

# PROJECT MANUAL

FOR

## ECISD BARRIENTES MIDDLE SCHOOL GYM A/C IMPROVEMENTS

EDINBURG CONSOLIDATED INDEPENDENT SCHOOL  
DISTRICT

February 19, 2020

MEP Solutions Project No.: 20003



MECHANICAL, ELECTRICAL, PLUMBING ENGINEERS  
TEXAS BOARD OF PROFESSIONAL ENGINEERS REGISTRATION #F-9748

600 E. Beaumont Suite #2  
McAllen, Texas 78501  
(956) 664-2727  
Fax (956) 664-2726



EDINBURG CONSOLIDATED INDEPENDENT SCHOOL DISTRICT  
 PURCHASING DEPARTMENT  
 411 North 8<sup>th</sup>/DRAWER 990  
 EDINBURG, TEXAS 78541  
 PH: (956) 289-2311  
 FX: (956) 383-7687

## Contractor Request for COMPETITIVE SEALED PROPOSALS

NO: 20-75

TITLE: BARRIENTES MIDDLE SCHOOL  
 GYM AIR CONDITIONER  
 INSTALLATION

This Proposal includes the following forms:

- Intent to Bid
- Vendor Check List
- Instructions to Bidders
- Bid Proposal Form
- Performance Bond
- Original Bid Proposal Form
- Form A
- Standard Terms & Conditions
- Felony Conviction Notification
- Conflict of Interest Questionnaire
- Certification of Interested Parties Example
- Deviation Form
- Wage Rate
- Authorization for W-9/Direct Deposit

**CLOSING TIME/DATE:**

Closing Time: 4:00 P.M.  
 Closing Date: March 27, 2020

**BUYER:**

**Claudina Longoria, Senior Buyer**  
 Phone: 956-289-2311, Ext.2135  
 Fax: 956-383-7687  
 Email: [d.longoria@ecisd.us](mailto:d.longoria@ecisd.us)

**DELIVER BIDS TO:**

Edinburg CISD  
 Office of the Purchasing Coordinator  
 411 North 8<sup>th</sup> Ave, 2<sup>nd</sup> Floor  
 Edinburg, TX 78541

*Amaro Tijerina* 3/6/2020  
 Purchasing Coordinator Date

**DATE WEBBED: March 6, 2020**

\*Do not deliver Bids/CSPs/RFPs/RFQs to other ECISD locations. All Bids/CSPs/RFPs/RFQs must be delivered to the delivery address above on or before the Bids/CSPs/RFP/RFQs closing time/date. Purchasing will not be responsible for late submittals as per Board Policy CH (LOCAL).

## Vendor Certification

The undersigned, by his/her signature, represents the he/she is authorized to bind the bidder to fully comply with the terms and conditions on this bid, including all forms and attachments included herein, for the amount(s) shown on the accompanying bid form(s), if accepted within sixty (60) calendar days after bid opening. **Note: Bidder is strongly encouraged to read the entire Solicitation prior to submitting. Failure to provide the above information in its entirety may be grounds for disqualification of response.**

Firm Name: \_\_\_\_\_

Telephone 1-800-\_\_\_\_\_

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

Or: \_\_\_\_\_

City: \_\_\_\_\_

Fax: \_\_\_\_\_

State: \_\_\_\_\_ Zip: \_\_\_\_\_

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

Email: \_\_\_\_\_

\_\_\_\_\_  
 (Signature of Person Authorized to Sign Bid)

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

Printed Name: \_\_\_\_\_

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

(Please print or type name above)

I can deliver in \_\_\_\_\_ days. Early Payment Discount \_\_\_\_\_% if Paid in \_\_\_\_\_ Days, Net 30

## INTENT TO BID

Fax, this **page only**, if solicitation was not faxed or e-mailed directly to your company. All other solicitation documents must be enclosed in a sealed envelope and mailed to the Purchasing Department.

