pulling lubricant.
- H. Cable ties.
- I. Firestop sleeves.

#### 1.02 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section 260505 - Selective Demolition for Electrical: Disconnection, removal, and/or extension of existing electrical conductors and cables.
- C. Section 260526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

#### 1.03 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013 (Reapproved 2024).
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2023.
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010, with Editorial Revision (2020).
- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2020).

- E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2024.
- F. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- G. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2021.
- H. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.
- I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
- K. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
- L. UL 267 - Outline of Investigation for Wire-Pulling Compounds; Current Edition, Including All Revisions.
- M. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.
- N. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
- O. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.
- P. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.

#### 1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
  - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
  - 2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
  - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

#### 1.05 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- B. Field Quality Control Test Reports.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.



- D. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

#### 1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

#### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

#### 1.08 FIELD CONDITIONS

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F (-10 degrees C), unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

### PART 2 PRODUCTS

#### 2.01 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Nonmetallic-sheathed cable is not permitted.
- D. Metal-clad cable is not permitted.

#### 2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Comply with NEMA WC 70.

- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductors for Grounding and Bonding: Also comply with Section 260526.
- H. Conductors and Cables Installed in Cable Tray: Listed and labeled as suitable for cable tray use.
- I. Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum rated, listed and labeled as suitable for use in return air plenums.
- J. Conductor Material:
  - 1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
  - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
  - 3. Tinned Copper Conductors: Comply with ASTM B33.
- K. Minimum Conductor Size:
  - 1. Branch Circuits: 12 AWG.
    - a. Exceptions:
      - 1) 20 A, 120 V circuits longer than 75 feet (23 m): 10 AWG, for voltage drop.
      - 2) 20 A, 120 V circuits longer than 150 feet (46 m): 8 AWG, for voltage drop.
      - 3) 20 A, 277 V circuits longer than 150 feet (46 m): 10 AWG, for voltage drop.
- L. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- M. Conductor Color Coding:
  - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
  - 2. Color Coding Method: Integrally colored insulation.
  - 3. Color Code:
    - a. 480Y/277 V, 3 Phase, 4 Wire System:
      - 1) Phase A: Brown.
      - 2) Phase B: Orange.
      - 3) Phase C: Yellow.
      - 4) Neutral/Grounded: Gray.
    - b. 208Y/120 V, 3 Phase, 4 Wire System:
      - 1) Phase A: Black.
      - 2) Phase B: Red.
      - 3) Phase C: Blue.
      - 4) Neutral/Grounded: White.
    - c. 240/120 V High-Leg Delta, 3 Phase, 4 Wire System:
      - 1) Phase A: Black.
      - 2) Phase B (High-Leg): Orange.

- 3) Phase C: Blue.
- 4) Neutral/Grounded: White.
- d. 240/120 V, 1 Phase, 3 Wire System:
  - 1) Phase A: Black.
  - 2) Phase B: Red.
  - 3) Neutral/Grounded: White.
- e. Equipment Ground, All Systems: Green.
- f. Isolated Ground, All Systems: Green with yellow stripe.
- g. Travelers for 3-Way and 4-Way Switching: Pink.
- h. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.
- i. For control circuits, comply with manufacturer's recommended color code.

## 2.03 SINGLE CONDUCTOR BUILDING WIRE

- A. Description: Single conductor insulated wire.
- B. Conductor Stranding:
  - 1. Feeders and Branch Circuits:
    - a. Size 10 AWG and Smaller: Solid.
    - b. Size 8 AWG and Larger: Stranded.
- C. Insulation Voltage Rating: 600 V.
- D. Insulation:
  - 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
    - a. Size 4 AWG and Larger: Type XHHW-2.
    - b. Installed Underground: Type XHHW-2.
    - c. Fixture Wiring Within Luminaires: Type TFFN/TFN for luminaires with labeled maximum temperature of 90 degrees C; Approved suitable type for luminaires with labeled maximum temperature greater than 90 degrees C.

## 2.04 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Connectors for Grounding and Bonding: Comply with Section 260526.
- C. Wiring Connectors for Splices and Taps:
  - 1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
  - 2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.
- D. Wiring Connectors for Terminations:

1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
  2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
  3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
  4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
  5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
- E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.
- G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F (105 degrees C) for standard applications and 302 degrees F (150 degrees C) for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
- H. Mechanical Connectors: Provide bolted type or set-screw type.
- I. Compression Connectors: Provide circumferential type or hex type crimp configuration.

## 2.05 ACCESSORIES

- A. Electrical Tape:
1. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F (105 degrees C).
  2. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F (-18 degrees C) and suitable for continuous temperature environment up to 221 degrees F (105 degrees C).
- B. Wire Pulling Lubricant:
1. Listed and labeled as complying with UL 267.
  2. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
  3. Suitable for use at installation temperature.
- C. Cable Ties: Material and tensile strength rating suitable for application.
- D. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

### PART 3 EXECUTION

#### 3.01 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as indicated.
- E. Verify that conditions are satisfactory for installation prior to starting work.

#### 3.02 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

#### 3.03 INSTALLATION

- A. Circuiting Requirements:
  - 1. Unless dimensioned, circuit routing indicated is diagrammatic.
  - 2. When circuit destination is indicated without specific routing, determine exact routing required.
  - 3. Arrange circuiting to minimize splices.
  - 4. Include circuit lengths required to install connected devices within 10 ft (3.0 m) of location indicated.
  - 5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
  - 6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
  - 7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is not permitted.
    - a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
    - b. Increase size of conductors as required to account for ampacity derating.
  - 8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
  - 9. Provide oversized neutral/grounded conductors where indicated and as specified below.
    - a. Provide 200 percent rated neutral for feeders fed from K-rated transformers.
    - b. Provide 200 percent rated neutral for feeders serving panelboards with 200 percent rated neutral bus.
- B. Install products in accordance with manufacturer's instructions.
- C. Perform work in accordance with NECA 1 (general workmanship).
- D. Installation in Raceway:

1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
  2. Pull all conductors and cables together into raceway at same time.
  3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
  4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- E. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- F. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.
  2. Installation in Vertical Raceways: Provide supports where vertical rise exceeds permissible limits.
- G. Install conductors with a minimum of 12 inches (300 mm) of slack at each outlet.
- H. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- I. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- J. Make wiring connections using specified wiring connectors.
1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
  2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
  3. Do not remove conductor strands to facilitate insertion into connector.
  4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminants. Do not use wire brush on plated connector surfaces.
  5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
  6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- K. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
- L. Insulate ends of spare conductors using vinyl insulating electrical tape.
- M. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- N. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.04 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
- C. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

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## SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.

#### 1.02 RELATED REQUIREMENTS

- A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
- B. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

#### 1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

#### 1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
  - 1. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

#### 1.05 SUBMITTALS

- A. Field quality control test reports.

### PART 2 PRODUCTS

#### 2.01 GROUNDING AND BONDING REQUIREMENTS

- A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
- B. Do not use products for applications other than as permitted by NFPA 70 and product listing.

- C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

## 2.02 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
  - 1. Provide products listed, classified, and labeled as suitable for the purpose intended.
  - 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 260526:
  - 1. Use insulated copper conductors unless otherwise indicated.
    - a. Exceptions:
      - 1) Use bare copper conductors where installed underground in direct contact with earth.
      - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
- C. Connectors for Grounding and Bonding:
  - 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
  - 2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
  - 3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Make grounding and bonding connections using specified connectors.
  - 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
  - 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
  - 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
  - 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
  - 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

- D. Identify grounding and bonding system components in accordance with Section 260553.

END OF SECTION

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## SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

### PART 1 GENERAL

#### 1.01 Section Includes

- A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

#### 1.02 Reference Standards

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.
- D. MFMA-4 - Metal Framing Standards Publication; 2004.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

#### 1.03 Submittals

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel/strut framing systems, nonpenetrating rooftop supports, and post-installed concrete/masonry anchors.

### PART 2 PRODUCTS

#### 2.01 Support and Attachment Components

- A. General Requirements:
  - 1. Comply with the following. Where requirements differ, comply with most stringent.
    - a. NFPA 70.
    - b. Requirements of authorities having jurisdiction.
  - 2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of electrical work.
  - 3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
  - 4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for load to be supported with minimum safety factor of \_\_\_\_\_. Include consideration for vibration, equipment operation, and shock loads where applicable.

5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
6. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
  - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
  - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps and clamps suitable for conduit or cable to be supported.
  1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
  2. Conduit Clamps: Bolted type unless otherwise indicated.
- C. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.
- D. Metal Channel/Strut Framing Systems:
  1. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
  2. Comply with MFMA-4.
- E. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.
- F. Anchors and Fasteners:
  1. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.
  2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
  3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
  4. Hollow Masonry: Use toggle bolts.
  5. Hollow Stud Walls: Use toggle bolts.
  6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
  7. Sheet Metal: Use sheet metal screws.
  8. Preset Concrete Inserts: Continuous metal channel/strut and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
    - a. Manufacturer: Same as manufacturer of metal channel/strut framing system.
    - b. Comply with MFMA-4.
    - c. Channel Material: Use galvanized steel.

### PART 3 EXECUTION

#### 3.01 Installation

- A. Install products in accordance with manufacturer's instructions.
- B. Install hangers and supports in accordance with NECA 1.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

- E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Equipment Support and Attachment:
  - 1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
  - 2. Use metal channel/strut secured to studs to support equipment surface mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
  - 3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
  - 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- I. Secure fasteners in accordance with manufacturer's recommended torque settings.
- J. Remove temporary supports.

### 3.02 Field Quality Control

- A. Inspect support and attachment components for damage and defects.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- C. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

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SECTION 260533.13 - CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. Stainless steel rigid metal conduit (RMC).
- C. Galvanized steel intermediate metal conduit (IMC).
- D. Stainless steel intermediate metal conduit (IMC).
- E. Flexible metal conduit (FMC).
- F. Liquidtight flexible metal conduit (LFMC).
- G. Galvanized steel electrical metallic tubing (EMT).
- H. Stainless steel electrical metallic tubing (EMT).
- I. Liquidtight flexible nonmetallic conduit (LFNC).

1.02 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section 260526 - Grounding and Bonding for Electrical Systems.
- C. Section 260529 - Hangers and Supports for Electrical Systems.

1.03 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2025.
- B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S); 2020.
- C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit; 2025.
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- E. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2020.
- F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.

- I. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
- J. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.
- K. UL 360 - Liquid-Tight Flexible Metal Conduit; Current Edition, Including All Revisions.
- L. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- M. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
- N. UL 797A - Electrical Metallic Tubing - Aluminum and Stainless Steel; Current Edition, Including All Revisions.
- O. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.
- P. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

#### 1.04 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

### PART 2 PRODUCTS

#### 2.01 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.
- C. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).
- D. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).
- E. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

- F. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).
- G. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).
- H. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).
  - 1. Locations subject to physical damage include, but are not limited to:
    - a. Where exposed below 8 feet (2.4 m), except within electrical and communication rooms or closets.
    - b. Where exposed below 20 feet (6.1 m) in warehouse areas.
- I. Exposed, Interior, Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), or stainless steel intermediate metal conduit (IMC).
  - 1. Locations subject to severe physical damage include, but are not limited to:
    - a. High traffic industrial and warehouse areas where exposed below 8 feet (2.4 m), except within electrical and communication rooms or closets.
    - b. Where exposed below 20 feet (6.1 m) in industrial manufacturing areas.
- J. Flexible Connections to Vibrating Equipment:
  - 1. Dry Locations: Use flexible metal conduit (FMC).
  - 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit (LFMC).
  - 3. Maximum Length: 6 feet (1.8 m) unless otherwise indicated.
  - 4. Vibrating equipment includes, but is not limited to:
    - a. Transformers.
    - b. Motors.

## 2.02 CONDUIT - GENERAL REQUIREMENTS

- A. Comply with NFPA 70.
- B. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling mandrel through them.
- C. Provide conduit, fittings, supports, and accessories required for complete raceway system.
- D. Provide products listed, classified, and labeled as suitable for purpose intended.
- E. Minimum Conduit Size, Unless Otherwise Indicated:
  - 1. Branch Circuits: 3/4-inch (21 mm) trade size.
  - 2. Branch Circuit Homeruns: 3/4-inch (21 mm) trade size.

3. Control Circuits: 1/2-inch (16 mm) trade size.

- F. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

B. Fittings:

1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
2. Material: Use steel or malleable iron.
3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.04 STAINLESS STEEL RIGID METAL CONDUIT (RMC)

- A. Description: NFPA 70, Type RMC stainless steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6A.

B. Fittings:

1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6A.
2. Material: Use stainless steel with corrosion resistance equivalent to conduit.
3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.05 GALVANIZED STEEL INTERMEDIATE METAL CONDUIT (IMC)

- A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

B. Fittings:

1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.
2. Material: Use steel or malleable iron.
3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.06 STAINLESS STEEL INTERMEDIATE METAL CONDUIT (IMC)

- A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

B. Fittings:

1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.

2. Hazardous/Classified Locations: Use fittings listed and labeled as complying with UL 1203 for classification of installed location.
3. Material: Use stainless steel with corrosion resistance equivalent to conduit.
4. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.07 FLEXIBLE METAL CONDUIT (FMC)

- A. Description: NFPA 70, Type FMC standard-wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems.
- B. Fittings:
  1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  2. Material: Use steel or malleable iron.

2.08 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- B. Fittings:
  1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  2. Material: Use steel or malleable iron.

2.09 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

- A. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- B. Fittings:
  1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  2. Material: Use steel or malleable iron.
  3. Connectors and Couplings: Use compression/gland or set-screw type.
    - a. Do not use indenter type connectors and couplings.
  4. Damp or Wet Locations, Where Permitted: Use fittings listed for use in wet locations.

2.10 STAINLESS STEEL ELECTRICAL METALLIC TUBING (EMT)

- A. Description: NFPA 70, Type EMT stainless steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797A.
- B. Fittings:
  1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  2. Connectors and Couplings: Use compression/gland or set-screw type.
  3. Damp or Wet Locations, Where Permitted: Use fittings listed for use in wet locations.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.

### 3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in accordance with NECA 1.
- C. Galvanized Steel Rigid Metal Conduit (RMC): Install in accordance with NECA 101.
- D. Intermediate Metal Conduit (IMC): Install in accordance with NECA 101.
- E. Conduit Routing:
  - 1. Unless dimensioned, conduit routing indicated is diagrammatic.
  - 2. When conduit destination is indicated without specific routing, determine exact routing required.
  - 3. Conceal conduits unless specifically indicated to be exposed.
  - 4. Conduits in the following areas may be exposed, unless otherwise indicated:
    - a. Electrical rooms.
    - b. Mechanical equipment rooms.
    - c. Within joists in areas with no ceiling.
  - 5. Unless otherwise approved, do not route exposed conduits:
    - a. Across floors.
    - b. Across roofs.
    - c. Across top of parapet walls.
    - d. Across building exterior surfaces.
  - 6. Conduits installed underground or embedded in concrete may be routed in shortest possible manner unless otherwise indicated. Route other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
  - 7. Arrange conduit to maintain adequate headroom, clearances, and access.
  - 8. Arrange conduit to provide no more than equivalent of four 90-degree bends between pull points.
  - 9. Arrange conduit to provide no more than 150 feet (46 m) between pull points.
  - 10. Route conduits above water and drain piping where possible.
  - 11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
  - 12. Maintain minimum clearance of 6 inches (150 mm) between conduits and piping for other systems.
  - 13. Maintain minimum clearance of 12 inches (300 mm) between conduits and hot surfaces. This includes, but is not limited to:

- a. Heaters.
- b. Hot water piping.
- c. Flues.

F. Conduit Support:

- 1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction; see Section 260529.
- 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- 3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
- 4. Use conduit strap to support single surface-mounted conduit.
  - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
- 5. Use metal channel/strut with accessory conduit clamps to support multiple parallel surface-mounted conduits.
- 6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
- 7. Use trapeze hangers assembled from threaded rods and metal channel/strut with accessory conduit clamps to support multiple parallel suspended conduits.
- 8. Use nonpenetrating rooftop supports to support conduits routed across rooftops, where approved.
- 9. Use of spring steel conduit clips for support of conduits is not permitted.
- 10. Use of wire for support of conduits is not permitted.

G. Connections and Terminations:

- 1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
- 2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
- 3. Use suitable adapters where required to transition from one type of conduit to another.
- 4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
- 5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
- 6. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect conductors.
- 7. Secure joints and connections to provide mechanical strength and electrical continuity.

H. Penetrations:

- 1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
- 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
- 3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
- 4. Conceal bends for conduit risers emerging above ground.
- 5. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
- 6. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations

- are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
7. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 078400.
- I. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
    1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
    2. Where conduits are subject to earth movement by settlement or frost.
  - J. Conduit Sealing:
    1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
      - a. Where conduits enter building from outside.
      - b. Where service conduits enter building from underground distribution system.
      - c. Where conduits enter building from underground.
      - d. Where conduits may transport moisture to contact live parts.
    2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
      - a. Where conduits pass from outdoors into conditioned interior spaces.
      - b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
  - K. Provide pull string in each empty conduit and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches (300 mm) at each end.
  - L. Provide grounding and bonding; see Section 260526.
- 3.03 FIELD QUALITY CONTROL
- A. See Section 014000 - Quality Requirements for additional requirements.
  - B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
  - C. Correct deficiencies and replace damaged or defective conduits.
- 3.04 CLEANING
- A. Clean interior of conduits to remove moisture and foreign matter.



3.05 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION

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## SECTION 260533.16 - BOXES FOR ELECTRICAL SYSTEMS

### PART 1 GENERAL

#### 1.01 RELATED REQUIREMENTS

- A. Section 260529 - Hangers and Supports for Electrical Systems.
- B. Section 260533.13 - Conduit for Electrical Systems:
  - 1. Conduit bodies and other fittings.
  - 2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
- C. Section 262726 - Wiring Devices:
  - 1. Wall plates.
  - 2. Additional requirements for locating boxes for wiring devices.

#### 1.02 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2016.
- C. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- D. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.
- E. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013 (Reaffirmed 2020).
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- I. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.
- J. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

#### 1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
  - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

#### 1.04 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.
- B. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

#### 1.05 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

### PART 2 PRODUCTS

#### 2.01 BOXES

- A. General Requirements:
  1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
  2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
  3. Provide products listed, classified, and labeled as suitable for the purpose intended.
  4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
  5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches (1,650 cu cm), Including Those Used as Junction and Pull Boxes:

1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
  2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
  3. Use suitable concrete type boxes where flush-mounted in concrete.
  4. Use suitable masonry type boxes where flush-mounted in masonry walls.
  5. Use raised covers suitable for the type of wall construction and device configuration where required.
  6. Use shallow boxes where required by the type of wall construction.
  7. Do not use "through-wall" boxes designed for access from both sides of wall.
  8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
  9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
  10. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
  11. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
  12. Minimum Box Size, Unless Otherwise Indicated:
    - a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
    - b. Communications Systems Outlets: 4 inch square by 2-1/8 inch (100 by 54 mm) trade size.
    - c. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.
  13. Wall Plates: Comply with Section 262726.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):
1. Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
  2. NEMA EN 10250 Environment Type, Unless Otherwise Indicated:
    - a. Indoor Clean, Dry Locations: Type 1, painted steel.
    - b. Outdoor Locations: Type 3R, painted steel.
  3. Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):
    - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

## 2.02 ACCESSORIES

- A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for boxes and facade materials to be installed.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify that field measurements are as indicated.

- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.

### 3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide separate boxes for emergency power and normal power systems.
- E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
- H. Box Locations:
  - 1. Unless dimensioned, box locations indicated are approximate.
  - 2. Locate boxes as required for devices installed under other sections or by others.
    - a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 262726.
  - 3. Locate boxes so that wall plates do not span different building finishes.
  - 4. Locate boxes so that wall plates do not cross masonry joints.
  - 5. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
  - 6. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches (150 mm) horizontal separation unless otherwise indicated.
  - 7. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches (610 mm) horizontal separation.
  - 8. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
    - a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches (610 mm) separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
    - b. Do not install flush-mounted boxes with area larger than 16 square inches (0.0103 sq m) or such that the total aggregate area of openings exceeds 100 square inches (0.0645 sq m) for any 100 square feet (9.29 sq m) of wall area.
  - 9. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 260533.13.
  - 10. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:

- a. Concealed above accessible suspended ceilings.
    - b. Within joists in areas with no ceiling.
    - c. Electrical rooms.
    - d. Mechanical equipment rooms.
  - I. Box Supports:
    - 1. Secure and support boxes in accordance with NFPA 70 and Section 260529 using suitable supports and methods approved by the authority having jurisdiction.
    - 2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
    - 3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
  - J. Install boxes plumb and level.
  - K. Flush-Mounted Boxes:
    - 1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch (6 mm) or does not project beyond finished surface.
    - 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
    - 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch (3 mm) at the edge of the box.
  - L. Install boxes as required to preserve insulation integrity.
  - M. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
  - N. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
  - O. Close unused box openings.
  - P. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
  - Q. Provide grounding and bonding in accordance with Section 260526.
- 3.03 CLEANING
- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.04 PROTECTION

- A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION



## SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Voltage markers.
- E. Warning signs and labels.

#### 1.02 RELATED REQUIREMENTS

- A. Section 099113 - Exterior Painting.
- B. Section 099123 - Interior Painting.
- C. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- D. Section 262726 - Wiring Devices: Device and wallplate finishes; factory pre-marked wallplates.

#### 1.03 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. NFPA 70E - Standard for Electrical Safety in the Workplace; 2024.
- C. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

#### 1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
  - 1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- B. Sequencing:
  - 1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
  - 2. Do not install identification products until final surface finishes and painting are complete.

1.05 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.06 FIELD CONDITIONS

- A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

- A. Identification for Equipment:
  - 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
    - a. Switchgear:
      - 1) Identify ampere rating.
      - 2) Identify voltage and phase.
      - 3) Identify power source and circuit number. Include location when not within sight of equipment.
      - 4) Use identification nameplate to identify main and tie devices.
      - 5) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
    - b. Switchboards:
      - 1) Identify ampere rating.
      - 2) Identify voltage and phase.
      - 3) Identify power source and circuit number. Include location when not within sight of equipment.
      - 4) Use identification nameplate to identify main overcurrent protective device.
      - 5) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
    - c. Motor Control Centers:
      - 1) Identify ampere rating.
      - 2) Identify voltage and phase.
      - 3) Identify power source and circuit number. Include location when not within sight of equipment.
      - 4) Use identification nameplate to identify main overcurrent protective device.
      - 5) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
    - d. Panelboards:
      - 1) Identify ampere rating.
      - 2) Identify voltage and phase.
      - 3) Identify power source and circuit number. Include location when not within sight of equipment.

- 4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
    - 5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
    - 6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
  - e. Transformers:
    - 1) Identify kVA rating.
    - 2) Identify voltage and phase for primary and secondary.
    - 3) Identify power source and circuit number. Include location when not within sight of equipment.
    - 4) Identify load(s) served. Include location when not within sight of equipment.
  - f. Enclosed switches, circuit breakers, and motor controllers:
    - 1) Identify voltage and phase.
    - 2) Identify power source and circuit number. Include location when not within sight of equipment.
    - 3) Identify load(s) served. Include location when not within sight of equipment.
2. Use identification nameplate to identify switchboards and panelboards utilizing a high leg delta system in accordance with NFPA 70.
3. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
4. Use identification label on inside of door at each fused switch to identify required NEMA fuse class and size.
5. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70 including but not limited to the following.
  - a. Service equipment.
  - b. Industrial control panels.
  - c. Motor control centers.
  - d. Elevator control panels.
  - e. Industrial machinery.
6. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
  - a. Minimum Size: 3.5 by 5 inches (89 mm by 127 mm).
  - b. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equivalent.
  - c. Service Equipment: Include the following information in accordance with NFPA 70.
    - 1) Nominal system voltage.

- 2) Available fault current.
- 3) Clearing time of service overcurrent protective device(s).
- 4) Date label applied.