This page is required if solicitation was downloaded without receiving an invitation by the District. Please complete and fax to 956-383-7687 immediately in order to be added to the vendor list and receive addendums or updates regarding this solicitation. It is the intent of the Purchasing Department to ensure that all interested vendors receive addendums or updates, but it will be the vendor's responsibility to check the Purchasing site periodically. If there are addendums posted on the site and your company has not been notified by fax or e-mail, it will be the vendor's responsibility to download from Purchasing site and make sure to include with their packet.

The Edinburg CISD Purchasing solicitations and addendums are available on line at [www.ecisd.us](http://www.ecisd.us).

**NAME:** \_\_\_\_\_

**TITLE:** \_\_\_\_\_

**ORGANIZATION:** \_\_\_\_\_

**STREET ADDRESS:** \_\_\_\_\_

**STREET ADDRESS 2:** \_\_\_\_\_

**CITY:** \_\_\_\_\_

**STATE:** \_\_\_\_\_

**ZIP CODE:** \_\_\_\_\_

**WORK PHONE:** \_\_\_\_\_

**FAX:** \_\_\_\_\_

**E-MAIL:** \_\_\_\_\_

**WEB SITE:** \_\_\_\_\_

## VENDOR CHECK LIST

- |  |     |     |     |    |
|--|-----|-----|-----|----|
| 1. Original Proposal/Addendum Form                                 | ___ | Yes | ___ | No |
| 2. Performance Bond  | ___ | Yes | ___ | No |
| 3. Form A  | ___ | Yes | ___ | No |
| 4. Signed Standard Terms & Conditions                              | ___ | Yes | ___ | No |
| 5. Signed Felony Conviction Notification                           | ___ | Yes | ___ | No |
| 6. Signed Conflict of Interest Questionnaire                       | ___ | Yes | ___ | No |
| 7. Signed Deviation Form   | ___ | Yes | ___ | No |
| 8. Read and understood Special Terms & Conditions                  | ___ | Yes | ___ | No |
| 9. Filled out Bid Form   | ___ | Yes | ___ | No |
| 10. Completed & submitted W9/Authorization for Direct Deposit Form | ___ | Yes | ___ | No |
| 11. Signed Certification of Interested Parties (Form 1295)         | ___ | Yes | ___ | No |
| 12. Completed & signed Vendor Check List                           | ___ | Yes | ___ | No |

I have read all the specifications and general bid requirements and do hereby certify that all items submitted meet all specifications, conditions, and instructions of said solicitation, and will follow District policy DBD (Local). The signature below confirms that our company will enter into a binding contract with Edinburg CISD for item(s) awarded to our company.

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

\_\_\_\_\_  
Print/Type Signature Name

\_\_\_\_\_  
Authorized Signature

\_\_\_\_\_  
Date

\_\_\_\_\_  
Official Title

**INVITATION FOR COMPETITIVE SEALED PROPOSALS**

---

**GENERAL**

**1.1 PROJECT DESCRIPTION**

- A. CSP 20-75, BARRIENTES MIDDLE SCHOOL GYM AIR CONDITIONER INSTALLATION

**1.2 INSTRUCTIONS TO OFFERORS**

- A. Refer to Bid Instructions

**1.3 PRE-BID CONFERENCE**

- A. The purpose of the Pre-Bid Conference is to answer any questions that any offers may have and an on-site visit.
- B. Date and Time: **March 24, 2020 @ 2:00 P.M.**
- C. Location: Edinburg CISD – Maintenance and Facilities Conference Room  
1305 East Schunior  
Edinburg, TX 78541

**1.4 OPENING OF BIDS**

- A. Place
1. Competitive sealed proposals will be received at the office of:  
Edinburg CISD – Purchasing Department  
Attn: Amaro Tijerina, Purchasing Director  
411 North 8th Avenue  
Edinburg, Texas 78541
- B. Date: **March 27, 2020**
- C. Hour: **4:00 P.M.**

**1.5 REJECTION**

- A. The Owner reserves the right to reject any or all Bids, and to waive any irregularities or formalities.

**INSTRUCTIONS TO BIDDERS**

---

**PART 1 GENERAL**

1.1 SECURITY BOND

- A. Security bond in the amount of five (5%) of the Bid must accompany each Bid. Security bond shall be issued by an insurance company authorized to provide bonds on work in the State of Texas and shall be payable to the Owner.

1.2 DOCUMENTS

- A. Qualified offerors may obtain one (1) set(s) of Drawings and Project Manuals from: Proposal documents can be downloaded from the ECISD Purchasing website from the Vendor CSP/RFP/RFQ Calendar. Vendors will be required to submit the Intent to Bid form to the Purchasing Department once they have downloaded the proposal. Failure to submit the Intent to Bid form to the Purchasing Department will cause the vendor from receiving any further documentation regarding this proposal. Hard copies of the proposal documents, including Drawings and Project Manual, may be obtained from the following: MEP Solutions, 600 E. Beaumont Ave., STE 2, McAllen, TX, PH: 956-664-2727 for a non-refundable fee of \$100.
- B. Subcontractors may obtain one (1) set of Drawings and Project Manuals from: Proposal documents can be downloaded from the ECISD Purchasing website from the Vendor CSP/RFP/RFQ Calendar. Vendors will be required to submit the Intent to Bid form to the Purchasing Department once they have downloaded the proposal. Failure to submit the Intent to Bid form to the Purchasing Department will cause the vendor from receiving any further documentation regarding this proposal. Hard copies of the proposal documents, including Drawings and Project Manual, may be obtained from the following: MEP Solutions, 600 E. Beaumont Ave., STE 2, McAllen, TX, PH: 956-664-2727 for a non-refundable fee of \$100.
- C. A non-refundable \$100 fee will be required for a set of Drawings and Project Manuals issued. Partial sets will not be issued.
- D. Complete sets of Construction Documents shall be used in preparing bids; neither the Owner nor the Architect/Engineer assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Construction Documents.
- E. The Owner or Architect in making copies of the Construction Documents available on the above terms, does so only for the purpose of obtaining bids on the work and does not confer a license or grant for any other use.
- F. Complete sets of Drawings and Project Manuals are on file at the following locations and subcontractors may examine them there:

- ECISD Facilities and Maintenance Department, 1305 E. Schunior, Edinburg, TX

- A.G.C. PLAN ROOMS, (McAllen, Harlingen, Brownsville)

- DODGE REPORTS (Online)

**PART 2 EXAMINATION**

- A. Offerors shall carefully examine the Construction Documents and the construction site to familiarize themselves with existing local conditions under which the Work is to be performed.

**PART 3**

- B. Extra payments will not be authorized for work that could have been foreseen by careful examination of the site. Submission of a bid shall constitute acceptance, by the offeror, of existing site conditions as a part of the requirements for this work.
- C. Offerors shall carefully examine the Construction Documents to verify that they agree with the Table of Contents in the Project Manual, the Index of Drawings Sheet on the Drawings, and the Cover Page of all Addenda. Offerors shall be responsible for obtaining any pages or sheets which have been inadvertently left out during the printing process.
  - 1. All entities providing bids on any portion of the work contained in the Construction Documents shall ascertain the completeness of the set of documents
  - 2. The Construction Documents are printed by an independent vendor and, although the Architect endeavors to check the documents for completeness, the Architect has, in the past, discovered missing or misplaced sheets in the drawings and the Specifications.
  - 3. Each entity receiving a set of Construction Documents shall check the indexes against the sheets or pages contained in the sets.
  - 4. Should pages or sheets be found to be misplaced or missing, immediately notify the Architect who will give direction as to placement or provide the sheets or pages that are missing.
  - 5. Failure to notify the Architect means the offeror is providing a bid based on a complete set of Construction Documents.