B. Identification for Conductors and Cables:

1. Color Coding for Power Conductors 600 V and Less: Comply with Section 260519.
2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
3. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
  - a. At each source and load connection.
  - b. Within boxes when more than one circuit is present.
  - c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
  - d. In cable tray, at maximum intervals of 20 feet (6.1 m).
4. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.

C. Identification for Raceways:

1. Use voltage markers, color-coded bands, or factory-painted conduits to identify systems other than normal power system for accessible conduits.
  - a. Maximum Intervals: 20 feet (6.1 m).
  - b. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches (76 mm) wide.
    - 1) Field-Painting: Comply with Section 099123 and 099113.
    - 2) Vinyl Color Coding Electrical Tape: Comply with Section 260519.
  - c. Color Code:
    - 1) Emergency Power System: Yellow .
    - 2) Fire Alarm System: Red.
2. Use identification labels or plastic marker tags to identify circuits enclosed for accessible conduits at wall penetrations, at floor penetrations, at roof penetrations, and at equipment terminations when source is not within sight.
3. Use identification labels or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.

D. Identification for Boxes:

1. Use voltage markers to identify highest voltage present.
2. Use voltage markers or color coded boxes to identify systems other than normal power system.
  - a. Color-Coded Boxes: Field-painted per the same color code used for raceways.
    - 1) Emergency Power System: Yellow .
    - 2) Fire Alarm System: Red.
  - b. For exposed boxes in public areas, do not color code.
3. Use identification labels to identify circuits enclosed.
  - a. For exposed boxes in public areas, use only identification labels.

4. Use warning labels to identify electrical hazards for boxes containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".

E. Identification for Devices:

1. Wiring Device and Wallplate Finishes: Comply with Section 262726.
2. Use identification label to identify fire alarm system devices.
  - a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.
3. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.
4. Use identification label or engraved wallplate to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.
5. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:

1. Materials:
  - a. Indoor Clean, Dry Locations: Use plastic nameplates.
  - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch (1.6 mm); engraved text.
3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch (0.8 mm); engraved or laser-etched text.
4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch (0.8 mm); engraved or laser-etched text.
5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch (25 mm) high; Four, located at corners for larger sizes.

B. Identification Labels:

1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:

1. Minimum Size: 1 inch (25 mm) by 2.5 inches (64 mm).
2. Legend:
  - a. Equipment designation or other approved description.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height:
  - a. Equipment Designation: 1/2 inch (13 mm).
5. Color:
  - a. Normal Power System: Black text on white background.

- D. Format for Receptacle Identification:
  - 1. Minimum Size: 3/8 inch (10 mm) by 1.5 inches (38 mm).
  - 2. Legend: Power source and circuit number or other designation indicated.
  - 3. Text: All capitalized unless otherwise indicated.
  - 4. Minimum Text Height: 3/16 inch (5 mm).
  - 5. Color: Black text on clear background.
- E. Format for Control Device Identification:
  - 1. Minimum Size: 3/8 inch (10 mm) by 1.5 inches (38 mm).
  - 2. Legend: Load controlled or other designation indicated.
  - 3. Text: All capitalized unless otherwise indicated.
  - 4. Minimum Text Height: 3/16 inch (5 mm).
  - 5. Color: Black text on clear background.

## 2.03 WIRE AND CABLE MARKERS

- A. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
- B. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
- C. Legend: Power source and circuit number or other designation indicated.
- D. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
- E. Minimum Text Height: 1/8 inch (3 mm).
- F. Color: Black text on white background unless otherwise indicated.

## 2.04 VOLTAGE MARKERS

- A. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.
- B. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.
- C. Minimum Size:
  - 1. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
  - 2. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches (29 by 110 mm).
  - 3. Markers for Junction Boxes: 1/2 by 2 1/4 inches (13 by 57 mm).
- D. Legend:
  - 1. Markers for Voltage Identification: Highest voltage present.
  - 2. Markers for System Identification:
- E. Color: Black text on orange background unless otherwise indicated.

## 2.05 WARNING SIGNS AND LABELS

- A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- B. Warning Signs:
  - 1. Materials:
    - a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
    - b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
  - 2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
  - 3. Minimum Size: 7 by 10 inches (178 by 254 mm) unless otherwise indicated.
- C. Warning Labels:
  - 1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
  - 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
  - 3. Minimum Size: 2 by 4 inches (51 mm by 102 mm) unless otherwise indicated.

## PART 3 EXECUTION

### 3.01 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

### 3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
  - 1. Surface-Mounted Equipment: Enclosure front.
  - 2. Flush-Mounted Equipment: Enclosure front.
  - 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
  - 4. Elevated Equipment: Legible from the floor or working platform.
  - 5. Branch Devices: Adjacent to device.
  - 6. Interior Components: Legible from the point of access.
  - 7. Conduits: Legible from the floor.
  - 8. Boxes: Outside face of cover.
  - 9. Conductors and Cables: Legible from the point of access.
  - 10. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.

- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Secure rigid signs using stainless steel screws.
- G. Mark all handwritten text, where permitted, to be neat and legible.

3.03 FIELD QUALITY CONTROL

- A. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION



## SECTION 260583 - WIRING CONNECTIONS

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Electrical connections to equipment.

#### 1.02 RELATED REQUIREMENTS

- A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables.
- B. Section 260533.13 - Conduit for Electrical Systems.
- C. Section 260533.16 - Boxes for Electrical Systems.
- D. Section 262726 - Wiring Devices.
- E. Section 262816.16 - Enclosed Switches.

#### 1.03 REFERENCE STANDARDS

#### 1.04 ADMINISTRATIVE REQUIREMENTS

- A. Sequencing:
  - 1. Install rough-in of electrical connections before installation of equipment is required.
  - 2. Make electrical connections before required start-up of equipment.

### PART 2 PRODUCTS

#### 2.01 MATERIALS

- A. Disconnect Switches: As specified and in individual equipment sections.
- B. Wiring Devices: As specified in Section 262726.
- C. Wire and Cable: As specified in Section 260519.
- D. Boxes: As specified in Section 260533.16.

### PART 3 EXECUTION

#### 3.01 EXAMINATION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION

## SECTION 262726 - WIRING DEVICES

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Receptacles.
- B. Wall plates and covers.

#### 1.02 RELATED REQUIREMENTS

- A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Manufactured wiring systems for use with access floor boxes with compatible pre-wired connectors.
- B. Section 260526 - Grounding and Bonding for Electrical Systems.
- C. Section 260533.16 - Boxes for Electrical Systems.
- D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 260583 - Wiring Connections: Cords and plugs for equipment.

#### 1.03 REFERENCE STANDARDS

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for; 2014h (Validated 2022).
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- C. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2016.
- D. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (Reaffirmed 2020).
- E. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2021.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.
- H. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.
- I. UL 943 - Ground-Fault Circuit-Interruption; Current Edition, Including All Revisions.

#### 1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:

1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
3. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
4. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

#### 1.05 SUBMITTALS

- A. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

#### 1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.

### PART 2 PRODUCTS

#### 2.01 Wiring Devices - General Requirements

- A. Provide wiring devices suitable for intended use with ratings adequate for load served.
- B. Except where explicitly permitted, substitution of combination switch-and-receptacle devices for separate switches and receptacles is not permitted.
- C. Wiring Device Applications:
  1. Receptacles Installed Outdoors or in Damp or Wet Locations: Use weather-resistant GFCI receptacles with weatherproof covers.
  2. Provide GFCI protection for:
    - a. Receptacles installed within 6 feet (1.8 m) of sinks.
- D. Wiring Device Finishes:
  1. Provide wiring device finishes as described below, unless otherwise indicated.
  2. Wiring Devices, Unless Otherwise Indicated: White with stainless steel wall plate.
  3. Wiring Devices Installed in Wet or Damp Locations: White with weatherproof cover.
  4. Wiring Devices Connected to Emergency Power: Red with stainless steel wall plate.

#### 2.02 RECEPTACLES

- A. General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
  1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
  2. NEMA configurations specified are according to NEMA WD 6.

B. Convenience Receptacles:

1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
2. Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.

C. GFCI Receptacles:

1. General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
  - a. Provide test and reset buttons of same color as device.
2. Standard GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
3. Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations.

2.03 Wall Plates and Covers

A. Wall Plates: Comply with UL 514D.

1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
2. Size: Standard; \_\_\_\_\_.
3. Screws: Metal with slotted heads finished to match wall plate finish.

B. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.

C. Weatherproof Receptacle Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.

D. Weatherproof Receptacle Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.

- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- F. Verify that conditions are satisfactory for installation prior to starting work.

### 3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

### 3.03 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 260533.16 as required for installation of wiring devices provided under this section.
  - 1. Mounting Heights: Unless otherwise indicated, as follows:
    - a. Wall Switches: 48 inches (1200 mm) above finished floor.
    - b. Receptacles: 18 inches (450 mm) above finished floor or 6 inches (150 mm) above counter.
  - 2. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
- C. Install wiring devices in accordance with manufacturer's instructions.
- D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- E. Where required, connect wiring devices using pigtails not less than 6 inches (150 mm) long. Do not connect more than one conductor to wiring device terminals.
- F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- H. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
- I. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- J. Install wall switches with OFF position down.
- K. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.

- L. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- M. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

### 3.04 FIELD QUALITY CONTROL

- A. Inspect each wiring device for damage and defects.
- B. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
- C. Test each receptacle to verify operation and proper polarity.
- D. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- E. Correct wiring deficiencies and replace damaged or defective wiring devices.

### 3.05 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

### 3.06 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

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## SECTION 262816.16 - ENCLOSED SWITCHES

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Enclosed safety switches.

#### 1.02 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding for Electrical Systems.
- B. Section 260529 - Hangers and Supports for Electrical Systems.
- C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 262813 - Fuses.

#### 1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- B. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- C. NEMA BS 31047 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013 (Reaffirmed 2023).
- D. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

#### 1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
  - 1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

#### 1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

#### 1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

#### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

### PART 2 PRODUCTS

#### 2.01 ENCLOSED SAFETY SWITCHES

- A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
  1. Altitude: Less than 6,600 feet (2,000 m).
  2. Ambient Temperature: Between -22 degrees F (-30 degrees C) and 104 degrees F (40 degrees C).
- D. Horsepower Rating: Suitable for connected load.
- E. Voltage Rating: Suitable for circuit voltage.
- F. Short Circuit Current Rating:

1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
2. Minimum Ratings:
  - a. Heavy Duty Single Throw Switches Protected by Class R, Class J, Class L, or Class T Fuses: 200,000 rms symmetrical amperes.
- G. Provide with switch blade contact position that is visible when the cover is open.
- H. Fuse Clips for Fusible Switches: As required to accept fuses indicated.
  1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.
- I. Conductor Terminations: Suitable for use with the conductors to be installed.
- J. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.
- K. Enclosures: Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E.
  1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
    - a. Indoor Clean, Dry Locations: Type 1.
    - b. Outdoor Locations: Type 3R.
  2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
- L. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
- M. Heavy Duty Switches:
  1. Comply with NEMA BS 31047.
  2. Conductor Terminations:
    - a. Provide mechanical lugs unless otherwise indicated.
    - b. Lug Material: Copper, suitable for terminating copper conductors only.
  3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

### PART 3 EXECUTION

#### 3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 260529.

- E. Install enclosed switches plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches (2000 mm) above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 260526.
- H. Provide fuses complying with Section 262813 for fusible switches as indicated or as required by equipment manufacturer's recommendations.
- I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

### 3.02 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
- C. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

### 3.03 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

### 3.04 CLEANING

- A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

## SECTION 262923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Variable-frequency motor controllers for low-voltage (600 V and less) AC motor applications.
- B. Overcurrent protective devices for motor controllers, including overload relays.

#### 1.02 RELATED REQUIREMENTS

- A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Variable-frequency drive cable.
- B. Section 260526 - Grounding and Bonding for Electrical Systems.
- C. Section 260529 - Hangers and Supports for Electrical Systems.
- D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 262813 - Fuses.

#### 1.03 REFERENCE STANDARDS

- A. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code); 1989 (Corrigendum 2019).
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- C. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- D. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2008 (Reaffirmed 2020).
- E. NEMA IA 10039 - Control Circuit and Pilot Devices; 2025.
- F. NEMA IA 10030 - Industrial Control and Systems: Enclosures; 2024.
- G. NEMA IS 10033 - Industrial Control and Systems: Adjustable-Speed Drives; 2026.
- H. NEMA IS 10034 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems; 2022 (Reapproved 2025).
- I. NEMA IS 10035 - Application Guide for AC Adjustable Speed Drive Systems; 2021 (Reaffirmed 2025).

- J. NEMA ICS 61800-2 - Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements-Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems; 2023.
- K. NEMA BS 31047 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013 (Reaffirmed 2023).
- L. NEMA MG 00001 - Motors and Generators; 2024.
- M. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.
- N. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- O. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.
- P. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- Q. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.
- R. UL 61800-5-1 - Standard for Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements – Electrical, Thermal, and Energy (Ed. 2); Current Edition, Including All Revisions.

#### 1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
  - 1. Coordinate work to avoid placement of ductwork, piping, equipment, and other obstructions within dedicated equipment spaces and working clearances required by NFPA 70.
  - 2. Coordinate work to provide motor controllers suitable for use with motors.
  - 3. Coordinate work to provide controllers and associated wiring suitable for interface with control devices.
  - 4. Coordinate arrangement of electrical equipment with dimensions and clearance requirements.
  - 5. Verify with manufacturer that conductor terminations are suitable for use with conductors.
  - 6. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

#### 1.05 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.
- B. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
  - 1. Include wiring diagrams showing factory and field connections.

- C. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
- D. Project Record Documents: Record actual installed locations of controllers and final equipment settings.
  - 1. Include nameplate data of actual installed motors and associated overload relay selections and settings.
  - 2. Motor Circuit Protectors: Include magnetic instantaneous trip settings.

#### 1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

#### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Maintain factory wrapping or provide additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

#### 1.08 FIELD CONDITIONS

- A. Maintain field conditions within required service conditions during and after installation.

### PART 2 PRODUCTS

#### 2.01 MANUFACTURERS

- A. Variable-Frequency Motor Controllers:
  - 1. ABB: [www.new.abb.com/#sle](http://www.new.abb.com/#sle).
  - 2. Eaton Corporation: [www.eaton.com/#sle](http://www.eaton.com/#sle).
  - 3. Rockwell Automation, Inc.: [www.rockwellautomation.com/#sle](http://www.rockwellautomation.com/#sle).
  - 4. Schneider Electric: [www.se.com/#sle](http://www.se.com/#sle).
- B. Source Limitations: Provide variable-frequency motor controllers and associated components produced by single manufacturer and obtained from single supplier.

#### 2.02 VARIABLE-FREQUENCY MOTOR CONTROLLERS

- A. Provide variable-frequency motor control system consisting of required controller assemblies, operator interfaces, control power transformers, instrumentation and control wiring, sensors, accessories, system programming, etc. as necessary for complete operating system.
- B. Provide products listed, classified, and labeled as suitable for purpose intended.

- C. Variable-Frequency Motor Controller:
  - 1. Configuration: Packaged controller with across-the-line bypass.
  - 2. Power Conversion System: Diode-based, 6-pulse type.
  - 3. Filtering: Provide input/line reactor and output/load reactor.
- D. Controller Assemblies: Comply with NEMA IS 10033, NEMA IS 10034, and NEMA ICS 61800-2; list and label as complying with UL 61800-5-1 or UL 508A as applicable.
- E. Provide controllers selected for actual installed motors and coupled mechanical loads in accordance with NEMA IS 10035, NEMA MG 00001 Part 30, and recommendations of manufacturers of both controller and load, where not in conflict with specified requirements; considerations include, but are not limited to:
  - 1. Motor type (e.g., induction, reluctance, and permanent magnet); consider NEMA MG 00001 design letter or inverter duty rating for induction motors.
  - 2. Motor load type (e.g., constant torque, variable torque, and constant horsepower); consider duty cycle, impact loads, and high inertia loads.
  - 3. Motor nameplate data.
  - 4. Requirements for speed control range, speed regulation, and braking.
  - 5. Motor suitability for bypass starting method, where applicable.
- F. Devices on Load Side of Controller: Suitable for application across full controller output frequency range.
- G. Operating Requirements:
  - 1. Input Voltage Tolerance: Plus/minus 10 percent of nominal.
  - 2. Input Frequency Tolerance: Plus/minus 5 percent of nominal.
  - 3. Efficiency: Minimum of 96 percent at full speed and load.
  - 4. Input Displacement Power Factor: Minimum of 0.96 throughout speed and load range.
  - 5. Overload Rating:
    - a. Variable Torque Loads: Minimum of 110 percent of nominal for 60 seconds.
    - b. Constant Torque Loads: Minimum of 150 percent of nominal for 60 seconds.
- H. Power Conversion System: Microprocessor-based, pulse width modulation type.
- I. Control System:
  - 1. Provide microprocessor-based control system for automatic control, monitoring, and protection of motors. Include sensors, wiring, and connections necessary for functions and status/alarm indications specified.
  - 2. Provide integral operator interface for controller programming, display of status/alarm indications, fault reset, and local control functions including motor run/stop, motor forward/reverse selection, motor speed increase/decrease, and local/remote control selection.
  - 3. Control Functions:
    - a. Control Method: Selectable vector and scalar/volts per hertz unless otherwise indicated.
      - 1) Scalar/Volts per Hertz Control: Provide IR compensation for improved low-speed torque.
      - 2) Vector Control: Provide selectable autotuning function.
    - b. Adjustable acceleration and deceleration time; linear and S-curve ramps; selectable coast to stop.



- c. Selectable braking control; DC injection or flux braking.
  - d. Adjustable minimum/maximum speed limits.
  - e. Adjustable pulse width modulation switching carrier frequency.
  - f. Adjustable motor slip compensation.
  - g. Selectable autorestart after noncritical fault; programmable number of time delay between restart attempts.
- 4. Status Indications:
  - a. Motor run/stop status.
  - b. Motor forward/reverse status.
  - c. Local/remote control status.
  - d. Output voltage.
  - e. Output current.
  - f. Output frequency.
  - g. DC bus voltage.
  - h. Motor speed.
- 5. Protective Functions/Alarm Indications:
  - a. Overcurrent.
  - b. Motor overload.
  - c. Undervoltage.
  - d. Overvoltage.
  - e. Controller overtemperature.
  - f. Input/output phase loss.
  - g. Output short circuit protection.
  - h. Output ground fault protection.
- 6. Inputs:
  - a. Digital Input(s): Three.
  - b. Analog Input(s): Two.
- 7. Outputs:
- 8. Communications: Compatible with connected systems. Provide accessories necessary for proper interface.
  - a. Serial Communications: RS-485; support for Modbus RTU protocol.
- 9. Features:
  - a. Password-protected security access.
  - b. Event log.
- J. Power Conditioning/Filtering:
  - 1. Provide DC link choke or input/line reactor for each controller unless otherwise indicated or required.
  - 2. Reactor Impedance: 3 percent, unless otherwise indicated or required.
- K. Packaged Controllers: Controllers factory-mounted in separate enclosure with externally operable disconnect and specified accessories.
  - 1. Disconnects: Circuit breaker or disconnect switch type.
    - a. Disconnect Switches: Fusible type or nonfusible type with separate input fuses.
    - b. Provide externally operable handle with means for locking in OFF position. Provide safety interlock to prevent opening cover with disconnect in ON position with capability of overriding interlock for testing purposes.

- c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
  2. Provide door-mounted remote operator interface.
  3. Packaged Controllers with Bypass: Provide contactors and controls to enable removal of variable-frequency controller from circuit.
    - a. Bypass Method: Manual, unless otherwise indicated.
    - b. Bypass Configuration: 3-contactor type, with contactors for bypass, drive output, and drive input.
    - c. Bypass Motor Starting Method: Full-voltage (across-the-line) with overload relay, unless otherwise indicated or required.
    - d. Overload Relays: Solid state or bimetallic thermal type.
  4. Pilot Devices Required:
    - a. Furnish local pilot devices for each unit as specified below unless otherwise indicated on drawings, except where equivalent function is provided by remote operator interface.
    - b. Packaged Controllers with Bypass:
      - 1) Bypass Mode Selector Switch: DRIVE/OFF/BYPASS.
      - 2) Motor Control Selector Switch: HAND/OFF/AUTO.
      - 3) Indicating Lights: For drive/bypass mode status, drive/bypass run status, and drive/bypass fault status.
- L. Service Conditions:
  1. Provide controllers and associated components suitable for operation under following service conditions without derating:
    - a. Altitude: Less than 3,300 feet (1,000 m).
    - b. Ambient Temperature: Between 32 degrees F (0 degrees C) and 104 degrees F (40 degrees C).
  2. Provide controllers and associated components suitable for operation at indicated ratings under service conditions at installed location.
- M. Short Circuit Current Rating:
  1. Provide controllers with listed short circuit current rating not less than available fault current at installed location as indicated on drawings.
  2. Provide line/input reactors where specified by manufacturer for required short circuit current rating.
- N. Conductor Terminations: Suitable for use with conductors to be installed.
- O. Enclosures:
  1. Comply with NEMA IA 10030.
  2. NEMA EN 10250 Environment Type or Equivalent IEC 60529 Rating: Unless otherwise indicated, as specified for following installation locations:
    - a. Indoor Clean, Dry Locations: Type 1 or Type 12.
  3. Finish: Manufacturer's standard unless otherwise indicated.
  4. Cooling: Forced air or natural convection as determined by manufacturer.

## 2.03 OVERCURRENT PROTECTIVE DEVICES

- A. Overload Relays:

1. Provide overload relays and, where applicable, associated current elements/heaters selected for actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.
  2. Comply with NEMA ICS 2.
  3. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
  4. Trip-free operation.
  5. Visible trip indication.
  6. Resettable.
    - a. Employ manual reset unless otherwise indicated.
    - b. Do not employ automatic reset with two-wire control.
  7. Bimetallic Thermal Overload Relays:
    - a. Interchangeable current elements/heaters.
    - b. Adjustable trip; plus/minus 10 percent of nominal, minimum.
    - c. Trip test function.
  8. Melting Alloy Thermal Overload Relays:
    - a. Interchangeable current elements/heaters.
  9. Solid State Overload Relays:
    - a. Adjustable full load current.
    - b. Phase loss protection.
    - c. Phase imbalance protection.
    - d. Ambient temperature insensitive.
    - e. Thermal memory.
    - f. Trip test function.
    - g. Provide isolated alarm contact.
- B. Fusible Disconnect Switches:
1. Description: Quick-make, quick-break, dead-front fusible switch units complying with NEMA BS 31047, and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated or as required.
  2. Fuse Clips: As required to accept indicated fuses.
    - a. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.
  3. Provide externally operable handle with means for locking in OFF position. Provide means for locking switch cover in closed position. Provide safety interlock to prevent opening of cover with switch in ON position with capability of overriding interlock for testing purposes.
- C. Circuit Breakers:
1. Motor Circuit Protectors:
    - a. Description: Instantaneous-trip circuit breakers furnished with magnetic instantaneous tripping elements for short circuit protection, but not with thermal inverse time tripping elements for overload protection; UL 489 recognized only for use as part of listed combination motor controller with overload protection; ratings, configurations, and features as indicated or as required.
    - b. Provide field-adjustable magnetic instantaneous trip setting.
    - c. Provide following features and accessories where indicated or where required to complete installation:

- 1) Pad-Lock Provision: For locking circuit breaker handle in OFF position.

## 2.04 ACCESSORIES

- A. Pilot Devices:
  1. Comply with NEMA IA 10039; heavy-duty type.
  2. Pushbuttons: Unless otherwise indicated, provide momentary, nonilluminated type with flush button operator; normally open or normally closed as indicated or as required.
  3. Selector Switches: Unless otherwise indicated, provide maintained, nonilluminated type with knob operator; number of switch positions as indicated or as required.
  4. Indicating Lights: Push-to-test type unless otherwise indicated.
  5. Provide LED lamp source for indicating lights and illuminated devices.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install controllers in accordance with NECA 1 (general workmanship).
- C. Install in accordance with NEMA IS 10034 and manufacturer's instructions.
- D. Do not exceed manufacturer's recommended maximum cable length between controller and motor.
- E. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- F. Provide required support and attachment in accordance with Section 260529.
- G. Install controllers plumb and level.
- H. Provide grounding and bonding in accordance with Section 260526.
- I. Install field-installed devices, components, and accessories.
- J. Provide fuses complying with Section 262813 for fusible switches as indicated.
- K. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- L. Set field-adjustable settings of controllers and associated components according to installed motor requirements, in accordance with recommendations of manufacturers of controller and load.