**3.2 INTERPRETATION OF CONSTRUCTION DOCUMENTS**

- A. Offerors shall promptly notify the Architect/Engineer of any ambiguity, inconsistency or error which they may discover upon examination of the Construction Documents or of the site and local conditions. Do not dimension the drawings. Any dimensions, questions, should be directed to the Architect/Engineer.
- B. Submit all questions regarding clarification or interpretation of Construction Documents to the Office of the District Architect: Edinburg CISD Facilities and Construction Department, 1305 E. Schunior, Edinburg, Texas, 78541, (Attn: Carlos Lima, (956) 316-7550 (fax).
- C. Submit all questions in writing. In the interest of time, requests may be made by telephone, but they must be confirmed in writing the same day. Replies to questions will be issued to all Offerors in the form of an Addenda. General contractor and subcontractors shall submit questions in writing forty-eight (48) hours prior to opening of bids.
- D. Make requests for interpretations as early as possible so as to allow adequate time to prepare and issue Addenda.
- E. All Offerors shall check with the Architect within six (6) hours prior to Opening of bids to secure all Addenda. The Architect will not be responsible for oral clarification.

**1.05 BASIS OF BIDS**

- A. Bids shall be on a lump sum basis for each and or combined bid packages and shall include all costs for these projects as described and indicated by the Construction Documents. Basis for bids shall be on brands, materials, processes, products, persons or organizations, etc.
- B. Bids shall include all unit price costs and all Alternate costs as indicated by the Construction Documents and Bid Form.

**1.06 BIDS**

- A. Bids shall be made on unaltered Bid Forms furnished by the Architect. No oral, telephone or personal Bids will be considered. All blank spaces shall be properly filled in by typewriter or manually in ink.
- B. Where so indicated by the makeup of the Bid Form, sums shall be expressed in both words and figures, and in case of discrepancy between the two, the written amount shall govern.
- C. Any alteration or erasure to information entered in the blank spaces must be initialed by the signer of the bid.
- D. Original typed sheets shall be submitted, signed in longhand below the typed name of the person authorized to bind the offeror to a Contract.
- E. Wherever the offeror is a corporation, Bid must be signed with the legal name of the corporation followed by the name of the State of Incorporation and the legal signature of a person authorized to bind the corporation to a contract.
- F. Failure to submit a bid on the firm requested, or the inclusion of conditions, imitations or provisions, distorting the intent of the Construction Documents, will render the Bid irregular and subject to rejection.

**1.07 SUBMITTALS**

- A. Submit bid, Security Bond and other required data in an opaque, sealed envelope. Submit bid at the time and place shown in the Notice for competitive Sealed Bids.
- B. Envelopes shall be addressed to the Owner and identified with the Project Name and the name and address of the offeror.
- C. If the Bid sent by mail, the sealed envelope shall be enclosed in a separate mailing envelope with the notation "BID ENCLOSED" on the face thereof. No envelopes shall be opened until the date and time bids are to be received.

**1.08 MODIFICATION OR WITHDRAWAL OF BID**

- A. A Bid may not be withdrawn or cancelled by the offeror during the stipulated time period following the time and date designated for the receipt of Bids, unless the award of Contract has been delayed more than sixty (60) days.
- B. Prior to the time and date designated for receipt of Bids, Bids submitted early may be modified or withdrawn only by notice to the party receiving Bids at the place and prior to the time designated for receipt of Bids.
- C. Modification of Bids shall be in writing over the signature of the offeror or be by telegram; if by telegram, written confirmation over the signature of offeror must have been mailed and postmarked on or before the date and time set for receipt of Bids; it shall be so worded as not to reveal the amount of the original Bid.
- D. Withdrawn Bid may be resubmitted up to the time designated for the receipt of Bids provided that they are then fully in conformance with these Bid Instructions.
- E. Security bond shall be in an amount sufficient for the Bid as modified or resubmitted.



**1.09 CONSIDERATION OF BID**

- A. Properly identified Bids received on time will be considered.
- B. The Owner shall have the right to reject any or all Bid and in particular to reject a Bid not accompanied by any required security bond or data required by the Contract Documents or a Bid in any way incomplete or irregular.
- C. The Owner shall have the right to waive any formality or irregularity in any bid received.
- D. If the Owner accepts any Alternates, he shall have the right to accept them in any order or combination.
- E. It is the intent of the Owner to award a contract to the offeror submitting the bid providing the "best value" to the Owner provided the Bid has been submitted in accordance with the requirements of the Contract Documents, selection criteria and adopted by the Owner.