### 3.02 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.

- B. Perform inspections and tests listed in NETA ATS, Section 7.17. Insulation-resistance test on control wiring listed as optional is not required.
- C. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
- D. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers larger than \_\_\_\_\_ amperes. Tests listed as optional are not required.
- E. Packaged Controllers with Bypass: Test for proper operation in both drive and bypass modes.
- F. Correct deficiencies and replace damaged or defective controllers or associated components.

### 3.03 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

### 3.04 CLEANING

- A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

### 3.05 CLOSEOUT ACTIVITIES

- A. Demonstration: Demonstrate proper operation of controllers to Owner, and correct deficiencies or make adjustments as directed.
- B. Training: Train Owner's personnel on operation, adjustment, and maintenance of controllers and associated devices.
  - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

### 3.06 PROTECTION

- A. Protect installed controllers from subsequent construction operations.

END OF SECTION



# GARDNER INTERNATIONAL MAGNET SCHOOL CHILLER REPLACEMENT

333 DAHLIA DR.  
LANSING, MI 48911

MATRIX PROJECT NUMBER: 260150.00  
LANSING SCHOOLS PROJECT NO. SO-1858

MECHANICAL/ELECTRICAL ENGINEER

MATRIX CONSULTING ENGINEERS, INC.  
544 CHERBOURG DRIVE  
LANSING, MI 48917  
(517) 487-2511



| DRAWING INDEX |             |
|---------------|-------------|
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| MECHANICAL DRAWING INDEX |                                          |
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| M-100                    | MECHANICAL SYMBOLS, ABBREV., + NOTES     |
| M-300                    | MECHANICAL ROOM PLAN - PIPING DEMOLITION |
| M-301                    | PARTIAL ROOF PLAN - PIPING DEMOLITION    |
| M-600                    | MECHANICAL ROOM PLAN - PIPING NEW        |
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| M-800                    | CHILLER PIPING DIAGRAM - DEMOLITION      |
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| ELECTRICAL DRAWING INDEX |                                            |
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| E-100                    | ELECTRICAL SYMBOLS, ABBREV. AND NOTES      |
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| E-500                    | MECHANICAL ROOM PLAN POWER                 |
| E-600                    | EXISTING RISER DIAGRAM AND PANEL SCHEDULES |
| E-601                    | REVISED RISER DIAGRAM AND PANEL SCHEDULES  |

| REVISIONS  |              |
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| 05/18/2026 | 100% BID SET |
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| APPROVED |  |
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| CAT      |  |



**MATRIX**  
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Matrix Project No. 260150.00

PROJECT

GARDNER INTERNATIONAL MAGNET SCHOOL  
CHILLER REPLACEMENT  
333 DAHLIA DR, LANSING, MI

| SHEET DESCRIPTION |
|-------------------|
| COVER SHEET       |

| DATE       |
|------------|
| 05/18/2026 |

| PROJECT NUMBER |
|----------------|
| 260150.00      |

| SHEET NUMBER |
|--------------|
| G-100        |



MECHANICAL ABBREVIATIONS

|        |                                          |         |                                          |
|--------|------------------------------------------|---------|------------------------------------------|
| AFF    | ABOVE FINISH FLOOR                       | ID      | INSIDE DIAMETER                          |
| AC     | AIR COMPRESSOR                           | I.E.    | INVERT ELEVATION                         |
| AHU    | AIR HANDLING UNIT                        | IAH     | INTAKE HOOD                              |
| AS     | AIR SEPARATOR                            |         |                                          |
| A.T.C. | ARCHITECTURAL TRADES CONTRACTOR          | LAT     | LEAVING AIR TEMPERATURE                  |
|        |                                          | LH      | LATENT HEAT (MBH)                        |
| B      | BOILER                                   | LWT     | LEAVING WATER TEMPERATURE                |
| B.A.S. | BUILDING AUTOMATION SYSTEM               |         |                                          |
| CAF    | COMBUSTION AIR FAN                       | MAX     | MAXIMUM                                  |
| CC     | COOLING COIL                             | MBH     | BTU PER HOUR (THOUSAND)                  |
| CFM    | CUBIC FEET PER MINUTE                    | MIN     | MINIMUM                                  |
| CHLR   | CHILLER                                  | M.T.C.  | MECHANICAL TRADES CONTRACTOR             |
| CHP    | CONSOLE HEAT PUMP                        |         |                                          |
| CONV   | CONVECTOR                                | N.C.    | NOISE CRITERIA                           |
| CT     | COOLING TOWER                            | NFPA    | NATIONAL FIRE PROTECTION ASSOCIATION     |
| CU     | CONDENSING UNIT                          | NTS     | NOT TO SCALE                             |
| CUH    | CABINET UNIT HEATER                      |         |                                          |
| CV     | CONTROL VALVE                            | P       | PUMP                                     |
| CWP    | CHILLED WATER PUMP                       | PCR     | PUMPED CONDENSATE RETURN                 |
|        |                                          | PD      | PRESSURE DROP                            |
|        |                                          |         |                                          |
| DB     | DRY BULB                                 | RCP     | RADIANT CEILING PANEL                    |
| DFU    | DUCT FURNACE                             | REQ'D   | REQUIRED                                 |
| DIA    | DIAMETER                                 | RG      | RETURN GRILLE                            |
| DN     | DOWN                                     | RH      | RELATIVE HUMIDITY                        |
| DKR    | DAMPER                                   | RLH     | RELIEF HOOD                              |
| DS     | DUCT SILENCER                            | RTU     | ROOF TOP UNIT                            |
|        |                                          |         |                                          |
| EAT    | ENTERING AIR TEMPERATURE                 | SD      | SUPPLY DIFFUSER                          |
| EF     | EXHAUST FAN                              | SF      | SUPPLY FAN                               |
| EG     | EXHAUST GRILLE                           | SG      | SUPPLY GRILLE                            |
| E.T.C. | ELECTRICAL TRADES CONTRACTOR             | SH      | SENSIBLE HEAT (MBH)                      |
| EVR    | EVAPORATOR                               | SM      | SHEET METAL                              |
| EWT    | ENTERING WATER TEMPERATURE               | SQ. FT. | SQUARE FEET                              |
| EXH    | EXHAUST                                  | SST     | SATURATED SUCTION TEMPERATURE            |
| EXIST  | EXISTING                                 | STR     | STRAINER                                 |
|        |                                          |         |                                          |
| FF     | FINISH FLOOR                             | TC      | TOTAL COOLING (MBH)                      |
| PFM    | FEET PER MINUTE                          | TCL     | TEMPERATURE CONTROL                      |
| FT     | FEET                                     | T&P     | TEMPERATURE & PRESSURE RELIEF VALVE      |
| FTR    | FINNED TUBE RADIATION                    | TYP     | TYPICAL                                  |
| FU     | FURNACE                                  |         |                                          |
|        |                                          | UH      | UNIT HEATER                              |
| GAL    | GALLON                                   |         |                                          |
| GFRH   | GAS FIRED RADIANT HEATER                 | VAV     | VARIABLE AIR VOLUME BOX                  |
| GR     | GRILLE                                   | VRH     | VARIABLE AIR VOLUME REHEAT BOX           |
|        |                                          | FPVAV   | FAN POWERED VARIABLE AIR VOLUME BOX      |
|        |                                          | V.F.D   | VARIABLE FREQUENCY DRIVE                 |
| H      | HUMIDIFIER                               |         |                                          |
| HC     | HEATING COIL                             |         |                                          |
| HD     | HEAD (FT)                                |         |                                          |
| HP     | HORSE POWER                              |         |                                          |
| HHP    | HORIZONTAL HEAT PUMP                     |         |                                          |
| HTG    | HEATING                                  |         |                                          |
| HVAC   | HEATING, VENTILATION, & AIR CONDITIONING |         |                                          |
| HWP    | HEATING WATER PUMP                       |         |                                          |
| HX     | HEAT EXCHANGER                           |         |                                          |
|        |                                          | X-SA    | EXISTING ITEM (EXISTING SUPPLY AIR DUCT) |
|        |                                          |         | ITEM                                     |
|        |                                          |         | EXISTING                                 |

GENERAL HVAC NOTES

- ALL WORK SHALL CONFORM TO MICHIGAN MECHANICAL CODE, LATEST APPLICABLE EDITION.
- INSTALL ALL EQUIPMENT, MATERIALS, AND ACCESSORIES PER MANUFACTURERS WRITTEN INSTRUCTIONS.
- ALL EXISTING SYSTEMS (INCLUDING EXHAUST FANS; AIR HANDLING UNITS; PUMPS) THAT SERVES AREAS BEING RENOVATED SHALL BE REBALANCED AS REQUIRED.
- NOTIFY OWNER OF ANY PIPING OR DUCTWORK DEMOLITION THAT MAY AFFECT NORMAL OPERATION OF OTHER AREAS.
- FIELD VERIFY LOCATIONS OF EXISTING PIPING THAT MAY CONFLICT WITH NEW CONSTRUCTION AND RELOCATE AS NEEDED.
- CONTRACTOR SHALL COORDINATE ALL WORK WITH OTHER DISCIPLINES PRIOR TO CONSTRUCTION TO AVOID CONFLICTS.
- PROVIDE MANUAL AIR VENTS WITH 3/4" HOSE CONNECTION AT ALL HIGH POINTS.
- THE CONTRACTOR SHALL FIELD VERIFY THE SIZES, LOCATION, ELEVATIONS, AND DETAILS OF ALL EXISTING CONDITIONS THAT MAY AFFECT THE WORK.
- THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING THE INTEGRITY OF ALL EQUIPMENT AND MATERIALS IN A "NEW" CONDITION DURING CONSTRUCTION.
- ALL WORK SHALL BE PERFORMED BY LICENSED CONTRACTORS AND SUBCONTRACTORS AS REQUIRED BY LAW.
- IF THERE IS CONFLICTING INFORMATION IN THE PLANS OR SPECIFICATIONS THE MORE STRINGENT AND GREATER COST ITEM SHALL BE USED.
- DRAWINGS INDICATE REQUIRED SIZES AND POINTS OF TERMINATION OF PIPES AND SUGGESTED ROUTES. IT IS NOT INTENTION OF DRAWINGS TO INDICATE ALL NECESSARY OFFSETS. INSTALL WORK IN MANNER TO CONFORM TO STRUCTURE, AVOID OBSTRUCTIONS, PRESERVE HEADROOM AND KEEP OPENINGS AND PASSAGEWAYS CLEAR. DO NOT SCALE FROM DRAWINGS.
- ANY INFORMATION FOUND ON THE DRAWINGS AND NOT IN THE SPECIFICATIONS, OR FOUND IN SPECIFICATIONS AND NOT IN THE DRAWINGS, SHALL BE CONSTRUED AS TO BE INCLUDED IN BOTH THE SPECIFICATIONS AND THE DRAWINGS. ANY CONFLICT BETWEEN THE PLANS AND THE SPECIFICATIONS WILL BE INTERPRETED BY THE ARCHITECT. IN THE EVENT OF CONFLICT, FOR THE PURPOSE OF BIDDING, THE CONTRACTOR SHALL PRESUME THE MOST EXPENSIVE COMBINATION OF QUALITY AND QUANTITY OF WORK SHALL PREVAIL.
- ABUSE OF THE REQUEST FOR INFORMATION (RFI) PROCESS WILL NOT BE TOLERATED. RFIS REQUESTING INFORMATION ALREADY CONTAINED IN THE DESIGN DOCUMENTS, INVOLVING MEANS AND METHODS OF CONSTRUCTION, COORDINATION OF WORK BETWEEN TRADES, OR ITEMS NOT PREVIOUSLY AND THOROUGHLY INVESTIGATED AND RESEARCHED BY THE GENERAL CONTRACTOR WILL BE RETURNED UNANSWERED TO THE GENERAL CONTRACTOR. ALLOW TWO WEEKS FOR RFI RESPONSES FROM THE DESIGN TEAM.
- PERFORM WORK IN ACCORDANCE WITH THE LATEST EDITIONS, REVISIONS, AMENDMENTS, OR SUPPLEMENTS OF APPLICABLE STATUTES, ORDINANCES, CODES OR REGULATIONS OF FEDERAL, STATE, AND LOCAL AUTHORITIES HAVING JURISDICTION IN EFFECT ON THE DATE BIDS ARE RECEIVED.
- WHERE APPROVED STANDARDS HAVE BEEN ESTABLISHED BY OSHA, UNDERWRITERS, LABORATORIES, AMERICAN CODES, ASA, ASHRAE, ARI, NEC, STATE FIRE INSURANCE REGULATION BODY, NFPA OR OTHERS, THESE STANDARDS SHALL BE FOLLOWED WHETHER OR NOT INDICATED ON THE DRAWING AND SPECIFICATIONS.
- PIPING LAYOUT IS SCHEMATIC. EXACT LOCATION OF PIPING AND EQUIPMENT SHALL BE COORDINATED WITH BUILDING STRUCTURE, EQUIPMENT FURNISHED, ARCHITECTURAL DRAWINGS, AND ALL OTHER TRADES PRIOR TO INSTALLATION. ANY CONTRACTOR INSTALLING WORK WITHOUT PRIOR COORDINATION SHALL RELOCATE HIS WORK AT HIS EXPENSE TO ALLOW PROPER INSTALLATION OF ANY AND ALL TRADES WORK.
- UNLESS OTHERWISE NOTED, ALL PIPING SHALL BE CONCEALED WHEREVER POSSIBLE. PROVIDE CHROME ESCUTCHEON AT EACH PENETRATION OF A FINISHED SURFACE.
- PIPING SHALL NOT BE RUN ABOVE ELECTRICAL GEAR IN THE SERVICE SPACE REQUIRED BY THE NATIONAL ELECTRICAL CODE.
- ANY ADDITIONAL LOW VOLTAGE CONTROL WIRING THAT IS REQUIRED SHALL BE PROVIDED BY THE HVAC CONTRACTOR. CONTROL WIRING SHALL BE RUN IN CONDUIT IF REQUIRED BY LOCAL CODES OR THE SPECIFICATIONS. POWER SHALL BE PROVIDED BY THE ELECTRICAL CONTRACTOR.
- PROVIDE VIBRATION ISOLATION AT EACH CONNECTION TO A MOTORIZED PIECE OF EQUIPMENT BY THE HVAC CONTRACTOR.

GENERAL DEMOLITION NOTES

- SEE ARCHITECTURAL DRAWINGS FOR ADDITIONAL INFORMATION.
- EXISTING EQUIPMENT LAYOUT IS SCHEMATIC. EXACT LOCATION OF EXISTING DUCT/PIPING AND EQUIPMENT SHALL BE COORDINATED WITH BUILDING STRUCTURE, EQUIPMENT FURNISHED, ARCHITECTURAL DRAWINGS AND ALL OTHER TRADES PRIOR TO DEMOLITION.
- PERFORM WORK IN ACCORDANCE WITH THE LATEST EDITIONS, REVISIONS, AMENDMENTS, OR SUPPLEMENTS OF APPLICABLE STATUTES, ORDINANCES, CODES OR REGULATIONS OF FEDERAL, STATE, AND LOCAL AUTHORITIES HAVING JURISDICTION IN EFFECT ON THE DATE BIDS ARE RECEIVED.
- WHERE APPROVED STANDARDS HAVE BEEN ESTABLISHED BY OSHA, UNDERWRITERS LABORATORIES, AMERICAN CODES, ASA, ASHRAE, ARI, NEC, STATE FIRE INSURANCE REGULATION BODY, NFPA OR OTHERS. THESE STANDARDS SHALL BE FOLLOWED WHETHER OR NOT INDICATED ON THE DRAWING AND SPECIFICATIONS.
- COORDINATE CUTTING AND PATCHING WITH GENERAL CONTRACTOR.
- ALL BOLD DASHED LINES INDICATE ITEMS TO BE REMOVED UNLESS NOTED BY KEYNOTE. ALL OTHER EXISTING SYSTEMS SHOWN FOR REFERENCE ONLY.
- PATCH AND REPAIR ALL FLOOR AND WALL SURFACES LEFT DAMAGED OR INCOMPLETE FROM REMOVAL OF EXISTING PARTITIONS, MILLWORK, CASEWORK, OR OTHER FIXED ACCESSORIES AND EQUIPMENT WITH MATERIALS TO MATCH EXISTING, AS ACCEPTABLE TO THE ARCHITECT.
- NOTATIONS ARE MADE IN VARIOUS PLACES ON THE DRAWINGS TO CALL ATTENTION TO DEMOLITION WHICH IS REQUIRED. HOWEVER, THESE DRAWINGS ARE NOT INTENDED TO SHOW EACH AND EVERY ITEM TO BE REMOVED. CONTRACTOR SHALL REMOVE ALL MATERIALS RELATED TO THEIR RESPECTIVE TRADES AS REQUIRED TO PERMIT THE CONSTRUCTION OF THE NEW WORK AS SHOWN.
- THE GENERAL CONTRACTOR SHALL COORDINATE THE EXTENT OF THE REQUIRED DEMOLITION OF THE EXISTING BUILDING AS REQUIRED TO FACILITATE THE CONSTRUCTION OF THE PROJECT AS SHOWN AS PART OF THIS WORK.
- ALL DEMOLITION SHALL BE APPROVED BY THE OWNER/TENANT PRIOR TO COMMENCEMENT AND SHALL BE PERFORMED UNDER REQUIREMENTS AND APPROVAL OF THE LOCAL CODE JURISDICTIONS.
- ASBESTOS ABATEMENT: CONTRACTOR SHALL NOTIFY BUILDING REPRESENTATIVE IMMEDIATELY WHEN AND IF ANY ITEMS ARE ENCOUNTERED THAT IN ANY WAY, SHAPE, OR FORM APPEAR TO BE HAZARDOUS OF NATURE. ASBESTOS ABATEMENT IS NOT PART OF THE DESIGN. PROFESSIONALS DOCUMENTATION OR RESPONSIBILITY TO SURVEY, IDENTIFY, OR FOR CONSULTATION OF PROPER DISPOSAL.
- PROTECT ALL EXISTING WORK WHICH IS TO REMAIN AND RESTORE IN AN APPROVED MANNER ANY SUCH WORK WHICH BECOMES DAMAGED.
- RUBBISH AND DEBRIS RESULTING FROM THE WORK SHALL BE REMOVED IMMEDIATELY FROM THE SITE IN A SAFE AND LEGAL MANNER BY THE CONTRACTOR.
- TEMPORARY LIGHTING AND POWER SHALL BE PART OF THE SCOPE OF THIS WORK; SEE ELECTRICAL.
- DEMOLITION CONTRACTOR SHALL BE RESPONSIBLE TO CONTACT BUILDING REPRESENTATIVE TO CLARIFY ANY ITEMS NOT SHOWN ON THESE DOCUMENTS OR SHOWN NOT MATCHING FIELD CONDITIONS.

MECHANICAL SYMBOLS LEGEND

HVAC DUCTWORK SYMBOLS

|  |                                                                      |
|--|----------------------------------------------------------------------|
|  | SUPPLY AIR DUCT RISER                                                |
|  | RETURN AIR DUCT RISER                                                |
|  | OUTSIDE AIR DUCT RISER (AS NOTED)                                    |
|  | EXHAUST AIR DUCT                                                     |
|  | INSULATED DUCTWORK (AS NOTED)                                        |
|  | SUPPLY AIR DIFFUSER (SQUARE)                                         |
|  | SUPPLY AIR DIFFUSER (INLINE)                                         |
|  | TURNING VANES                                                        |
|  | SURFACE MTD. GRILLE                                                  |
|  | SUPPLY AIR DIFFUSER (ROUND)                                          |
|  | 90° TEE W/45° APPROACH                                               |
|  | CONICAL TAKE-OFF                                                     |
|  | CONICAL TAKE-OFF W/ DAMPER                                           |
|  | BALANCE DAMPER                                                       |
|  | RETURN AIR DUCT BOOT                                                 |
|  | ECCENTRIC REDUCER                                                    |
|  | CONCENTRIC REDUCER                                                   |
|  | VERTICAL FIRE DAMPER                                                 |
|  | EXISTING VERTICAL FIRE DAMPER                                        |
|  | HORIZONTAL FIRE DAMPER                                               |
|  | EXISTING HORIZONTAL FIRE DAMPER                                      |
|  | VERTICAL SMOKE DAMPER                                                |
|  | HORIZONTAL SMOKE DAMPER                                              |
|  | VERTICAL FIRE / SMOKE DAMPER                                         |
|  | HORIZONTAL FIRE / SMOKE DAMPER                                       |
|  | DUCT SMOKE DETECTOR, INSTALLED BY M.T.C., PROVIDED & WIRED BY E.T.C. |
|  | UNIT HEATER                                                          |
|  | CEILING EXHAUST FAN                                                  |
|  | ROOF MOUNTED EXHAUST FAN                                             |
|  | DEMOLITION                                                           |

HVAC DUCTWORK & DIFFUSER TAGS

|      |     |      |         |
|------|-----|------|---------|
| SD-1 | 250 | TAG  | CFM     |
| Ø 2  | --- | NECK | REMARKS |
|      |     | SIZE |         |

MISCELLANEOUS NOTES

|  |                                                        |
|--|--------------------------------------------------------|
|  | POINT OF CONNECTION BETWEEN NEW AND EXISTING           |
|  | POINT OF EXISTING TO REMAIN AND EXISTING TO BE REMOVED |
|  | INDICATES PLAN NOTE                                    |
|  | INDICATES DEMOLITION NOTE                              |
|  | DETAIL BUBBLE                                          |
|  | DETAIL NUMBER                                          |
|  | PAGE LOCATION INDICATES                                |
|  | DIRECTION OF DETAIL SECTION                            |

HVAC PIPING

|               |                                      |
|---------------|--------------------------------------|
| — CWS —       | CHILLED WATER SUPPLY                 |
| — CWR —       | CHILLED WATER RETURN                 |
| — CD —        | CONDENSATE DRAIN                     |
| — CS —        | CONDENSER WATER SUPPLY               |
| — CR —        | CONDENSER WATER RETURN               |
| — CTS —       | COOLING TOWER WATER SUPPLY           |
| — CTR —       | COOLING TOWER WATER RETURN           |
| — DX —        | DIRECT EXPANSION                     |
| — HPS —       | HEAT PUMP WATER SUPPLY               |
| — HPR —       | HEAT PUMP WATER RETURN               |
| — HS —        | HEATING WATER SUPPLY                 |
| — HR —        | HEATING WATER RETURN                 |
| — S —         | SUCTION (REFRIGERANT)                |
| — L —         | LIQUID (REFRIGERANT)                 |
| — DXS —       | SUCTION (DIRECT EXPANSION)           |
| — DXL —       | LIQUID (DIRECT EXPANSION)            |
| — LPS —       | LOW PRESSURE STEAM (0-20 LBS.)       |
| — MPS —       | MEDIUM PRESSURE STEAM (21-75 LBS.)   |
| — HPS —       | HIGH PRESSURE STEAM (76 LBS. & ABV.) |
| --- SC ---    | STEAM CONDENSATE (GRAVITY)           |
| --- SCP ---   | PUMPED STEAM CONDENSATE              |
| -- SC (BF) -- | STEAM CONDENSATE BOILER FEED         |

HVAC DUCTWORK

|          |                        |
|----------|------------------------|
| — SA —   | SUPPLY AIR DUCT        |
| — X-SA — | EXIST SUPPLY AIR DUCT  |
| — RA —   | RETURN AIR DUCT        |
| — X-RA — | EXIST RETURN AIR DUCT  |
| — OA —   | OUTSIDE AIR DUCT       |
| — X-OA — | EXIST OUTSIDE AIR DUCT |
| — EA —   | EXHAUST AIR DUCT       |
| — X-EA — | EXIST EXHAUST AIR DUCT |

HVAC PIPING VALVES

|  |                                        |
|--|----------------------------------------|
|  | GATE VALVE                             |
|  | GAS COCK                               |
|  | CHECK VALVE                            |
|  | BALANCE COCK                           |
|  | CIRCUIT SETTER                         |
|  | TWO-WAY CONTROL VALVE                  |
|  | THREE-WAY CONTROL VALVE                |
|  | GLOBE VALVE                            |
|  | BALL VALVE                             |
|  | SOLENOID VALVE                         |
|  | EXPANSION VALVE WITH THERMOSTATIC BULB |
|  | PLUG VALVE                             |
|  | BUTTERFLY VALVE                        |
|  | RELIEF VALVE                           |
|  | HOSE & DRAIN END VALVE                 |
|  | PRESSURE RELIEF VALVE                  |
|  | PRESSURE REDUCING VALVE                |
|  | TRIPLE DUTY VALVE                      |
|  | GAS PRESSURE REGULATOR                 |
|  | STRAINER (BLOW-OFF)                    |

TEMPERATURE CONTROL SYMBOLS

|  |                               |
|--|-------------------------------|
|  | THERMOSTAT                    |
|  | PROGRAMMABLE THERMOSTAT       |
|  | THERMOSTAT (W/ NIGHT SETBACK) |
|  | ROOM SENSOR                   |
|  | HUMIDISTAT                    |
|  | PRESSURE GAUGE                |
|  | DAMPER (ELECTRIC OPERATION)   |
|  | DAMPER (PNEUMATIC OPERATION)  |
|  | DAMPER BLADES                 |

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| 05/18/2026 | 100% BID SET |  |  |

|          |
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| DRAWN    |
| EJE      |
| APPROVED |
| CAT      |

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PROJECT

**GARDNER INTERNATIONAL MAGNET SCHOOL**  
**CHILLER REPLACEMENT**  
**333 DAHLIA DR. LANSING, MI**

SHEET DESCRIPTION

**MECHANICAL**  
**SYMBOLS**  
**ABBREV.**  
**+ NOTES**

DATE

**05/18/2026**

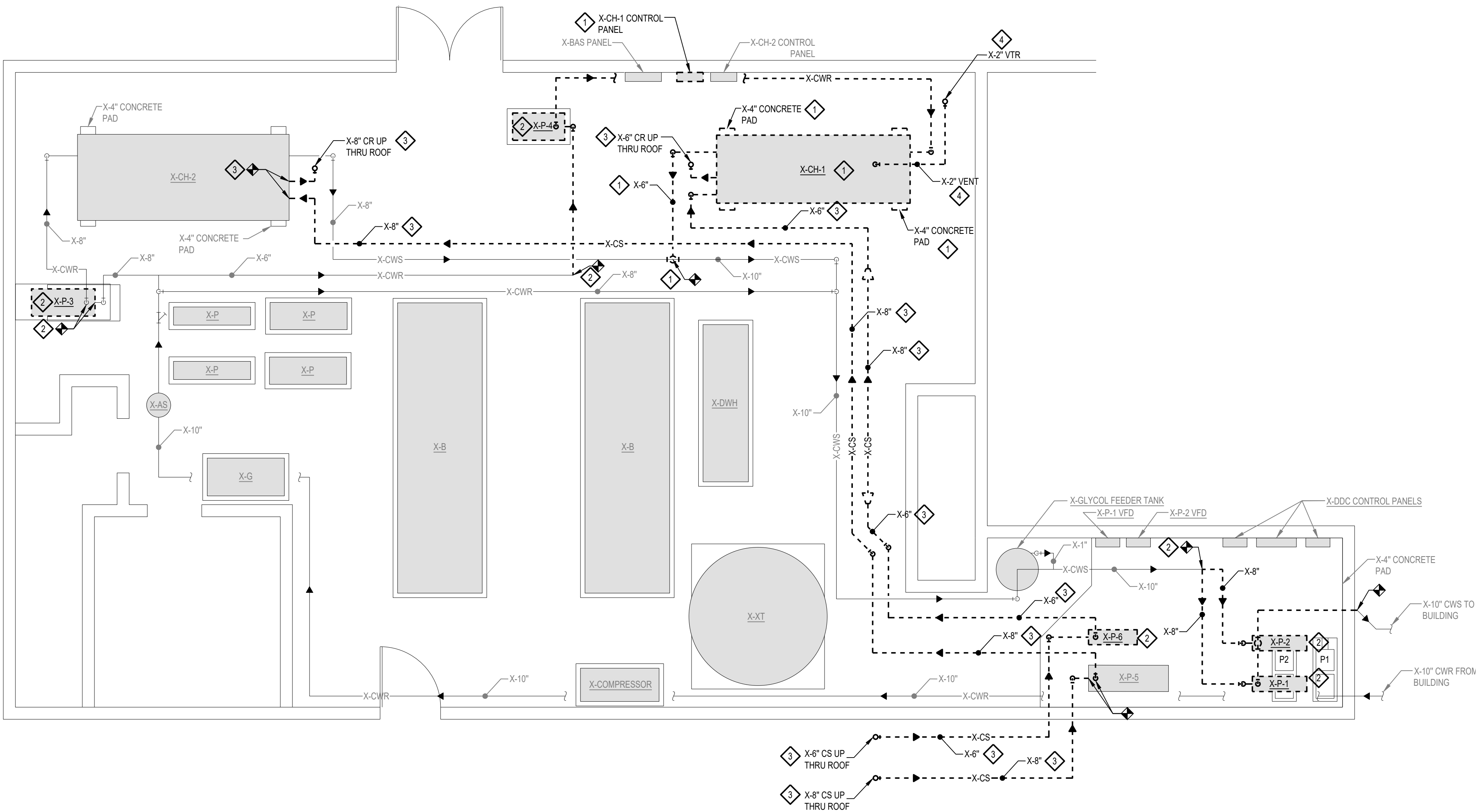
PROJECT NUMBER

**260150.00**

SHEET NUMBER

**M-100**





### MECHANICAL ROOM PLAN - PIPING DEMOLITION

0 1 5 10  
SCALE: 1/4" = 1'-0"

### DEMOLITION NOTES

- 1 DISCONNECT, REMOVE, & DEMOLISH EXISTING CHILLER, CONCRETE PADS, CONTROL PANEL, AND ALL ASSOCIATED ACCESSORIES. DEMOLISH PIPING TO POINT INDICATED ON DRAWINGS.
- 2 DISCONNECT, REMOVE, AND DEMOLISH EXISTING BASE-MOUNTED PUMP, VALVES AND ALL ASSOCIATED ACCESSORIES. DEMOLISH PIPING TO POINT INDICATED ON DRAWINGS. EXISTING CONCRETE PAD TO REMAIN.
- 3 DISCONNECT, REMOVE, AND DEMOLISH EXISTING CONDENSER WATER SUPPLY AND RETURN PIPING, HANGERS, SUPPORTS AND ALL ASSOCIATED ACCESSORIES IN THEIR ENTIRETY. PREPARE EXISTING ROOF OPENINGS FOR REUSE.
- 4 DISCONNECT, REMOVE, AND DEMOLISH EXISTING CHILLER VENT IN ITS ENTIRETY. PREPARE EXISTING ROOF OPENING FOR REUSE.

| REVISIONS  |              |  |  |
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| 05/18/2026 | 100% BID SET |  |  |
| DRAWN      |              |  |  |
| EJE        |              |  |  |
| APPROVED   |              |  |  |
| CAT        |              |  |  |

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**GARDNER INTERNATIONAL MAGNET SCHOOL**  
CHILLER REPLACEMENT  
333 DAHLIA DR, LANSING, MI

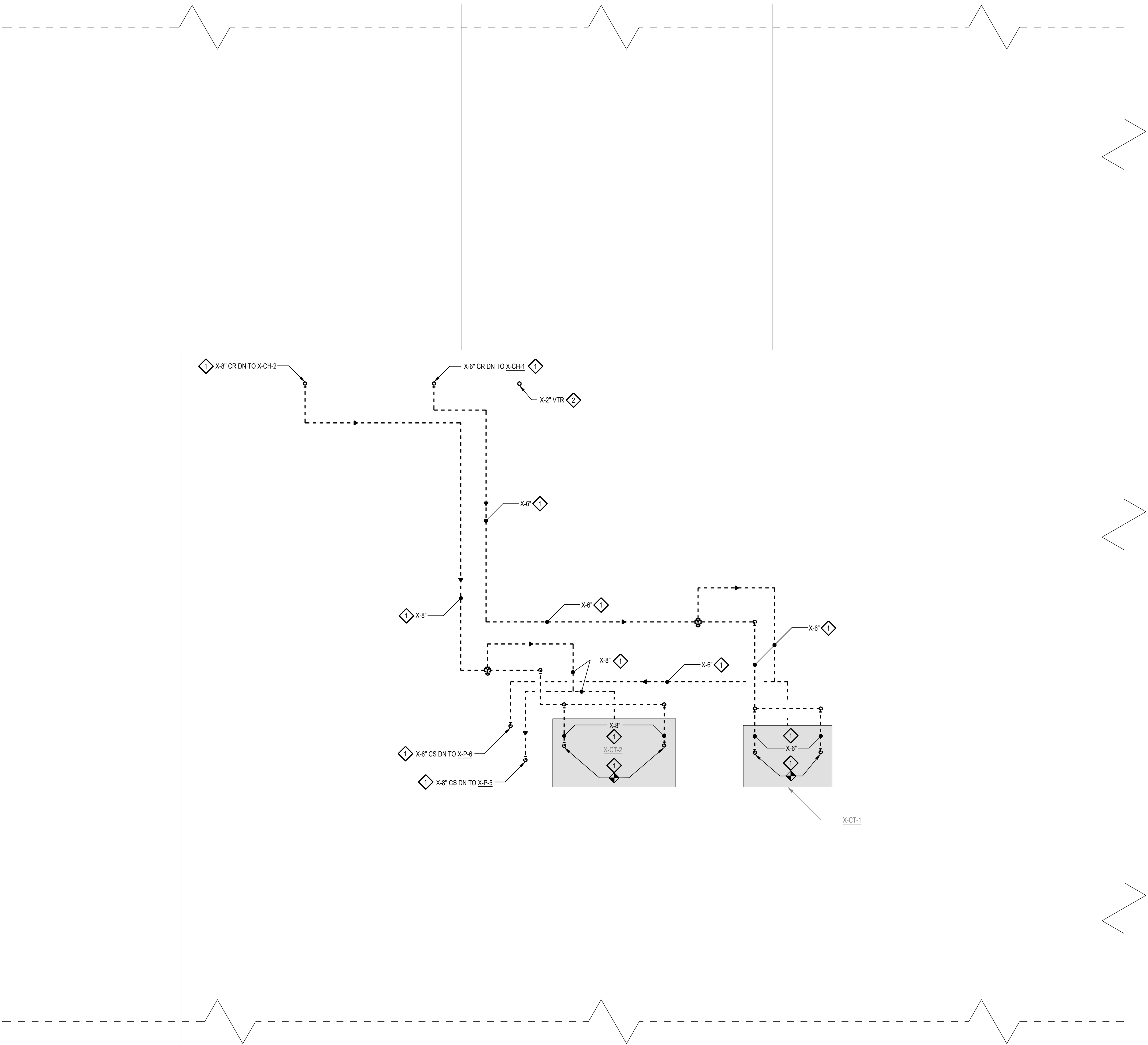
**MECHANICAL ROOM PLAN - PIPING DEMOLITION**

05/18/2026

260150.00

**M-300**





DEMOLITION NOTES

- 1 DISCONNECT, REMOVE, AND DEMOLISH EXISTING CONDENSER WATER SUPPLY AND RETURN PIPING, HANGERS, SUPPORTS AND ALL ASSOCIATED ACCESSORIES IN THEIR ENTIRETY. PREPARE EXISTING ROOF OPENINGS FOR REUSE.
- 2 DISCONNECT, REMOVE, AND DEMOLISH EXISTING CHILLER VENT IN ITS ENTIRETY. PREPARE EXISTING ROOF OPENING FOR REUSE.

| REVISIONS                  |  |  |  |
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| DRAWN                      |  |  |  |
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| APPROVED                   |  |  |  |
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**PROJECT**  
GARDNER INTERNATIONAL MAGNET SCHOOL  
CHILLER REPLACEMENT  
333 DAHLIA DR, LANSING, MI

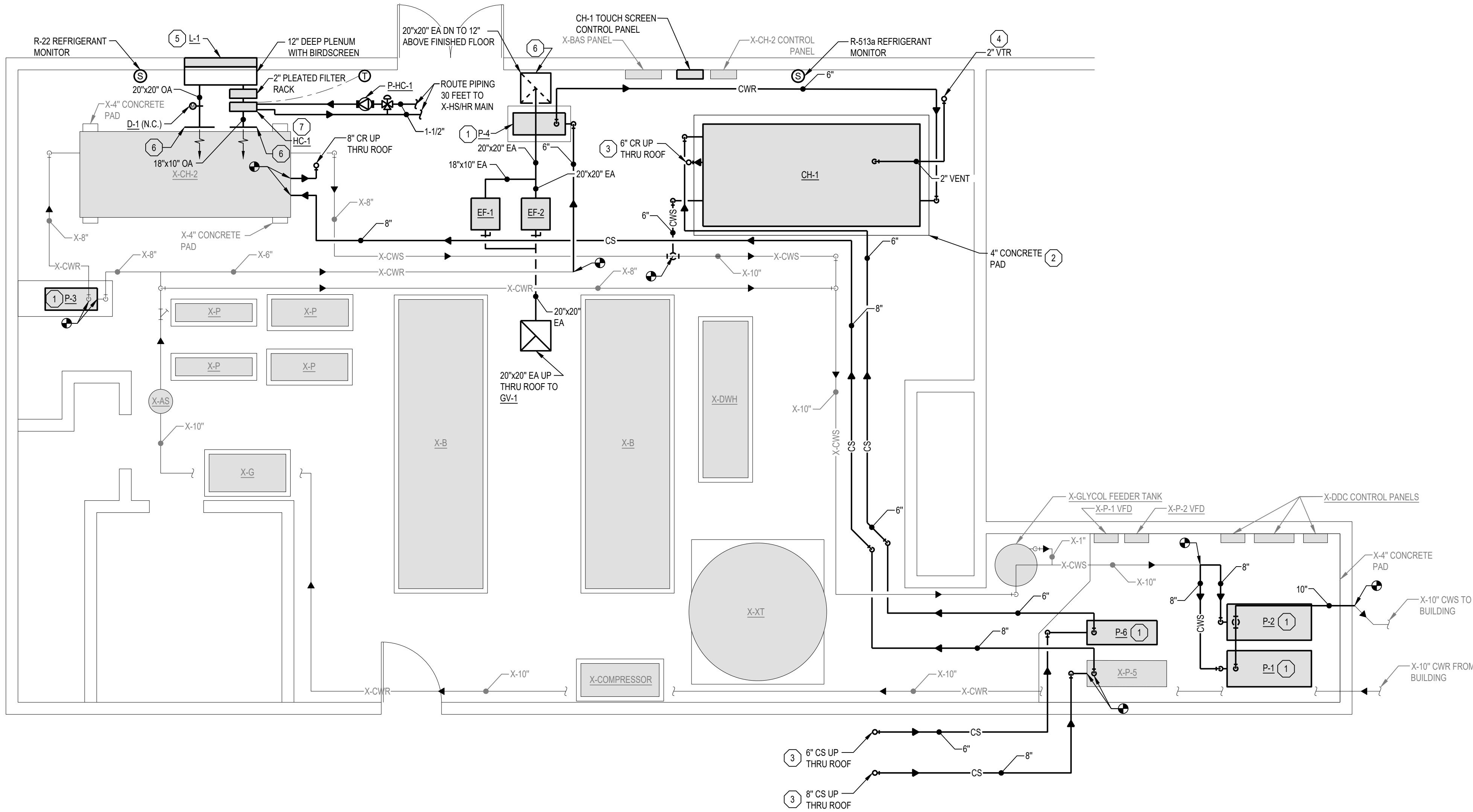
**SHEET DESCRIPTION**  
PARTIAL ROOF  
PLAN - PIPING  
DEMOLITION

**DATE**  
05/18/2026

**PROJECT NUMBER**  
260150.00

**SHEET NUMBER**  
M-301





MECHANICAL ROOM PLAN - PIPING NEW

0 1 5 10  
SCALE: 1/4" = 1'-0"

MECHANICAL KEY NOTES

- 1 FURNISH AND INSTALL PUMP AND ALL ASSOCIATED ACCESSORIES ON EXISTING CONCRETE PAD IN LOCATION SHOWN.
- 2 FURNISH AND INSTALL HOUSEKEEPING PAD WITH 6" OF CLEARANCE ON EACH SIDE OF CHILLER. NEW HOUSEKEEPING PAD AND AREA WHERE EXISTING HOUSEKEEPING PADS WERE REMOVED TO MATCH EXISTING CONDITIONS IN TYPE MATERIAL AND APPEARANCE. EXTEND EXISTING FLOOR DRAIN AS NECESSARY TO REMAIN ON TOP OF NEW PAD.
- 3 REUSE EXISTING ROOF PENETRATIONS FOR NEW CONDENSER WATER SUPPLY AND RETURN PIPING.
- 4 REUSE EXISTING ROOF PENETRATIONS FOR NEW CHILLER VENT.
- 5 FURNISH AND INSTALL LOUVER 10'-0" ABOVE FINISHED FLOOR. CONTRACTOR SHALL PROVIDE UNTEL ABOVE LOUVER. CONTRACTOR SHALL INCLUDE STAMPED SUBMITTAL BY LICENSED STRUCTURAL ENGINEER FOR NEW UNTEL IN BID.
- 6 FURNISH AND INSTALL BIRDSCREEN OVER DUCT OPENING.
- 7 FURNISH AND INSTALL 18"x10" ACCESS PANEL UPSTREAM OF HC-1.

GENERAL MECHANICAL NOTES

1. PROVIDE NEW HANGERS AND SUPPORTS FOR ALL NEW PIPING.
2. CONTRACTOR TO INSTALL QUANTITY OF REFRIGERANT MONITOR SENSORS PER CHILLER MANUFACTURERS REQUIREMENTS TO COVER ENTIRE MECHANICAL ROOM AREA.

| REVISIONS  |              |  |  |
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| 05/18/2026 | 100% BID SET |  |  |

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EJE

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PROJECT

GARDNER INTERNATIONAL MAGNET SCHOOL  
CHILLER REPLACEMENT  
333 DAHLIA DR, LANSING, MI

SHEET DESCRIPTION

MECHANICAL  
ROOM PLAN -  
PIPING  
NEW

DATE

05/18/2026

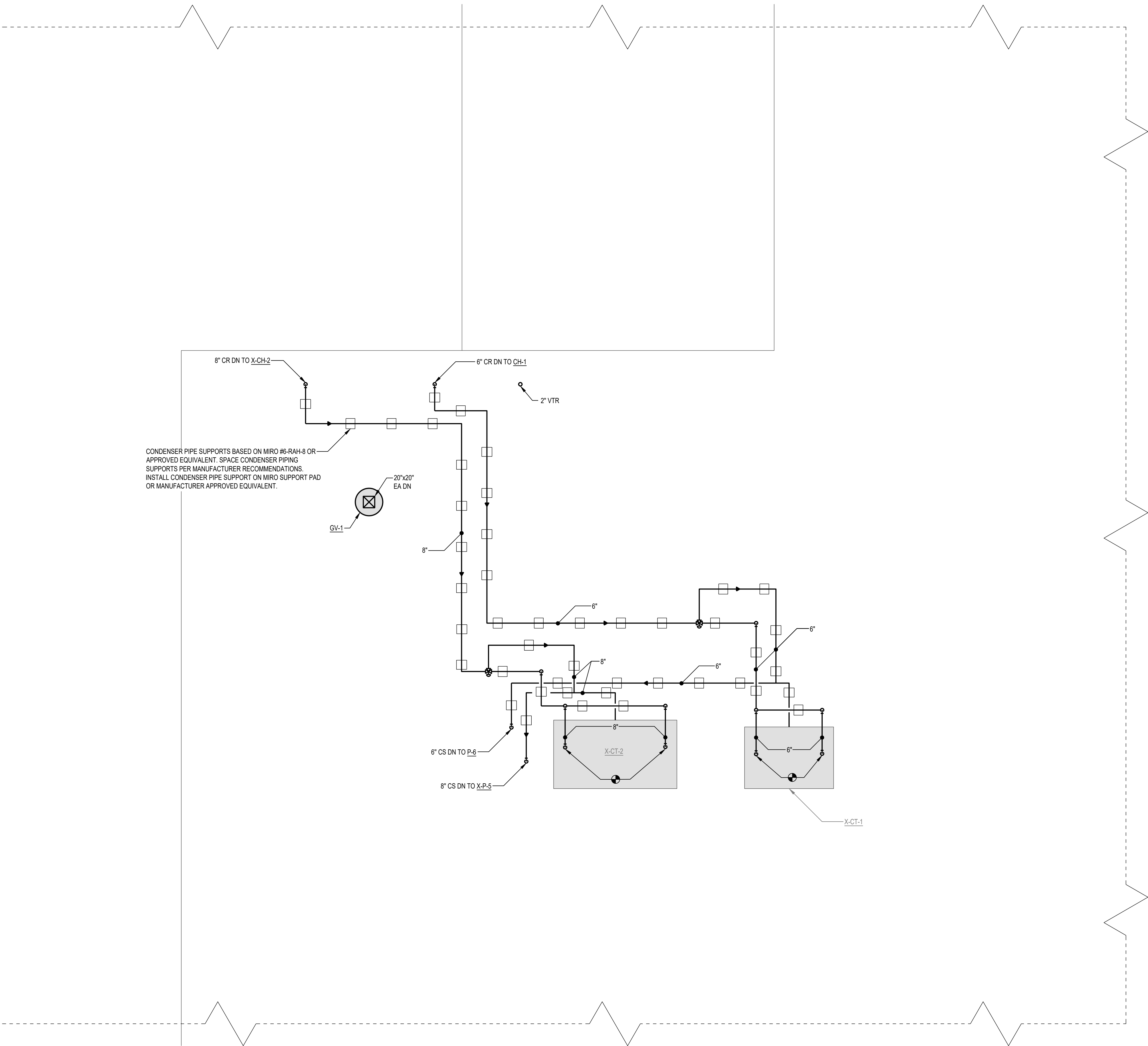
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SHEET NUMBER

M-600

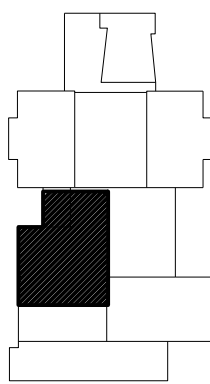
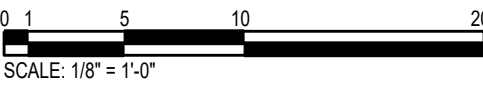




CONDENSER PIPE SUPPORTS BASED ON MIRO #6-RAH-8 OR APPROVED EQUIVALENT. SPACE CONDENSER PIPING SUPPORTS PER MANUFACTURER RECOMMENDATIONS. INSTALL CONDENSER PIPE SUPPORT ON MIRO SUPPORT PAD OR MANUFACTURER APPROVED EQUIVALENT.



PARTIAL ROOF PLAN - PIPING NEW



| REVISIONS  |              |  |  |
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PROJECT  
GARDNER INTERNATIONAL MAGNET SCHOOL  
CHILLER REPLACEMENT  
333 DAHLIA DR. LANSING, MI

SHEET DESCRIPTION  
PARTIAL ROOF  
PLAN - PIPING  
NEW

DATE  
05/18/2026

PROJECT NUMBER  
260150.00

SHEET NUMBER  
M-601



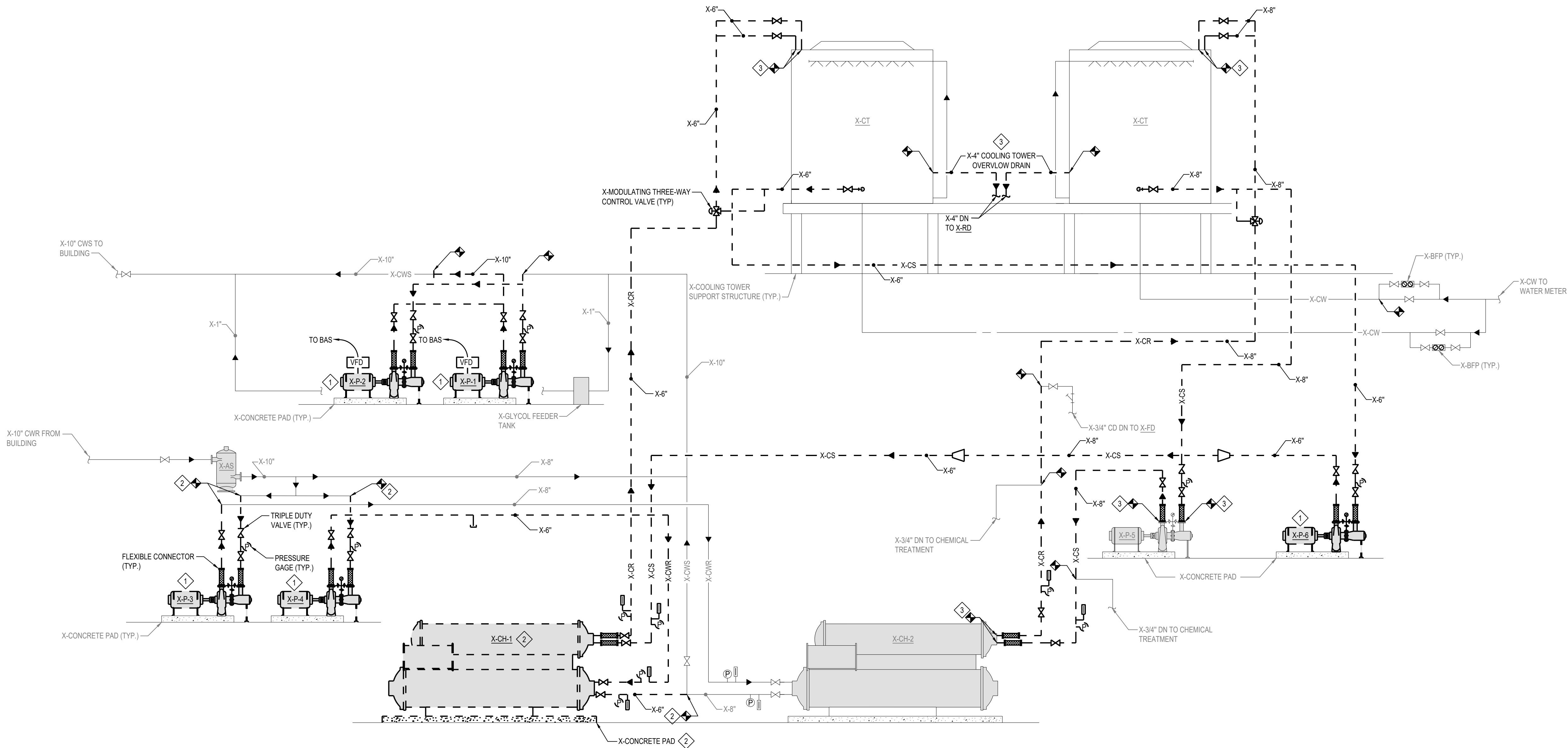
DEMOLITION NOTES

- 1

DISCONNECT, REMOVE, AND DEMOLISH EXISTING PUMP AND ALL ASSOCIATED ACCESSORIES. EXISTING HOUSEKEEPING PAD TO REMAIN. DEMO EXISTING PIPING TO EXTENTS SHOWN.
- 2

DISCONNECT, REMOVE, AND DEMOLISH EXISTING CHILLER AND ALL ASSOCIATED ACCESSORIES. DEMOLISH EXISTING PIPING TO EXTENTS SHOWN. EXISTING HOUSEKEEPING PAD TO BE DEMOLISHED.
- 3

DISCONNECT, REMOVE, AND DEMOLISH ALL EXISTING COOLING TOWER SUPPLY/RETURN PIPING AND ALL ASSOCIATED ACCESSORIES.



1 CHILLER PIPING DIAGRAM - DEMOLITION  
SCALE: NTS

| REVISIONS  |              |  |  |
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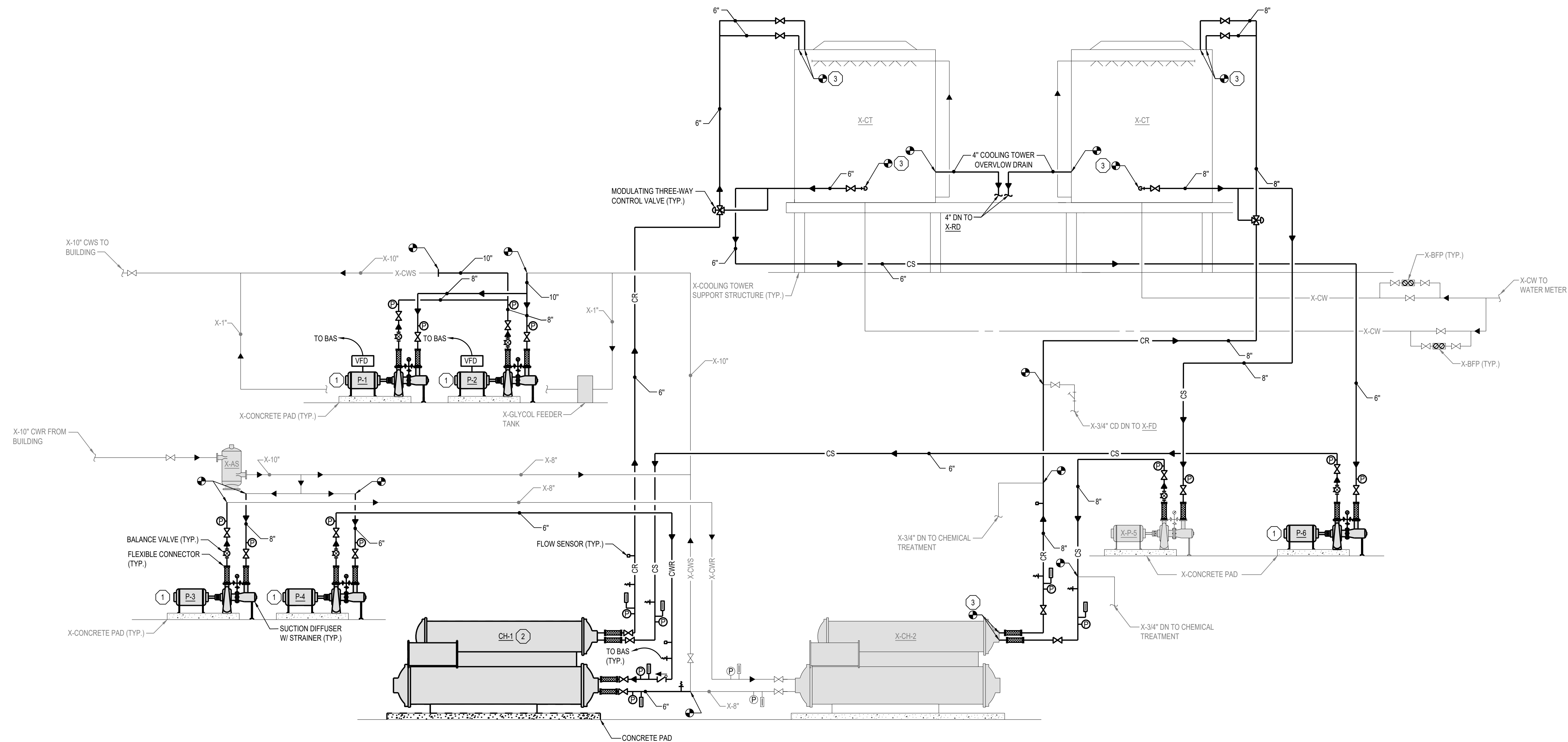
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PROJECT

GARDNER INTERNATIONAL MAGNET SCHOOL  
CHILLER REPLACEMENT  
333 DAHLIA DR, LANSING, MI

| SHEET DESCRIPTION                         |  |
|-------------------------------------------|--|
| CHILLER PIPING<br>DIAGRAM -<br>DEMOLITION |  |
| DATE                                      |  |
| 05/18/2026                                |  |
| PROJECT NUMBER                            |  |
| 260150.00                                 |  |
| SHEET NUMBER                              |  |
| M-800                                     |  |





1 CHILLER PIPING DIAGRAM - NEW  
SCALE: NTS

PIPING KEY NOTES

- 1 FURNISH AND INSTALL NEW PUMP AND ALL ASSOCIATED ACCESSORIES ON EXISTING HOUSEKEEPING PAD. MODIFY/EXTEND PIPING AS NECESSARY.
- 2 FURNISH AND INSTALL NEW CHILLER AND ALL ASSOCIATED ACCESSORIES ON A NEW HOUSEKEEPING PAD AS SHOWN. MODIFY/EXTEND PIPING AS NECESSARY.
- 3 FURNISH AND INSTALL NEW COOLING TOWER SUPPLY/RETURN PIPING AND ALL ASSOCIATED ACCESSORIES AS SHOWN.

| REVISIONS  |              |  |  |
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| 05/18/2026 | 100% BID SET |  |  |
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| APPROVED   |              |  |  |
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PROJECT

GARDNER INTERNATIONAL MAGNET SCHOOL  
CHILLER REPLACEMENT  
333 DAHLIA DR, LANSING, MI

SHEET DESCRIPTION

CHILLER PIPING  
DIAGRAM -  
NEW

DATE

05/18/2026

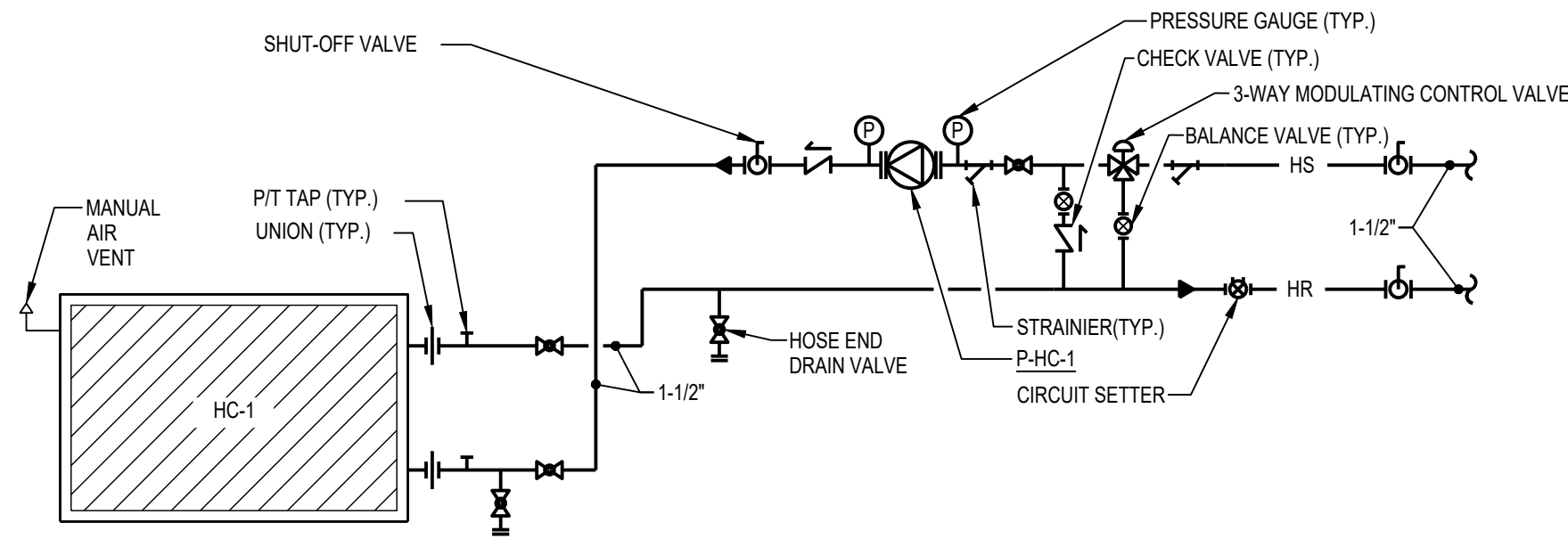
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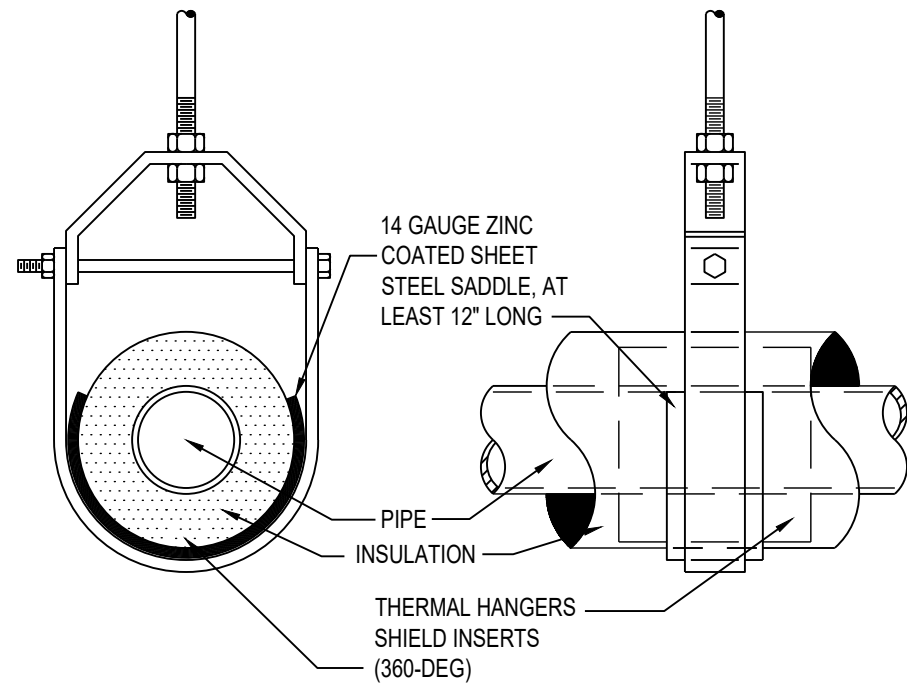
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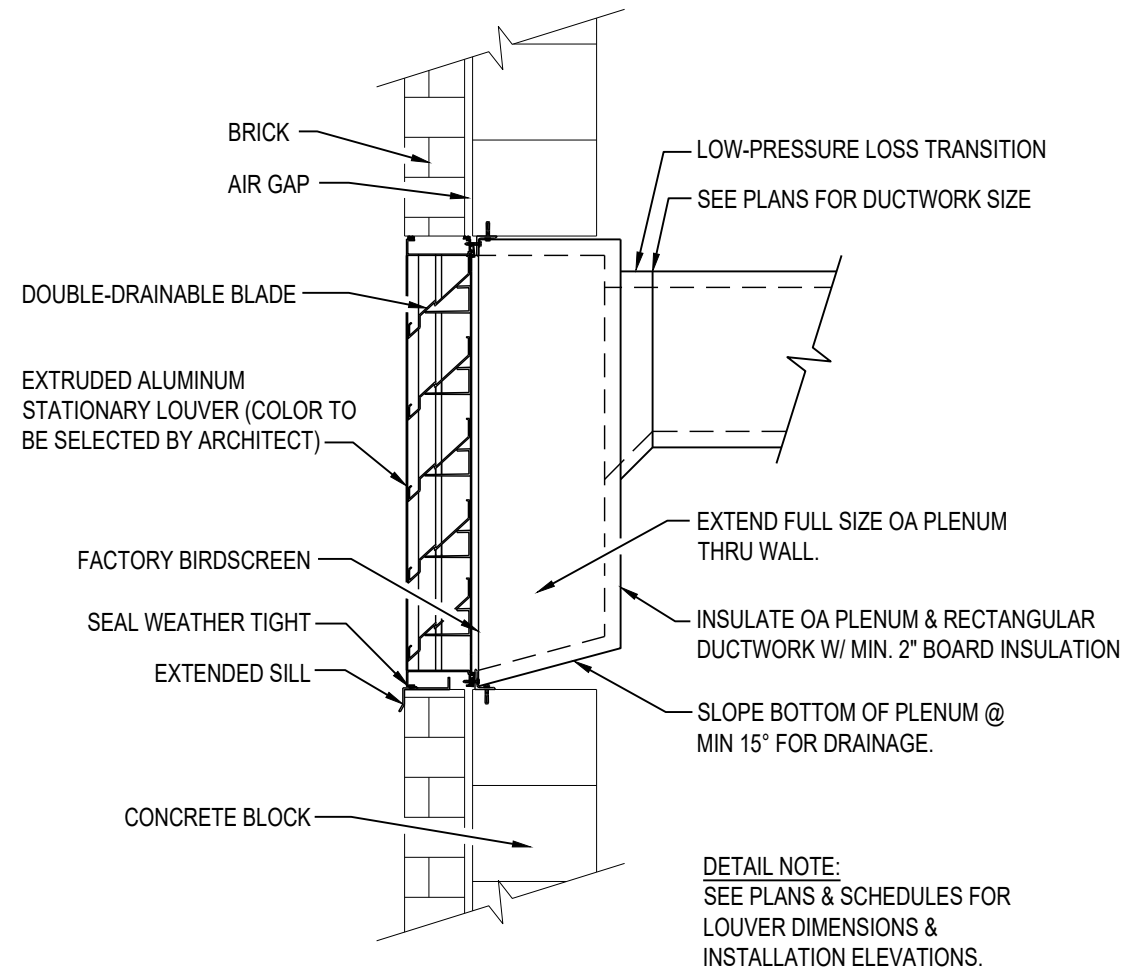




1 **HYDRONIC HEATING COIL DETAIL**  
SCALE: NTS



2 **INSULATION HANGER DETAIL**  
SCALE: NTS



3 **OUTSIDE AIR LOUVER DETAIL**  
SCALE: NTS

| REVISIONS  |              |  |  |
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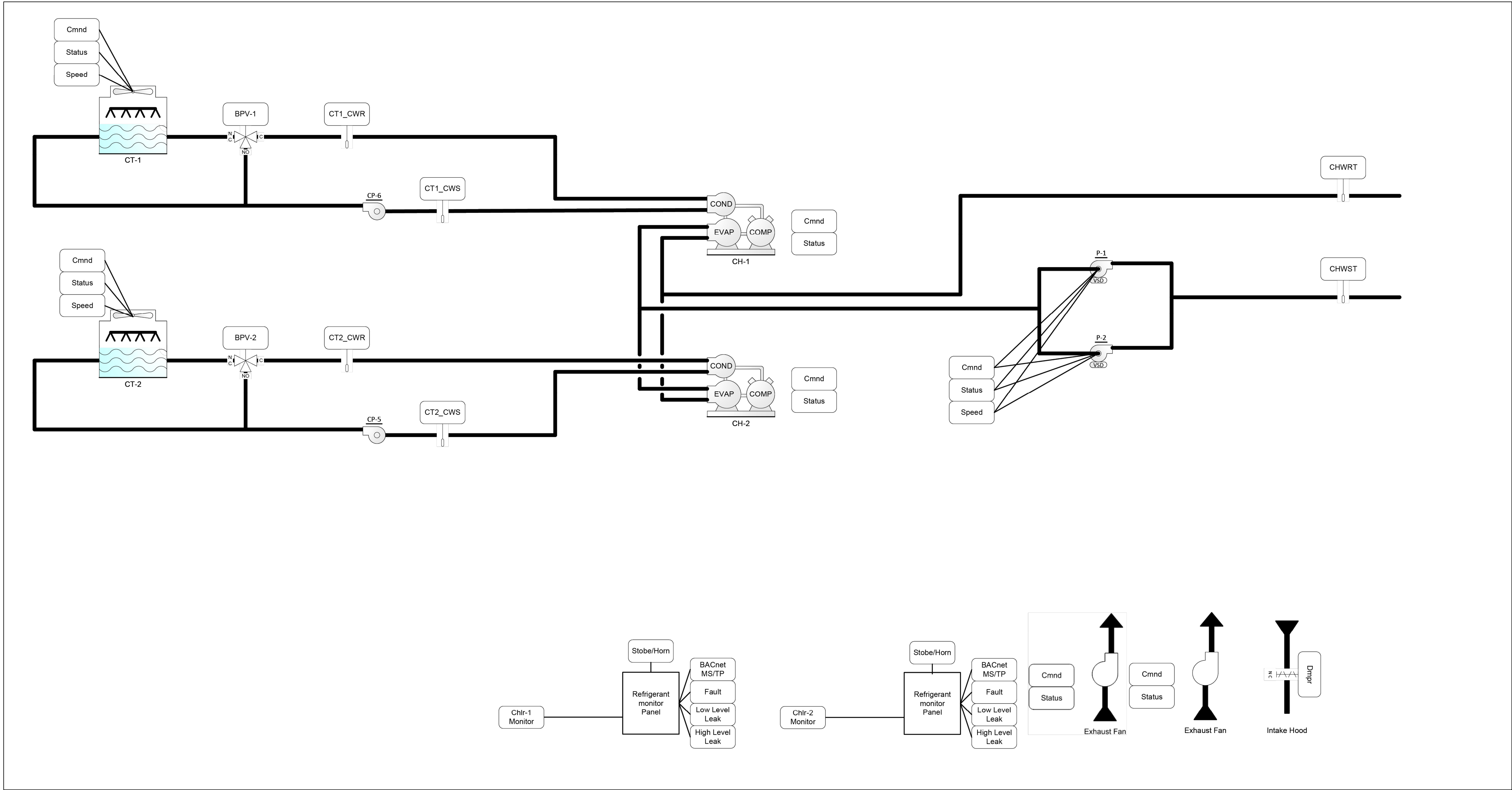
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**GARDNER INTERNATIONAL MAGNET SCHOOL**  
CHILLER REPLACEMENT  
333 DAHLIA DR, LANSING, MI

| SHEET DESCRIPTION     |
|-----------------------|
| MECHANICAL<br>DETAILS |
| DATE                  |
| 05/18/2026            |
| PROJECT NUMBER        |
| 260150.00             |
| SHEET NUMBER          |
| M-802                 |





1 COOLING PLANT - CONTROL DIAGRAM  
SCALE: NTS

SEQUENCE OF OPERATION: CHILLED WATER PLANT

- OPERATION**
- THE OPERATING MODE OF THE UNIT SHALL BE CONTROLLED THROUGH THE DDC SYSTEM. THE SYSTEM OPERATORS SHALL BE ABLE TO RESET TIMES AND SCHEDULES THROUGH THE BUILDING AUTOMATION SYSTEM.
- CHILLER**
- CHILLERS OPERATE WITHIN THEIR CONTROL SEQUENCE, THE BMS SHALL ENABLE THE CHILLER (S) BASED ON OSA TEMP AND SCHEDULE.
  - WHEN OSA1 IS ABOVE 65°F (ADJ), CHLR-1 WILL BE ENABLED TO MAINTAIN CHILLED WATER SETPOINT (SET AT THE CHILLER) 45°F. CHLR-2 IS DISABLED.
  - IF THE CHWS TEMP IS GREATER THAN +2°F (ADJ) OVER THE SETPOINT FOR MORE THAN 20 MIN (ADJ) WHILE CHLR-1 IS OPERATIONAL, CHLR-2 SHALL BE ENALBED AND CHLR-1 SHALL BE DISABLED.
  - IF THE CHWS TEMP IS GREATER THAN +2°F (ADJ) OVER THE SETPOINT FOR MORE THAN 20 MIN (ADJ) WHILE CHLR-2 IS OPERATIONAL, CHLR-1 SHALL BE ENABLED AND BOTH CHILLERS OPERATE TOGETHER TO MAINTAIN SETPOINT UNTIL THE END OF THE SCHEDULE. AND BOTH CHILLERS SHALL BE DISABLED.

- CHILLED WATER SYSTEM PUMPS**
- THE BMS SHALL ENABLE THE SYSTEM PUMPS UPON ENABLING OF THE CHILLED WATER SYSTEM.
  - THE BMS MONITOR THREE (3) EXISTING DPT'S AND AVERAGE THEM FOR ONE (1) DPT AND RAMP THE SYSTEM PUMP(S) TO MAINTAIN SETPOINT OF 10PSI (ADJ.)
  - SYSTEM PUMPS SHALL RUN IN A LEADLAG FUNCTION ROTATING EVERY 500HRS (ADJ.). IF LEAD PUMP CAN NOT MAINTAIN PRESSURE OR THERE IS NO STATUS, LAG PUMP SHALL ENERGIZE.
  - THE BMS SHALL MONITOR THE PUMPS AND GENERATE AN ALARM IF ABDNORMAL CONDITION OCCUR.

- COOLING TOWER**
- COOLING TOWER SHALL BE ALLOWED TO RUN WHENEVER THE CHILLED WATER SYSTEM IS ENABLED.
- COOLING TOWER-1 (CT1)**
- COND PUMP (CP-6) SHALL BE ENABLED WHENEVER A CHILLER-1 IS ENABLED
  - BYPASS VALVE-1 (BPV-1) SHALL MODULATE TO MAINTAIN CWS SETPOINT OF 72" (ADJ), BPV-1 SHALL BE AT 50% WHENEVER THE CIRC PUMP IS OFF.
  - CT1 FAN SHALL BE ENABLE WHEN THE CWS TEMP IS ABOVE THE FAN ENABLE SETPOINT (85°F)
  - WHEN CHILLER IS DISABLED AND THE CWS TEMP FALLS BELOW 85°F (ADJ), THE CT1 FAN IS DISABLED THEN AFTER A TIME DELAY OF 10MIN (ADJ) CP-6 SHALL BE DISABLED

- COOLING TOWER-2 (CT2)**
- COND PUMP (CP-5) SHALL BE ENABLED WHENEVER A CHILLER-2 IS ENABLED
  - BYPASS VALVE-2 (BPV-2) SHALL MODULATE TO MAINTAIN CWS SETPOINT OF 72" (ADJ), BPV-2 SHALL BE AT 50% WHENEVER THE CIRC PUMP IS OFF.
  - CT2 FAN SHALL BE ENABLE WHEN THE CWS TEMP IS ABOVE THE FAN ENABLE SETPOINT (85°F)
  - WHEN CHILLER IS DISABLED AND THE CWS TEMP FALLS BELOW 85°F (ADJ), THE CT2 FAN IS DISABLED THEN AFTER A TIME DELAY OF 10MIN (ADJ) CP-5 SHALL BE DISABLED

- REFRIGERATION MONITORS**
- DETECTION OF LOW LEVEL REFRIGERANT LEAK: ALARM LIGHTS INSIDE AND OUTSIDE THE MECHANICAL ROOM (BUT NOT THE HORNS) SHALL ACTIVATE AND A "LOW" REFRIGERANT LEAK ALARM SHALL BE GENERATE AT THE BAS
  - DETECTION OF HIGH LEVEL REFRIGERANT LEAK: ALARM LIGHTS AND HORNS INSIDE AND OUTSIDE THE MECHANICAL ROOM SHALL ACTIVATE. THE MACHINE ROOM VENTILATION SYSTEM SHALL BE PLACED INTO EMERGENCY EXHAUST/VENTILATION MODE, AND A "HIGH" REFRIGERANT LEAK ALARM SHALL BE GENERATED AT THE BAS.
  - DETECTION OF A REFRIGERANT MONITOR FAULT CONDITION OR LOSS OF POWER TO MONITOR PANEL: A COMMON ALARM SHALL BE GENERATED AT BAS INDICATING A FAULT OR LOSS OF POWER IT SHALL BE POSSIBLE TO SILENCE ALL HORNS DURING AN ALARM, WITH A MOMENTARY 2-POSITION KEYED SWITCH LOCATED OUTSIDE THE MACHINE ROOM. HOLDING THE KEYED SWITCH MOMENTARILY IN THE "SILENCE" POSITION AND THEN RELEASING IT SHALL SILENCE ALL HORNS UNTIL THE CONDITION THAT CAUSED THE ALARM, AS DETECTED BY THE REFRIGERANT MONITOR, HAS ABATED. ONCE THE CONDITION THAT CAUSED THE ALARM CLEARS AND THE MONITOR PANEL IS RESET, THE HORN SILENCE FUNCTION SHALL AUTOMATICALLY RESET.
  - ALARMS SHALL BE LATCHED, AND SHALL BE RESETTABLE VIA A SWITCH INSIDE THE REFRIGERANT MONITOR PANEL ONCE THE CONDITION THAT CAUSED THE ALARM HAS ABATED.

- MONITORING POINTS**
- CHILLED WATER SUPPLY TEMP
  - CHILLED WATER RETURN TEMP
  - X-CT-1 CWS1
  - X-CT-1 CWR1
  - X-CT-2 CWS1
  - X-CT-2 CWR1
  - DPT-1
  - DPT-2
  - DPT-3
  - PUMP-1 STATUS
  - PUMP-2 STATUS
  - PUMP-3 STATUS
  - PUMP-4 STATUS
  - PUMP-6 STATUS
  - CT-1 FAN STATUS
  - CT-2 FAN STATUS
  - NEW CHILLER BACnet (MS/TP)
  - REFRIGERATION MONITOR - CH-1
  - REFRIGERATION MONITOR - X-CH-2

REFRIGERANT PURGE MONITORING

THE BAS SHALL MONITOR REFRIGERANT LEVELS, EXHAUST FAN STATUS, AND ALARM STATUS.

EXHAUST FAN, EF-1 SHALL OPERATE AT ALL TIMES.

HEATING COIL HC-1, SHALL MODULATE TO MAINTAIN A HEATING SET POINT OF 65 DEGREES FAHRENHEIT.

IF EITHER REFRIGERANT MONITOR DETECTS A REFRIGERANT LEAK, AN ALARM SIREN SHALL SOUND, AND AN ALARM SHALL BE SENT TO THE BAS. EXHAUST FAN, EF-2 SHALL ENABLE AND RUN. A MANUAL RESET WILL BE REQUIRED TO SHUT OFF EF-2.

DAMPER, D-1 SHALL BE INTERLOCKED WITH EF-2

FREEZE PROTECTION

THE HOT WATER COIL PUMP, P-HC-1, SHALL RUN CONTINUOUSLY WHENEVER THE OUTSIDE AIR TEMPERATURE DROPS BELOW 38 DEGREES F (ADJUSTABLE) AND SHALL SHUT OFF WHENEVER THE OUTSIDE AIR TEMPERATURE RISES ABOVE 40 DEGREES F.

| REVISIONS  |              |  |  |
|------------|--------------|--|--|
| 05/18/2028 | 100% BID SET |  |  |

DRAWN  
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**MATRIX**  
CONSULTING ENGINEERS, INC.

PROJECT

GARDNER INTERNATIONAL MAGNET SCHOOL  
CHILLER REPLACEMENT  
333 DAHLIA DR, LANSING, MI

SHEET DESCRIPTION  
MECHANICAL  
CONTROLS

DATE  
05/18/2028

PROJECT NUMBER  
260150.00

SHEET NUMBER  
M-802



| WATER COOLED CHILLER                                                                                                                              |                   |                 |                             |            |        |                                                                         |                           |           |        |                    |                           |                                                                                                                                                                      |       |       |     |          |            |                            |
|---------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-----------------|-----------------------------|------------|--------|-------------------------------------------------------------------------|---------------------------|-----------|--------|--------------------|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-------|-----|----------|------------|----------------------------|
| TAG                                                                                                                                               | MODEL             | CAPACITY (TONS) | COOLING EFFICIENCY (Kw/TON) | EVAPORATOR |        |                                                                         |                           | CONDENSER |        |                    |                           | ELECTRICAL                                                                                                                                                           |       |       |     |          |            | COMMENTS                   |
|                                                                                                                                                   |                   |                 |                             | EWLT °F    | LWT °F | NOMINAL FLOW (GPM)                                                      | EVAP. PRES. DROP (FT H2O) | EWLT °F   | LWT °F | NOMINAL FLOW (GPM) | EVAP. PRES. DROP (FT H2O) | VOLTAGE                                                                                                                                                              | PHASE | MCA   | MOP | DISC. BY | STARTER BY |                            |
| CH-1                                                                                                                                              | RTHD WATER-COOLED | 210             | 0.7285                      | 53.8       | 42     | 450                                                                     | 5.9                       | 85        | 94.6   | 648                | 7.3                       | 460                                                                                                                                                                  | 3     | 272.9 | 450 | EC       | EC         | 1,2,3,4,5,6,7              |
| <b>NOTES:</b>                                                                                                                                     |                   |                 |                             |            |        |                                                                         |                           |           |        |                    |                           |                                                                                                                                                                      |       |       |     |          |            |                            |
| 1. BASED ON TRANE                                                                                                                                 |                   |                 |                             |            |        | 5. TRANSPORT FLUID SHALL CONSIST OF 30% PROPYLENE GLYCOL AND 70% WATER. |                           |           |        |                    |                           | 8. CHILLER TO BE DISASSEMBLED AS NEEDED TO POSITION THE CHILLER INTO THE BUILDING TO ITS FINAL EQUIPMENT LOCATION UNDER THE SUPERVISION OF THE CHILLER MANUFACTURER. |       |       |     |          |            | ELECTRICAL NOTES:          |
| 2. BACNET COMMUNICATION FOR INTEGRATION INTO EXISTING BAS                                                                                         |                   |                 |                             |            |        | 6. IPLV:IP 0.5764 KW/TON                                                |                           |           |        |                    |                           | AFTER THE CHILLER HAS BEEN REASSEMBLED THE CHILLER MANUFACTURER SHALL TEST THE CHILLER TO VERIFY IT IS OPERATING PROPERLY. CONTRACTOR IS RESPONSIBLE FOR HIRING      |       |       |     |          |            | EC - ELECTRICAL CONTRACTOR |
| 3. INSTALLING CONTRACTOR TO WORK WITH CHILLER MANUFACTURER TO ENSURE PROPER CLEARANCES, INSTALLATION REQUIREMENTS, AND ORIENTATIONS ARE SATISFIED |                   |                 |                             |            |        | 7. TOUCH SCREEN CONTROL PANEL                                           |                           |           |        |                    |                           | CHILLER MANUFACTURER FOR SUPERVISION AND TESTING.                                                                                                                    |       |       |     |          |            | MC - MECHANICAL CONTRACTOR |
| 4. REFRIGERANT: R-513A                                                                                                                            |                   |                 |                             |            |        |                                                                         |                           |           |        |                    |                           |                                                                                                                                                                      |       |       |     |          |            | NR - NOT REQUIRED          |

| HEATING COIL SCHEDULE              |        |      |                   |             |            |                       |                      |     |      |     |     |      |      |              |                |           |          |
|------------------------------------|--------|------|-------------------|-------------|------------|-----------------------|----------------------|-----|------|-----|-----|------|------|--------------|----------------|-----------|----------|
| TAG                                | SERVES | TYPE | MAX FACE VELOCITY | HEIGHT (IN) | WIDTH (IN) | ACTUAL FACE AREA (FT) | TOTAL CAPACITY (MBH) | DB  |      | EWT | LWT | GPM  | CFM  | FINS PER FT. | NUMBER OF ROWS | APD ("WC) | COMMENTS |
|                                    |        |      |                   |             |            |                       |                      | EAT | LAT  |     |     |      |      |              |                |           |          |
| HC-1                               | L-1    | WP   | 427               | 18          | 10         | 2.34                  | 113.5                | -10 | 94.7 | 180 | 160 | 11.5 | 1000 | 132          | 2              | 0.125     | 1        |
| <b>NOTES:</b><br>1. BASED ON TRANE |        |      |                   |             |            |                       |                      |     |      |     |     |      |      |              |                |           |          |

| PUMP SCHEDULE                                                                       |          |                 |                           |       |             |                  |         |          |      |           |                |       |       |                                                                                                 |      |       |          |  |
|-------------------------------------------------------------------------------------|----------|-----------------|---------------------------|-------|-------------|------------------|---------|----------|------|-----------|----------------|-------|-------|-------------------------------------------------------------------------------------------------|------|-------|----------|--|
| TAG                                                                                 | SERVES   | LOCATION        | SERIES                    | MODEL | TYPE        | FLUID            |         |          | PUMP |           |                |       | MOTOR |                                                                                                 |      |       | COMMENTS |  |
|                                                                                     |          |                 |                           |       |             | TYPE             | % CONC. | TEMP. °F | GPM  | HEAD (FT) | IMP. DIA. (IN) | % EFF | RPM   | HP                                                                                              | VOLT | PHASE |          |  |
| P-1                                                                                 | BUILDING | MECHANICAL ROOM | e-1510                    | 5GB   | END SUCTION | PROPYLENE GLYCOL | 30      | 68       | 1025 | 110       | 12.125         | 82.1  | 1800  | 50                                                                                              | 480  | 3     | 1,2      |  |
| P-2                                                                                 | BUILDING | MECHANICAL ROOM | e-1510                    | 5GB   | END SUCTION | PROPYLENE GLYCOL | 30      | 68       | 1025 | 110       | 12.125         | 82.1  | 1800  | 50                                                                                              | 480  | 3     | 1,2      |  |
| P-3                                                                                 | X-CH-2   | MECHANICAL ROOM | e-1510                    | 6E    | END SUCTION | PROPYLENE GLYCOL | 30      | 68       | 880  | 25        | 9.625          | 83.2  | 1200  | 10                                                                                              | 480  | 3     | 1,3      |  |
| P-4                                                                                 | CH-1     | MECHANICAL ROOM | e-1510                    | 4AD   | END SUCTION | PROPYLENE GLYCOL | 30      | 68       | 450  | 20        | 6.25           | 79.6  | 1800  | 5                                                                                               | 480  | 3     | 1,3      |  |
| P-6                                                                                 | X-CT-1   | MECHANICAL ROOM | e-1510                    | 5BD   | END SUCTION | WATER            | -       | 68       | 650  | 40        | 7.375          | 75    | 1800  | 10                                                                                              | 480  | 3     | 1,3      |  |
| P-HC-1                                                                              | HC-1     | MECHANICAL ROOM | PL MAINTENANCE FREE PUMPS | PL-36 | INLINE      | WATER            | -       | 180      | 11.5 | 20        | -              | -     | 3300  | 1/6                                                                                             | 120  | 1     | 1,3      |  |
| <b>NOTES:</b><br>1. BASED ON: BELL & GOSSETT<br>2. VFD BY EC<br>3. DISCONNECT BY EC |          |                 |                           |       |             |                  |         |          |      |           |                |       |       |                                                                                                 |      |       |          |  |
|                                                                                     |          |                 |                           |       |             |                  |         |          |      |           |                |       |       | ABBREVIATIONS<br>EC - ELECTRICAL CONTRACTOR<br>MC - MECHANICAL CONTRACTOR<br>MFR - MANUFACTURER |      |       |          |  |

| EXHAUST FAN SCHEDULE                                                                                                                                                                                                                     |           |                   |       |        |        |             |         |       |            |         |       |          |            |          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------------|-------|--------|--------|-------------|---------|-------|------------|---------|-------|----------|------------|----------|
| TAG                                                                                                                                                                                                                                      | MODEL     | SERVICE/ LOCATION | CFM   | TYPE   | DRIVE  | ESP (IN WC) | FAN RPM | SONES | ELECTRICAL |         |       |          |            | COMMENTS |
|                                                                                                                                                                                                                                          |           |                   |       |        |        |             |         |       | FLA        | VOLTAGE | PHASE | DISC. BY | STARTER BY |          |
| EF-1                                                                                                                                                                                                                                     | SQ-120-VG | MECHANICAL ROOM   | 1,000 | INLINE | DIRECT | 1           | 1,502   | 6.9   | 6.6        | 120     | 1     | EC       | EC         | 1,2,3    |
| EF-2                                                                                                                                                                                                                                     | BSQ-120   | MECHANICAL ROOM   | 2,200 | INLINE | DIRECT | 0.5         | 2,126   | 15.9  | 16         | 120     | 1     | EC       | EC         | 1,2,4    |
| <b>NOTES:</b><br>1. BASED ON: GREENHECK<br>2. GRAVITY BACKDRAFT DAMPER<br>3. CONTINOUS OPERATION<br>4. EMERGENCY REFRIGERANT PURGE<br><br>ABBRECIATIONS<br>EC - ELECTRICAL CONTRACTOR<br>MC - MECHANICAL CONTRACTOR<br>NR - NOT REQUIRED |           |                   |       |        |        |             |         |       |            |         |       |          |            |          |

| GRAVITY VENTILATOR SCHEDULE                                                                                     |             |         |      |     |                        |          |
|-----------------------------------------------------------------------------------------------------------------|-------------|---------|------|-----|------------------------|----------|
| TAG                                                                                                             | SERVES      | MODEL   | CFM  | ESP | WEIGHT W/O ACCESSORIES | COMMENTS |
| GV-1                                                                                                            | EF-1 & EF-2 | GRSR-30 | 3200 | 0.1 | 73                     | 1,2,3,4  |
| <b>NOTES:</b><br>1. BASED ON GREENHECK<br>2. INCLUDE GRAVITY BACKDRAFT DAMPER<br>3. RELIEF HOOD<br>4. ROOF CURB |             |         |      |     |                        |          |

| LOUVER SCHEDULE                                         |         |             |          |           |        |       |                         |       |                      |     |          |
|---------------------------------------------------------|---------|-------------|----------|-----------|--------|-------|-------------------------|-------|----------------------|-----|----------|
| TAG                                                     | MODEL   | SERVES      | FUNCTION | NECK SIZE |        | DEPTH | INLET FREE AREA (SQ FT) | CFM   | PRESSURE DROP (" WC) | FPM | COMMENTS |
|                                                         |         |             |          | WIDTH     | HEIGHT |       |                         |       |                      |     |          |
| L-1                                                     | ESD-635 | EF-1 & EF-2 | INTAKE   | 48        | 36     | 6     | 6.8                     | 3,200 | 0.03                 | 473 | 1, 2     |
| <b>NOTES:</b><br>1. BASED ON GREENHECK<br>2. BIRDSCREEN |         |             |          |           |        |       |                         |       |                      |     |          |

| DAMPER SCHEDULE                                                                                                                                                                                                                                |          |                 |                     |       |        |       |       |            |          |           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------|---------------------|-------|--------|-------|-------|------------|----------|-----------|
| TAG                                                                                                                                                                                                                                            | FUNCTION | SERVES          | LOUVER/HOOD SERVICE | WIDTH | HEIGHT | DEPTH | CFM   | ELECTRICAL |          | COMMENTS  |
|                                                                                                                                                                                                                                                |          |                 |                     |       |        |       |       | VOLTAGE    | DISC. BY |           |
| D-1                                                                                                                                                                                                                                            | INTAKE   | MECHANICAL ROOM | L-1                 | 20"   | 20"    | 6"    | 2,200 | 24         | NR       | 1,2,3,4,5 |
| <b>NOTES:</b><br>1. BASED ON RUSKIN<br>2. LOW LEAKAGE AND LOW PRESSURE<br>3. DAMPER ACTUATOR<br>4. INTERLOCK WITH EF-2<br>5. NORMALLY CLOSED<br>ABBREVIATIONS<br>EC - ELECTRICAL CONTRACTOR<br>MC - MECHANICAL CONTRACTOR<br>NR - NOT REQUIRED |          |                 |                     |       |        |       |       |            |          |           |

| REVISIONS  |              |  |  |
|------------|--------------|--|--|
|            |              |  |  |
|            |              |  |  |
| 05/18/2026 | 100% BID SET |  |  |

|          |
|----------|
| DRAWN    |
| EJE      |
| APPROVED |
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MATRIX

CONSULTING ENGINEERS, INC

PROJECT

GARDNER INTERNATIONAL MAGNET SCHOOL  
CHILLER REPLACEMENT  
333 DAHLIA DR, LANSING, MI

SHEET DESCRIPTION

MECHANICAL SCHEDULES

DATE

05/18/2026

PROJECT NUMBER

260150.00

SHEET NUMBER

M-900



ELECTRICAL SYMBOLS LEGEND

| OUTLETS    |                              |  | FIXTURES               |                                                        |  | SERVICE and EQUIPMENT |       |                                                         |
|------------|------------------------------|--|------------------------|--------------------------------------------------------|--|-----------------------|-------|---------------------------------------------------------|
|            | SINGLE RECEPTACLE (120 VOLT) |  |                        | LIGHT FIXTURE                                          |  |                       | TVSS  | TRANSIENT VOLTAGE SURGE SUPPRESSION                     |
|            | DUPLEX RECEPTACLE            |  |                        | STRIP FIXTURE                                          |  |                       | VFD   | VARIABLE FREQUENCY DRIVE                                |
|            | EMERGENCY RECEPTACLE         |  |                        | EMERGENCY LIGHT FIXTURE                                |  |                       | TRANS | TRANSFORMER                                             |
|            | DOUBLE DUPLEX RECEPTACLE     |  |                        | IN-GRADE LIGHT FIXTURE                                 |  |                       | FDS   | FUSED DISCONNECT SWITCH                                 |
|            | FLUSH FLOOR BOX              |  |                        | SPOTLIGHT (number of heads shown)                      |  |                       | MS    | MAGNETIC STARTER                                        |
|            | SURFACE FLOOR BOX            |  |                        | EXIT SIGN (face & direction as shown)                  |  |                       | CS    | COMB. STARTER                                           |
|            | SPECIAL EQUIPMENT RECEPTACLE |  |                        | WALL MOUNT LIGHT FIXTURE                               |  |                       | PSB   | PANELBOARD, SURFACE MOUNTED                             |
|            | TELEPHONE OUTLET             |  |                        | CEILING LIGHT FIXTURE                                  |  |                       | FLB   | PANELBOARD, FLUSH MOUNTED                               |
|            | DATA OUTLET                  |  |                        | TRACK & FIXTURE                                        |  |                       | WH    | WEATHERHEAD                                             |
|            | TELEPHONE / DATA OUTLET      |  |                        | STREET TYPE POLE FIXTURE                               |  |                       | UM    | UTILITY METER, AS REQUIRED                              |
|            | POWER POLE                   |  |                        | POLE MOUNTED LIGHT FIXTURE                             |  |                       | DEM   | DIGITAL EQUIPMENT METER, AS REQUIRED                    |
|            | JUNCTION BOX                 |  |                        | EXTERIOR WALL MOUNT LIGHT FIXTURE                      |  |                       | CT    | CURRENT TRANSFORMERS                                    |
|            | WALL JUNCTION BOX            |  |                        | WALLPACK LIGHT FIXTURE                                 |  |                       | GEN   | GENERATOR, KW SHOWN                                     |
|            | PULL (JUNCTION) BOX          |  |                        | SPECIAL PURPOSE LIGHT FIXTURE                          |  |                       | TTB   | TELEPHONE TERMINAL BOARD                                |
|            | UNDERFLOOR JUNCTION BOX      |  |                        | HIGH BAY LIGHT FIXTURE                                 |  |                       | GC    | GROUND CONNECTION PER N.E.C.                            |
|            | CEILING MOUNTED WIFI         |  |                        | EMERGENCY EGRESS LIGHT FIXTURE (number of heads shown) |  |                       | WW    | WIREWAY                                                 |
| SWITCHES   |                              |  |                        | DOCK LIGHT FIXTURE                                     |  |                       | TS    | TRANSFER SWITCH                                         |
|            | SINGLE-POLE SWITCH           |  | CIRCUITRY and RACEWAYS |                                                        |  |                       | ECB   | ENCLOSED CIRCUIT BREAKER                                |
|            | THREE-WAY SWITCH             |  |                        | CONDUIT INSTALLED (by E.C.)                            |  |                       | CAP   | CAPACITOR                                               |
|            | FOUR-WAY SWITCH              |  |                        | CONDUIT INSTALLED (by others)                          |  | CONTROL               |       |                                                         |
|            | SWITCH WITH PILOT LIGHT      |  |                        | CONDUIT STUB UP                                        |  |                       | TH    | THERMOSTAT                                              |
|            | THERMAL OVERLOAD SWITCH      |  |                        | CONDUIT STUB DOWN                                      |  |                       | HM    | HUMIDISTAT                                              |
|            | MANUAL MOTOR SWITCH          |  |                        | HOME RUN (with circuit numbers)                        |  |                       | PC    | PHOTOCELL (voltage as required)                         |
|            | KEY SWITCH                   |  |                        | END OF CONDUIT RUN                                     |  |                       | TC    | TIME CLOCK (24 hour U.O.N.)                             |
|            | TIME SWITCH                  |  |                        | END OF CONDUIT RUN, CAP AND STAKE                      |  |                       | BS    | PUSHBUTTON STATION (number of buttons indicated)        |
|            | DIMMER SWITCH                |  |                        | "CONDUIT RUN CONTINUES" INDICATION                     |  |                       | CT    | CONTROL TRANSFORMER                                     |
| MECHANICAL |                              |  |                        | FLEXIBLE PIGTAILS/CONNECTIONS                          |  |                       | LC    | LIGHTING CONTACTOR                                      |
|            | SINGLE PHASE MOTOR           |  |                        | WIREMOLD AS SPECIFIED                                  |  |                       | IC    | IRRIGATION CONTROLLER (120 volt xxVA connection by x/C) |
|            | THREE PHASE MOTOR            |  |                        | PLUGMOLD AS SPECIFIED                                  |  | SOUND and SIGNAL      |       |                                                         |
|            | RESISTANCE HEATER, KW SHOWN  |  |                        | BUS DUCT                                               |  |                       | S     | SPEAKER                                                 |
|            | PIPE TRACE HEATER            |  |                        | UNDERFLOOR DUCT                                        |  |                       | WS    | WALL MOUNTED SPEAKER                                    |
|            | ELECTRIC UNIT HEATER         |  | NURSE CALL             |                                                        |  |                       | WS/C  | WALL MOUNTED SPEAKER / CLOCK COMBO                      |
|            | ELECTRIC WATER HEATER        |  |                        | NURSE CALL CONTROLLER                                  |  |                       | SFC   | SINGLE FACE CLOCK                                       |
|            |                              |  |                        | MASTER STATION                                         |  |                       | DFC   | DUAL FACE CLOCK                                         |
|            |                              |  |                        | EMERGENCY PULL STATION                                 |  |                       | VI    | VIDEO INPUT                                             |
|            |                              |  |                        | EMERGENCY PUSH STATION                                 |  |                       | AV    | AUDIO / VIDEO INPUT                                     |
|            |                              |  |                        | CODE BLUE STATION                                      |  |                       | B     | BELL                                                    |
|            |                              |  |                        | PENDENT INTERFACE                                      |  |                       | V     | VOLUME CONTROL                                          |
|            |                              |  |                        | BED / LIGHT INTERFACE                                  |  |                       | BZ    | BUZZER                                                  |
|            |                              |  |                        | SINGLE BED STATION                                     |  |                       | CH    | CHIME                                                   |
|            |                              |  |                        | DUAL BED STATION                                       |  |                       | TV    | TELEVISION OUTLET                                       |
|            |                              |  |                        | DOME LIGHT                                             |  |                       | MO    | MICROPHONE OUTLET                                       |
|            |                              |  |                        | STAFF REGISTER STATION                                 |  |                       | IO    | INTERCOM OUTLET                                         |
|            |                              |  |                        | STAFF STATION                                          |  |                       | C     | CAMERA                                                  |
|            |                              |  |                        | DUTY STATION                                           |  |                       | DC    | DOOR CONTACT                                            |
|            |                              |  | DESIGNATIONS           |                                                        |  |                       | MD    | MOTION DETECTOR                                         |
|            |                              |  |                        | DEMOLITION NOTE                                        |  |                       | BD    | BEAM DETECTOR                                           |
|            |                              |  |                        | PLAN NOTE                                              |  |                       | KP    | KEY PAD                                                 |
|            |                              |  |                        | ADDENDUM NOTE                                          |  |                       | SSCP  | SECURITY SYSTEM CONTROL PANEL                           |
|            |                              |  |                        |                                                        |  |                       | CCTV  | CCTV CONTROL PANEL                                      |
|            |                              |  |                        |                                                        |  |                       | CR    | CARD READER                                             |
|            |                              |  |                        |                                                        |  |                       | SS    | STUDENT STATION                                         |
|            |                              |  |                        |                                                        |  |                       | AS    | ADMINISTRATION STATION                                  |
|            |                              |  |                        |                                                        |  |                       | TS    | TEACHER STATION                                         |
|            |                              |  |                        |                                                        |  |                       | GB    | GLASS BREAK                                             |

GENERAL ELECTRICAL NOTES

- ALL WALL AND FLOOR PENETRATIONS ARE TO BE SEALED TO MAINTAIN ORIGINAL RATING.
- ALL CONDUITS TO BE FIELD ROUTED ALONG EXISTING PIPING AND STRUCTURAL STEEL.
- THE DIVISION 26 CONTRACTORS SHALL VISIT THE PROJECT AND DETERMINE THE EXACT EXTENT OF THE DEMOLITION WORK REQUIRED BEFORE BIDDING THE PROJECT.
- REMOVE ALL EXISTING OBSOLETE EXPOSED CONDUIT, WIRE AND UNUSED EQUIPMENT WHERE WORK IS BEING DONE EXCEPT ITEMS NOTED OTHERWISE.
- WHERE BUILDING SURFACES ARE DAMAGED BY THE REMOVAL OF OLD WORK, SURFACES SHALL BE PATCHED TO MATCH ADJACENT.
- EXISTING WORK WHICH IS PRESENTLY CONCEALED AND WHICH WILL REMAIN CONCEALED AND DOES NOT INTERFERE WITH ANY NEW WORK OF ANY TRADE NEED NOT BE REMOVED. HOWEVER, ALL CONDUIT SHALL BE CAPPED BELOW FINISH SURFACE AND THEN PATCHED TO MATCH, OR AS NOTED.
- EXISTING OPENINGS, WHICH ARE TO BE REUSED, SHALL BE MODIFIED OR ENLARGED TO SUIT THE NEW SYSTEMS AS REQUIRED. PROVIDE ALL REQUIRED CUTTING AND PATCHING.
- IF ASBESTOS IS PRESENT, IT WILL BE REMOVED OR RENDERED HARMLESS UNDER SEPARATE CONTRACT BY THE OWNER.
- THE DIVISION 26 CONTRACTOR SHALL BE RESPONSIBLE FOR PATCHING THE EXISTING WALLS TO MATCH THE ADJACENT SURFACES BEHIND ALL SURFACE MOUNTED EQUIPMENT.
- CONTRACTOR SHALL FIELD VERIFY ALL EQUIPMENT VOLTAGES AND LOADS PRIOR TO INSTALLING SERVICE TO EQUIPMENT.
- DRAWINGS ARE BASED ON EXISTING RECORD DOCUMENT AND CASUAL FIELD OBSERVATION. REPORT ANY DISCREPANCIES TO ENGINEER FOR CLARIFICATION.

ABBREVIATIONS LEGEND

|            |                               |         |                                      |        |                                  |
|------------|-------------------------------|---------|--------------------------------------|--------|----------------------------------|
| A          | AMPS                          | GC      | GENERAL CONTRACTOR                   | P      | POLE                             |
| AC         | ABOVE COUNTER                 | GFI     | GROUND FAULT INTERRUPTER             | P-     | PUMP                             |
| ACU-       | AIR CONDITIONING UNIT         | GND     | GROUND                               | PB     | PULL BOX                         |
| AFF        | ABOVE FINISHED FLOOR          |         |                                      | PNL    | PANEL                            |
| AHJ        | AUTHORITY HAVING JURISDICTION | H-      | HUMIDIFIER                           | PRV-   | POWER ROOF VENTILATOR            |
| AHU-       | AIR HANDLING UNIT             | HID     | HIGH INTENSITY DISCHARGE             | PVC    | POLY VINYL CLORIDE               |
| AIC        | AMPS INTERRUPTING CAPACITY    | HOA     | HAND-OFF-AUTO SELECTOR SWITCH        | PWR    | POWER                            |
| AS         | ABOVE SHELF                   | HP      | HORSEPOWER                           |        |                                  |
| ATS        | AUTOMATIC TRANSFER SWITCH     | HR      | HOUR                                 | RECEPT | RECEPTACLE                       |
|            |                               | HVAC    | HEATING/VENTILATING/AIR CONDITIONING | RGC    | RIGID GALVANIZED STEEL CONDUIT   |
| B-         | BOILER                        |         |                                      | RTU-   | ROOF TOP UNIT                    |
| BC         | BELOW COUNTER                 | IG      | ISOLATED GROUND                      |        |                                  |
| BLDG       | BUILDING                      | IMC     | INTERMEDIATE METAL CONDUIT           | SF-    | SUPPLY FAN                       |
|            |                               | JB      | JUNCTION BOX                         | SPEC   | SPECIFICATIONS                   |
| CHLR-      | CHILLER                       | LC      | LIGHT CONTROL                        | SW     | SWITCH                           |
| CND (C)    | CONDUIT                       | LT      | LIGHT                                | SWBD   | SWITCHBOARD                      |
| CKT        | CIRCUIT                       | LTG     | LIGHTING                             | TCC    | TEMPERATURE CONTROL CONTRACTOR   |
| CKT BKR    | CIRCUIT BREAKER               | LT FLEX | LIQUID TIGHT FLEXIBLE METAL CONDUIT  | TR     | TAMPER PROOF RECEPTACLE          |
| CT-        | COOLING TOWER                 |         |                                      | TS     | TAMPER PROOF SWITCH              |
| CU-        | CONDENSING UNIT               |         |                                      | TYP    | TYPICAL                          |
| CUH-       | CABINET UNIT HEATER           | MAX     | MAXIMUM                              | UF     | UNDER FLOOR                      |
|            |                               | MC      | MECHANICAL CONTRACTOR                | UH-    | UNIT HEATER                      |
| DFU-       | DUCT FURNACE                  | MCC     | MOTOR CONTROL CENTER                 | UL     | UNDERWRITERS' LABORATORIES, INC. |
| DISC       | DISCONNECT                    | MIN     | MINIMUM                              | UNO    | UNLESS NOTED OTHERWISE           |
| DWG        | DRAWING                       | MLO     | MAIN LUG ONLY                        |        |                                  |
| DWH-       | DOMESTIC WATER HEATER         | MT      | MOUNT                                | V      | VOLTS                            |
|            |                               | MTD     | MOUNTED                              | VL     | VERIFY LOCATION WITH OWNER       |
| EBB-       | ELECTRIC BASEBOARD            | MTG     | MOUNTING                             |        |                                  |
| EC         | ELECTRICAL CONTRACTOR         | MUAU-   | MAKE-UP AIR UNIT                     | W      | WATTS                            |
| EF-        | EXHAUST FAN                   |         |                                      | W/     | WITH                             |
| EM         | EMERGENCY                     | NC      | NORMALLY CLOSED                      | W/O    | WITHOUT                          |
| EMT        | ELECTRICAL METALLIC TUBING    | NIC     | NOT IN CONTRACT                      | WP     | WEATHER PROOF                    |
| EWC        | ELECTRIC WATER COOLER         | NL      | NIGHT LIGHT                          |        |                                  |
| EXIST./EX. | EXISTING                      | NO      | NORMALLY OPEN                        | XFMR   | TRANSFORMER                      |
|            |                               | NTS     | NOT TO SCALE                         |        |                                  |
| FLA        | FULL LOAD AMPS                |         |                                      |        |                                  |
| FLEX       | FLEXIBLE CONDUIT              |         |                                      |        |                                  |
| FLR        | FLOOR                         |         |                                      |        |                                  |
| FLUOR      | FLUORESCENT                   |         |                                      |        |                                  |
| FSES       | FOOD SERVICE EQUIP. SUPPLIER  |         |                                      |        |                                  |
| F/S        | FIRE/SMOKE                    |         |                                      |        |                                  |
| FU-        | FURNACE                       |         |                                      |        |                                  |

| REVISIONS  |              |  |  |
|------------|--------------|--|--|
|            |              |  |  |
|            |              |  |  |
|            |              |  |  |
| 05/18/2026 | 100% BID SET |  |  |

|          |
|----------|
| DRAWN    |
| BTT      |
| APPROVED |
| JFS      |



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PROJECT

**GARDNER INTERNATIONAL MAGNET SCHOOL**  
CHILLER REPLACEMENT  
333 DAHLIA DR, LANSING, MI

SHEET DESCRIPTION

**ELECTRICAL  
SYMBOLS  
ABBREV.  
AND NOTES**

DATE

05/18/2026

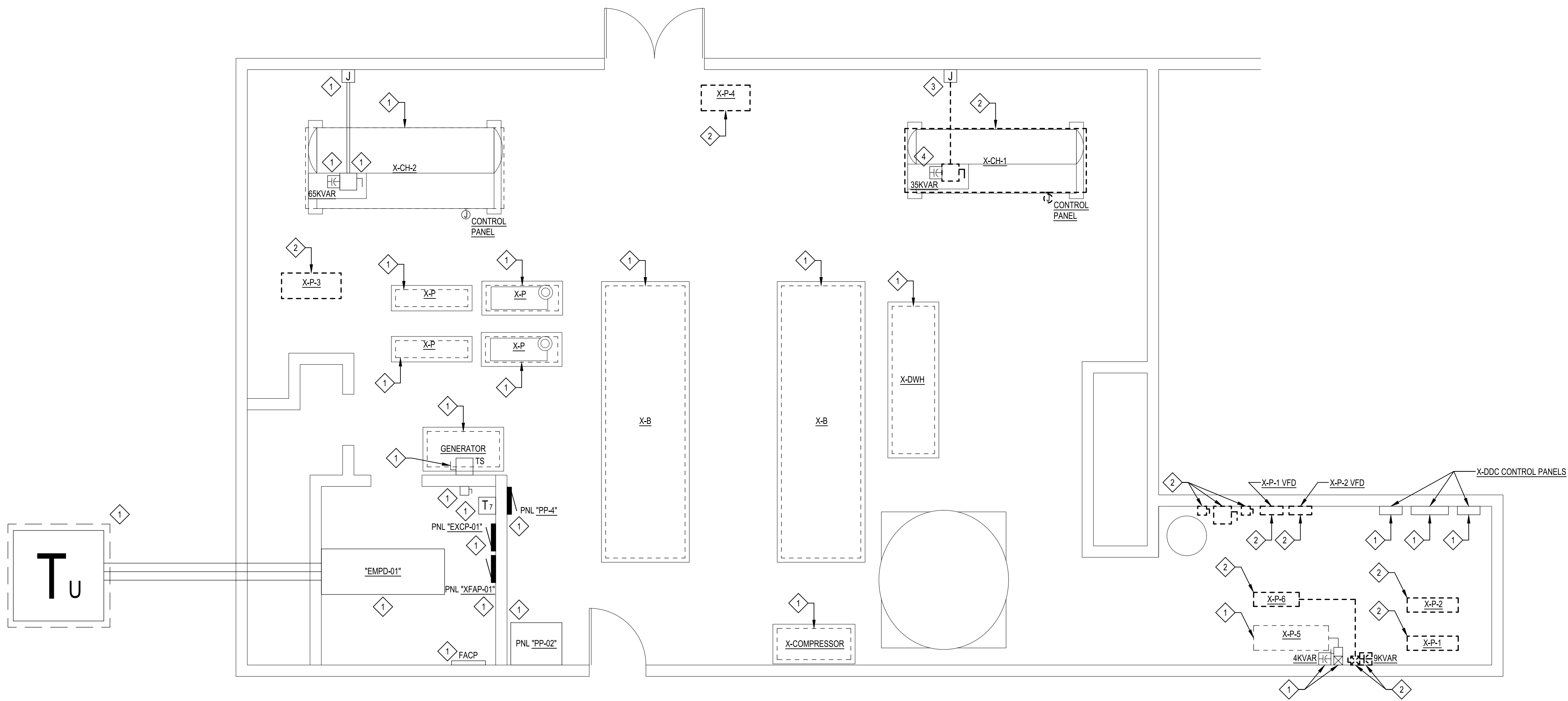
PROJECT NUMBER

260150.00

SHEET NUMBER

**E-100**



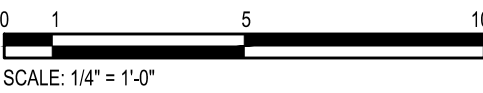


**DEMOLITION NOTES**

- 1 EXISTING EQUIPMENT TO REMAIN.
- 2 BASE BID: DISCONNECT AND REMOVE EXISTING EQUIPMENT, ASSOCIATED CONDUIT TO REMAIN FOR CONNECTION TO NEW EQUIPMENT, REMOVE ASSOCIATED WIRE BACK TO SOURCE.  
  
ADD ALTERNATE: DISCONNECT AND REMOVE EXISTING EQUIPMENT, ASSOCIATED CONDUIT TO BE CAPPED ABOVE FINISHED FLOOR, REMOVE ASSOCIATED WIRE BACK TO SOURCE.
- 3 BASE BID: EXISTING EQUIPMENT TO REMAIN, ASSOCIATED CONDUIT TO REMAIN FOR CONNECTION TO NEW EQUIPMENT, REMOVE ASSOCIATED WIRE BACK TO SOURCE.  
  
ADD ALTERNATE: EXISTING EQUIPMENT TO REMAIN, ASSOCIATED CONDUIT TO BE TERMINATED TO PULL BOX, REMOVE ASSOCIATED WIRE BACK TO SOURCE.
- 4 DISCONNECT AND REMOVE EXISTING CAPACITOR FOR REMOVAL OF CHILLER, RE-CONNECT CAPACITOR TO NEW CHILLER.



**MECHANICAL ROOM PLAN - DEMOLITION**



| REVISIONS  |              |  |  |
|------------|--------------|--|--|
|            |              |  |  |
| 05/18/2026 | 100% BID SET |  |  |
| DRAWN      |              |  |  |
| BTT        |              |  |  |
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GARDNER INTERNATIONAL MAGNET SCHOOL  
CHILLER REPLACEMENT  
333 DAHLIA DR, LANSING, MI

SHEET DESCRIPTION

MECHANICAL  
ROOM PLAN  
DEMOLITION

DATE

05/18/2026

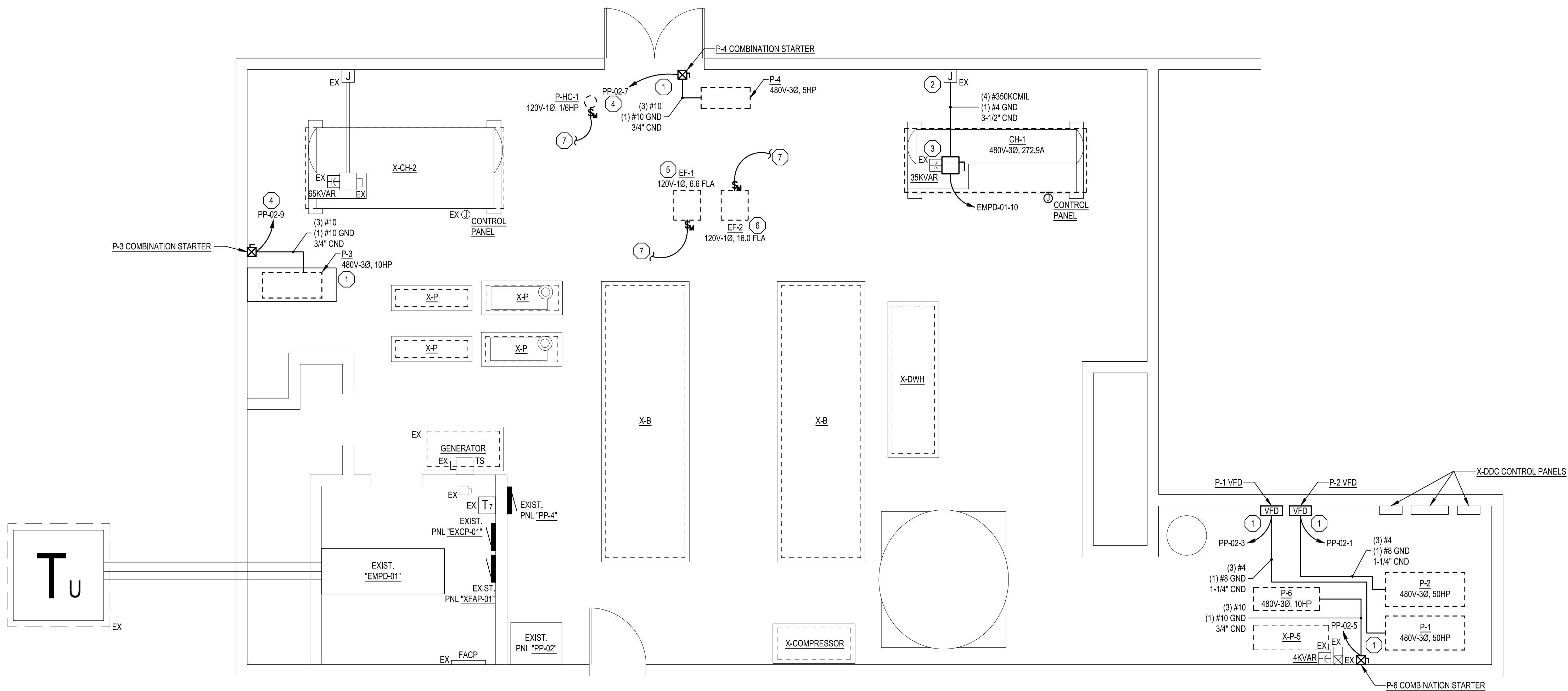
PROJECT NUMBER

260150.00

SHEET NUMBER

E-300





## MECHANICAL ROOM PLAN - POWER

0 1 5 10  
SCALE: 1/4" = 1'-0"

## ELECTRICAL KEY NOTES

- BASE BID:**  
REUSE EXISTING CONDUIT FOR CONNECTION TO NEW EQUIPMENT, PROVIDE AND INSTALL NEW WIRE.
- ADD ALTERNATE:**  
PROVIDE AND INSTALL NEW CONDUIT AND WIRE FOR CONNECTION TO NEW EQUIPMENT.
- BASE BID:**  
REUSE EXISTING CONDUIT TO PULL BOX FOR CONNECTION TO NEW EQUIPMENT. PROVIDE AND INSTALL NEW CONDUIT FROM PULL BOX TO CHILLER. PROVIDE AND INSTALL NEW WIRE IN ENTIRETY.
- ADD ALTERNATE:**  
PROVIDE AND INSTALL NEW CONDUIT AND WIRE FOR CONNECTION TO NEW EQUIPMENT.
- RE-CONNECT CAPACITOR TO NEW CHILLER.**
- EXISTING CIRCUIT IS UNKNOWN, NEW CIRCUIT NUMBER IS SHOWN FOR LOAD PURPOSES. CONTRACTOR SHALL FIELD VERIFY EXISTING CIRCUIT, FOR POTENTIAL RE-CONNECTION.**
- EXHAUST FAN TO RUN CONTINUOUSLY.**
- EXHAUST FAN SHALL BE CONTROLLED BY REFRIGERANT MONITOR. ROUTE CIRCUIT THROUGH RIB RELAY CONTROLLED BY BAS SYSTEM. PROVIDE ALL WIRE AND CONDUIT FOR A COMPLETE INSTALLATION.**
- FEED EQUIPMENT FROM NEAREST EXISTING PANEL LOCATED IN THE BUILDING. EQUIPMENT TO BE FED FROM 120V PANEL WITH 20A/1P EXISTING SPARE BREAKER OR NEW 120V 20A/1P BREAKER OF THE SAME TYPE. CONTRACTOR SHALL ENSURE ADDING NEW LOADS TO THE CHOSEN PANEL WILL NOT OVERLOAD THE PANEL LOAD RATING.**

| REVISIONS  |              |  |  |
|------------|--------------|--|--|
| 05/18/2026 | 100% BID SET |  |  |

DRAWN  
**BTT**

APPROVED  
**JFS**

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**PROJECT**

GARDNER INTERNATIONAL MAGNET SCHOOL  
CHILLER REPLACEMENT  
333 DAHLIA DR, LANSING, MI

**SHEET DESCRIPTION**

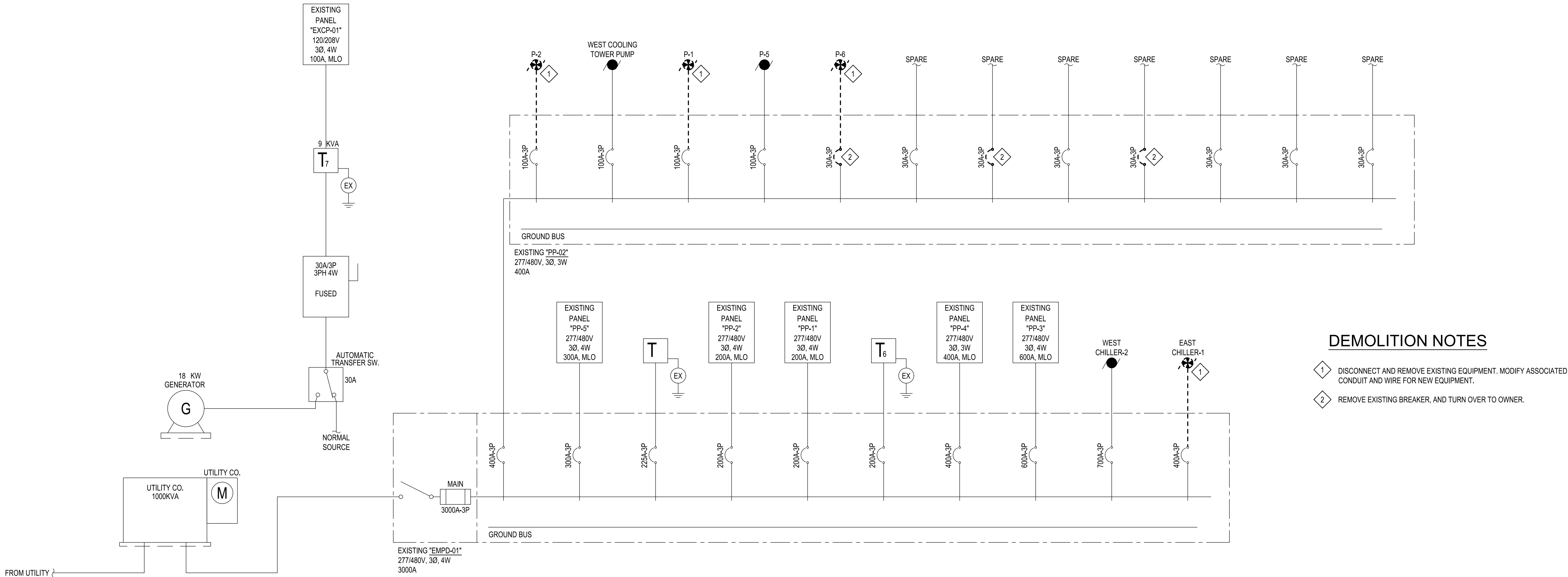
MECHANICAL  
ROOM PLAN  
POWER

DATE  
05/18/2026

PROJECT NUMBER  
260150.00

SHEET NUMBER  
**E-500**





DEMOLITION NOTES

- 1 DISCONNECT AND REMOVE EXISTING EQUIPMENT. MODIFY ASSOCIATED CONDUIT AND WIRE FOR NEW EQUIPMENT.
- 2 REMOVE EXISTING BREAKER, AND TURN OVER TO OWNER.

| SERVICE LOAD SUMMARY    |        |        |  |
|-------------------------|--------|--------|--|
|                         | W      | AMPS   |  |
| EXISTING DEMAND         | 606530 | 729.56 |  |
| ADDITIONAL 25% CAPACITY | 151633 | 182.39 |  |
| REMOVED LOAD            | 346355 | 416.61 |  |
| ADDITIONAL LOAD         | 390135 | 469.27 |  |
| TOTAL                   | 801943 | 964.62 |  |

PARTIAL RISER DIAGRAM - EXISTING

SCALE: N.T.S.

| EXISTING PANEL "EMPD-01"                                    |   |                         |         |                                        |             |         |   |                                   |    |             |                         |     |   |      |           |
|-------------------------------------------------------------|---|-------------------------|---------|----------------------------------------|-------------|---------|---|-----------------------------------|----|-------------|-------------------------|-----|---|------|-----------|
| LOCATION: MAIN ELECTRICAL ROOM<br>SUPPLY FROM: UTILITY XFMR |   |                         |         | MOUNTING: SURFACE<br>ENCLOSURE: NEMA 1 |             |         |   | A.I.C. RATING: EXISTING<br>NOTES: |    |             |                         |     |   |      |           |
| VOLTS: 480 /277                                             |   |                         |         | PHASE: 3                               |             | WIRE: 4 |   | AMPS: 3000                        |    | MAIN: MCB   |                         |     |   |      |           |
| BRKR                                                        |   | DESCRIPTION             | CIRCUIT |                                        | PHASE LOADS |         |   | CIRCUIT                           |    | DESCRIPTION | BRKR                    |     |   |      |           |
| A                                                           | P |                         | VA      |                                        | A           | B       | C | VA                                | A  |             | P                       |     |   |      |           |
| 400                                                         | 3 | EXISTING PNL "PP-02"    |         | 1                                      | 0           |         | 0 |                                   | 2  |             | EXISTING PNL "PP-5"     | 300 | 3 |      |           |
|                                                             |   |                         |         |                                        |             |         | 0 |                                   |    |             |                         |     |   |      |           |
| 225                                                         | 3 | EXISTING TRANSFORMER    |         | 3                                      | 0           |         | 0 |                                   | 4  |             | EXISTING PNL "PP-2"     | 200 | 3 |      |           |
|                                                             |   |                         |         |                                        |             |         | 0 |                                   |    |             |                         |     |   |      |           |
| 200                                                         | 3 | EXISTING PNL "PP-1"     |         | 5                                      | 0           |         | 0 |                                   | 6  |             | EXISTING TRANSFORMER #6 | 200 | 3 |      |           |
|                                                             |   |                         |         |                                        |             |         | 0 |                                   |    |             |                         |     |   |      |           |
| 400                                                         | 3 | EXISTING PNL "PP-4"     |         | 7                                      | 0           |         | 0 |                                   | 8  |             | EXISTING PNL "PP-3"     | 600 | 3 |      |           |
|                                                             |   |                         |         |                                        |             |         | 0 |                                   |    |             |                         |     |   |      |           |
| 700                                                         | 3 | EXISTING WEST CHILLER-2 |         | 9                                      | 0           |         | 0 |                                   | 10 |             | EXISTING EAST CHILLER-1 | 400 | 3 |      |           |
|                                                             |   |                         |         |                                        |             |         | 0 |                                   |    |             |                         |     |   |      |           |
| CONNECTED                                                   |   |                         |         |                                        | 0           | 0       | 0 | TOTAL CONNECTED LOAD              |    |             |                         |     |   | 0    | VOLT-AMPS |
| TOTAL CONNECTED                                             |   |                         |         |                                        | 0           |         |   |                                   |    |             |                         |     |   | 0.00 | AMPS      |

| EXISTING PANEL "PP-02"                            |   |              |         |                                        |             |       |       |                                                                            |       |                                     |      |   |                  |  |
|---------------------------------------------------|---|--------------|---------|----------------------------------------|-------------|-------|-------|----------------------------------------------------------------------------|-------|-------------------------------------|------|---|------------------|--|
| LOCATION: MECHANICAL ROOM<br>SUPPLY FROM: EMPD-01 |   |              |         | MOUNTING: SURFACE<br>ENCLOSURE: NEMA 1 |             |       |       | A.I.C. RATING: EXISTING<br>NOTES: LOADS LISTED IN ITALICS<br>ARE ESTIMATED |       |                                     |      |   |                  |  |
| VOLTS: 480 /277                                   |   |              |         | PHASE: 3 WIRE: 3                       |             |       |       | AMPS: 400 MAIN: MLO                                                        |       |                                     |      |   |                  |  |
| BRKR                                              |   | DESCRIPTION  | CIRCUIT |                                        | PHASE LOADS |       |       | CIRCUIT                                                                    |       | DESCRIPTION                         | BRKR |   |                  |  |
| A                                                 | P |              | VA      |                                        | A           | B     | C     |                                                                            | VA    |                                     | A    | P |                  |  |
| 100                                               | 3 | EXISTING P-2 | 14410   | 1                                      | 28820       |       |       | 2                                                                          | 14410 | EXISTING WEST COOLING<br>TOWER PUMP | 100  | 3 |                  |  |
|                                                   |   |              | 14410   |                                        | 28820       |       | 14410 |                                                                            |       |                                     |      |   |                  |  |
|                                                   |   |              |         |                                        |             | 28820 |       |                                                                            | 14410 |                                     |      |   |                  |  |
| 100                                               | 3 | EXISTING P-1 | 14410   | 3                                      | 28820       |       |       | 4                                                                          | 14410 | EXISTING P-5                        | 100  | 3 |                  |  |
|                                                   |   |              | 14410   |                                        | 28820       |       | 14410 |                                                                            |       |                                     |      |   |                  |  |
|                                                   |   |              |         |                                        |             | 28820 |       |                                                                            | 14410 |                                     |      |   |                  |  |
| 30                                                | 3 | EXISTING P-6 | 5820    | 5                                      | 5820        |       |       | 6                                                                          |       | SPARE                               | 30   | 3 |                  |  |
|                                                   |   |              | 5820    |                                        | 5820        |       |       |                                                                            |       |                                     |      |   |                  |  |
|                                                   |   |              | 5820    |                                        |             | 5820  |       |                                                                            |       |                                     |      |   |                  |  |
| 30                                                | 3 | SPARE        |         | 7                                      | 0           |       |       | 8                                                                          |       | SPARE                               | 30   | 3 |                  |  |
|                                                   |   |              |         |                                        |             | 0     |       |                                                                            |       |                                     |      |   |                  |  |
|                                                   |   |              |         |                                        | 0           |       | 0     |                                                                            |       |                                     |      |   |                  |  |
| 30                                                | 3 | SPARE        |         | 9                                      |             | 0     |       | 10                                                                         |       | SPARE                               | 30   | 3 |                  |  |
|                                                   |   |              |         |                                        |             |       | 0     |                                                                            |       |                                     |      |   |                  |  |
|                                                   |   |              |         |                                        | 0           |       |       |                                                                            |       |                                     |      |   |                  |  |
| 30                                                | 3 | SPARE        |         | 11                                     | 0           |       |       | 12                                                                         |       | SPARE                               | 30   | 3 |                  |  |
|                                                   |   |              |         |                                        |             | 0     |       |                                                                            |       |                                     |      |   |                  |  |
|                                                   |   |              |         |                                        |             | 0     |       |                                                                            |       |                                     |      |   |                  |  |
| CONNECTED                                         |   |              |         |                                        | 63460       | 63460 | 63460 | TOTAL CONNECTED LOAD                                                       |       |                                     |      |   | 190381 VOLT-AMPS |  |
| TOTAL CONNECTED                                   |   |              |         |                                        | 190381      |       |       |                                                                            |       |                                     |      |   | 228.99 AMPS      |  |

| REVISIONS  |              |  |  |
|------------|--------------|--|--|
| 05/18/2026 | 100% BID SET |  |  |
| DRAWN      |              |  |  |
| BTT        |              |  |  |
| APPROVED   |              |  |  |
| JFS        |              |  |  |

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PROJECT

GARDNER INTERNATIONAL MAGNET SCHOOL  
CHILLER REPLACEMENT  
333 DAHLIA DR, LANSING, MI

SHEET DESCRIPTION

EXISTING RISER  
DIAGRAM AND  
PANEL  
SCHEDULES

DATE

05/18/2026

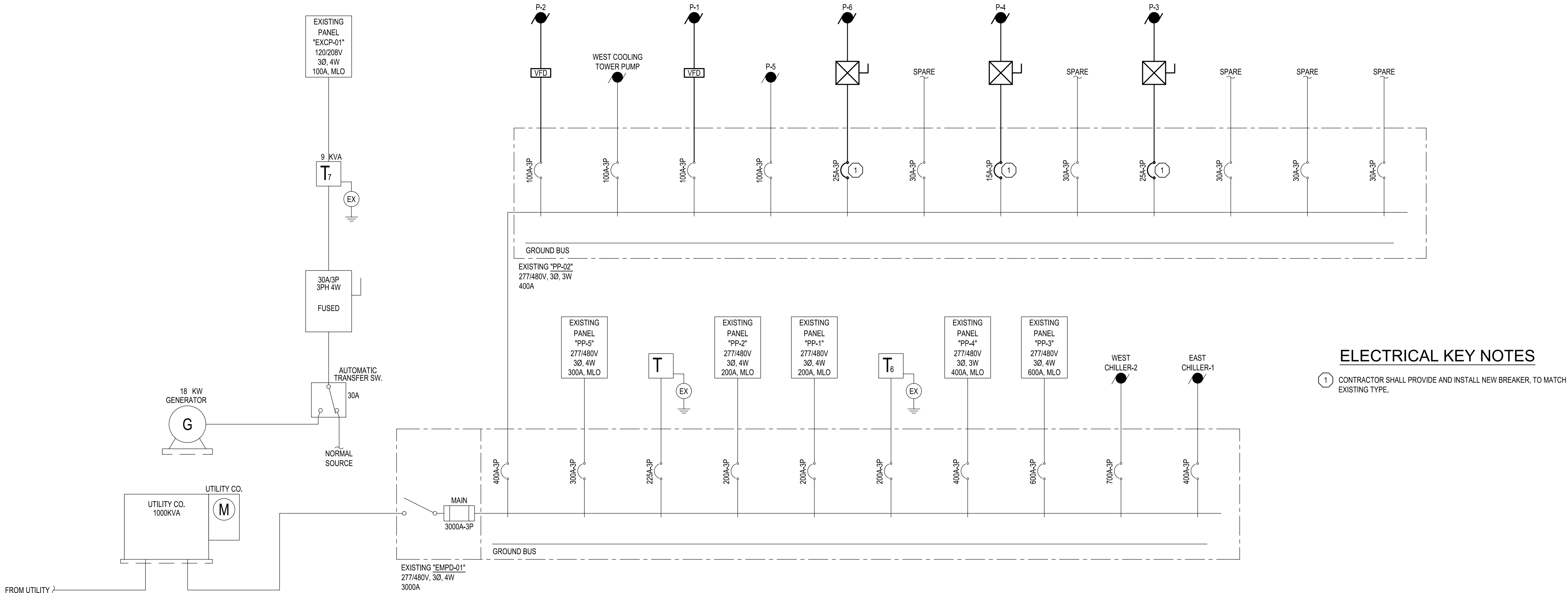
PROJECT NUMBER

260150.00

SHEET NUMBER

E-600





ELECTRICAL KEY NOTES

- 1 CONTRACTOR SHALL PROVIDE AND INSTALL NEW BREAKER, TO MATCH EXISTING TYPE.

| SERVICE LOAD SUMMARY    |         |        |
|-------------------------|---------|--------|
|                         | W       | AMPS   |
| EXISTING DEMAND         | 606.520 | 729.56 |
| ADDITIONAL 25% CAPACITY | 1516.53 | 182.39 |
| REMOVED LOAD            | 346.555 | 416.61 |
| ADDITIONAL LOAD         | 390.135 | 469.27 |
| TOTAL                   | 801.943 | 964.62 |

PARTIAL RISER DIAGRAM - REVISED

SCALE: N.T.S.

| REVISED PANEL "EMPD-01"                                     |   |                         |         |                                        |             |         |       |                                   |    |             |                         |     |   |                  |  |
|-------------------------------------------------------------|---|-------------------------|---------|----------------------------------------|-------------|---------|-------|-----------------------------------|----|-------------|-------------------------|-----|---|------------------|--|
| LOCATION: MAIN ELECTRICAL ROOM<br>SUPPLY FROM: UTILITY XFMR |   |                         |         | MOUNTING: SURFACE<br>ENCLOSURE: NEMA 1 |             |         |       | A.I.C. RATING: EXISTING<br>NOTES: |    |             |                         |     |   |                  |  |
| VOLTS: 480 / 277                                            |   |                         |         | PHASE: 3                               |             | WIRE: 4 |       | AMPS: 3000                        |    | MAIN: MCB   |                         |     |   |                  |  |
| BRKR                                                        |   | DESCRIPTION             | CIRCUIT |                                        | PHASE LOADS |         |       | CIRCUIT                           |    | DESCRIPTION | BRKR                    |     |   |                  |  |
| A                                                           | P |                         | VA      |                                        | A           | B       | C     | VA                                |    |             | A                       | P   |   |                  |  |
| 400                                                         | 3 | EXISTING PNL "PP-02"    |         | 1                                      | 0           |         | 0     |                                   | 2  |             | EXISTING PNL "PP-5"     | 300 | 3 |                  |  |
|                                                             |   |                         |         |                                        |             |         | 0     |                                   |    |             |                         |     |   |                  |  |
| 225                                                         | 3 | EXISTING TRANSFORMER    |         | 3                                      | 0           |         | 0     |                                   | 4  |             | EXISTING PNL "PP-2"     | 200 | 3 |                  |  |
|                                                             |   |                         |         |                                        |             |         | 0     |                                   |    |             |                         |     |   |                  |  |
| 200                                                         | 3 | EXISTING PNL "PP-1"     |         | 5                                      | 0           |         | 0     |                                   | 6  |             | EXISTING TRANSFORMER #6 | 200 | 3 |                  |  |
|                                                             |   |                         |         |                                        |             |         | 0     |                                   |    |             |                         |     |   |                  |  |
| 400                                                         | 3 | EXISTING PNL "PP-4"     |         | 7                                      | 0           |         | 0     |                                   | 8  |             | EXISTING PNL "PP-3"     | 600 | 3 |                  |  |
|                                                             |   |                         |         |                                        |             |         | 0     |                                   |    |             |                         |     |   |                  |  |
| 700                                                         | 3 | EXISTING WEST CHILLER-2 |         | 9                                      | 75539       |         |       |                                   | 10 | 75539       | NEW EAST CHILLER-1      | 400 | 3 |                  |  |
|                                                             |   |                         |         |                                        |             | 75539   |       |                                   |    | 75539       |                         |     |   |                  |  |
|                                                             |   |                         |         |                                        |             |         | 75539 |                                   |    |             |                         |     |   |                  |  |
| CONNECTED                                                   |   |                         |         |                                        | 75539       | 75539   | 75539 | TOTAL CONNECTED LOAD              |    |             |                         |     |   | 226617 VOLT-AMPS |  |
| TOTAL CONNECTED                                             |   |                         |         |                                        | 226617      |         |       |                                   |    |             |                         |     |   | 272.58 AMPS      |  |

| REVISED PANEL "PP-02"                             |   |             |         |                                        |             |         |       |                                                                                   |       |                                     |      |   |                  |  |
|---------------------------------------------------|---|-------------|---------|----------------------------------------|-------------|---------|-------|-----------------------------------------------------------------------------------|-------|-------------------------------------|------|---|------------------|--|
| LOCATION: MECHANICAL ROOM<br>SUPPLY FROM: EMPD-01 |   |             |         | MOUNTING: SURFACE<br>ENCLOSURE: NEMA 1 |             |         |       | A.I.C. RATING: EXISTING<br>NOTES: * DENOTES NEW<br>CONTRACTOR PROVIDED<br>BREAKER |       |                                     |      |   |                  |  |
| VOLTS: 480 /277                                   |   |             |         | PHASE: 3                               |             | WIRE: 3 |       | AMPS: 400                                                                         |       | MAIN: MLO                           |      |   |                  |  |
| BRKR                                              |   | DESCRIPTION | CIRCUIT |                                        | PHASE LOADS |         |       | CIRCUIT                                                                           |       | DESCRIPTION                         | BRKR |   |                  |  |
| A                                                 | P |             | VA      |                                        | A           | B       | C     | VA                                                                                |       |                                     | A    | P |                  |  |
| 100                                               | 3 | NEW P-2     | 18013   |                                        | 32423       |         |       | 2                                                                                 | 14410 | EXISTING WEST COOLING<br>TOWER PUMP | 100  | 3 |                  |  |
|                                                   |   |             | 18013   | 1                                      |             | 32423   |       |                                                                                   |       |                                     |      |   | 14410            |  |
|                                                   |   |             | 18013   |                                        |             |         | 32423 |                                                                                   |       |                                     |      |   | 14410            |  |
| 100                                               | 3 | NEW P-1     | 18013   |                                        | 32423       |         |       | 4                                                                                 | 14410 | EXISTING P-5                        | 100  | 3 |                  |  |
|                                                   |   |             | 18013   | 3                                      |             | 32423   |       |                                                                                   |       |                                     |      |   | 14410            |  |
|                                                   |   |             | 18013   |                                        |             |         | 32423 |                                                                                   |       |                                     |      |   | 14410            |  |
| 30                                                | 3 | NEW P-6     | 3876    |                                        | 3876        |         |       | 6                                                                                 |       | SPARE                               | 30   | 3 |                  |  |
|                                                   |   |             | 3876    | 5                                      |             | 3876    |       |                                                                                   |       |                                     |      |   |                  |  |
|                                                   |   |             | 3876    |                                        |             |         | 3876  |                                                                                   |       |                                     |      |   |                  |  |
| 15                                                | 3 | *NEW P-4    | 2106    |                                        | 2106        |         |       | 8                                                                                 |       | SPARE                               | 30   | 3 |                  |  |
|                                                   |   |             | 2106    | 7                                      |             | 2106    |       |                                                                                   |       |                                     |      |   |                  |  |
|                                                   |   |             | 2106    |                                        |             |         | 2106  |                                                                                   |       |                                     |      |   |                  |  |
| 25                                                | 3 | *NEW P-3    | 3880    |                                        | 3880        |         |       | 10                                                                                |       | SPARE                               | 30   | 3 |                  |  |
|                                                   |   |             | 3880    | 9                                      |             | 3880    |       |                                                                                   |       |                                     |      |   |                  |  |
|                                                   |   |             | 3880    |                                        |             |         | 3880  |                                                                                   |       |                                     |      |   |                  |  |
| 30                                                | 3 | SPARE       |         |                                        | 0           |         |       | 12                                                                                |       | SPARE                               | 30   | 3 |                  |  |
|                                                   |   |             |         | 11                                     |             | 0       |       |                                                                                   |       |                                     |      |   |                  |  |
|                                                   |   |             |         |                                        |             |         | 0     |                                                                                   |       |                                     |      |   |                  |  |
| CONNECTED                                         |   |             |         |                                        | 74708       | 74708   | 74708 | TOTAL CONNECTED LOAD                                                              |       |                                     |      |   | 224124 VOLT-AMPS |  |
| TOTAL CONNECTED                                   |   |             |         |                                        | 224124      |         |       |                                                                                   |       |                                     |      |   | 269.58 AMPS      |  |

| REVISIONS  |              |  |
|------------|--------------|--|
| 05/18/2026 | 100% BID SET |  |
| DRAWN      |              |  |
| BTT        |              |  |
| APPROVED   |              |  |
| JFS        |              |  |

MATRIX

CONSULTING ENGINEERS, INC

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Matrix Project No. 260150.00

GARDNER INTERNATIONAL MAGNET SCHOOL  
CHILLER REPLACEMENT  
333 DAHLIA DR, LANSING, MI

SHEET DESCRIPTION  
REVISED RISER  
DIAGRAM AND  
PANEL  
SCHEDULES

DATE  
05/18/2026

PROJECT NUMBER  
260150.00

SHEET NUMBER  
E-601