**1.10 LOCATION AND ACCESS TO PREMISES**

- A. The project site location: Refer to vicinity map on drawings.
- B. The offeror shall have free access to the premises for the purpose of acquainting himself with the conditions, delivering equipment, and performing the work necessary to fulfill the contract. Offeror shall cooperate with the other contractors who may concurrently be working on the premises, integrating his work with that of others, all to the best interest of the total work and its orderly completion.

**1.11 STATE SALES TAX**

- A. The Owner will furnish the Contractor proof or Certificate of Exemption upon award of contract.

**PROPOSAL FORM  
CSP NO. 20-75, BARRIENTES MIDDLE SCHOOL GYM AIR CONDITIONER INSTALLATION  
EDINBURG, TEXAS**

MR. AMARO TIJERINA  
DIRECTOR OF PURCHASING  
EDINBURG CISD  
411 N. 8<sup>TH</sup> AVENUE  
EDINBURG, TEXAS 78541

The undersigned, as bidder(s), declares that the only person or parties interested in this proposal as principals are those named herein, that this proposal is made without collusion with any other person, firm or corporation; that he has carefully examined the Form of Contract, Notice to Bidders, General Conditions, Special Provisions, Measurement and Basis of Payment, specifications and the plans thereon referred to, and has carefully examined the locations, and conditions and classes of materials of the proposed work; and agrees that he will provide all the necessary labor, machinery, tools, and apparatus, and other items incidental to construction, and will do all the work and furnish all the materials called for in the contract and specifications in the manner prescribed therein and according to the requirements of the Engineer/Architect as therein set forth.

It is understood that the following quantities of work to be done at unit prices are approximate only and are intended principally to serve as guide in evaluating bids.

It is further agreed that the quantities of work to be done at unit price and materials to be furnished, may be increased or diminished as may be considered necessary, in the opinion of the Engineer, to complete the work fully as planned and contemplated, and that all quantities of the work, whether increased or decreased, are to be performed at the unit prices set forth below except as provided for in the specifications.

It is further agreed that lump sum prices may be increased to cover additional work ordered by the Engineer, but not shown on the plans or required by the specifications, in accordance with the provisions of the General Conditions. Similarly, they may be decreased to cover deletion of work so ordered.

The 5% bid security accompanying this proposal shall be returned to the bidder, unless in case of the acceptance of the proposal the bidder shall fail to execute a contract and file a performance bond and payment bond within the ten (10) days after its acceptance, in which case the bid security shall become the property of the OWNER, and shall be considered as payment for damages due to delay and other inconveniences suffered by the Owner on account of such failure of the bidder, it is understood that the Owner reserves the right to reject any or all bids.

**ORIGINAL BID PROPOSAL FORM MUST BE SUBMITTED ALONG WITH THE BID AND CONTRACT DOCUMENTS BOOKLET**

BIDDERS BOND in the amount of \$ \_\_\_\_\_, (5%) of the greatest amount bid in compliance with the INSTRUCTION TO BIDDERS.

The above Cashier’s Check or Bidder’s Bond is to become the property of the OWNER, in the event the construction contract (when offered by the Owner) and bonds are not executed within the time set forth.

**IMPORTANT NOTE:**

**For information regarding the method UNIT ITEMS are to be MEASURED AND PAID, please refer to the “MEASUREMENT AND BASIS OF PAYMENT” Section attached and made part of this Proposal.**

Item No.	Estimated Quantity	Unit	Item Description	Unit Price	Total
1.	2	EACH	Demolition Cost		
2.	2	EACH	Installation of AC units (chilled water piping, electrical, plumbing, etc.)		
3.	2	EACH	Installation of Ducting		
4.	2	EACH	Structural Cost		
5.	2	EACH	Miscellaneous cost for turnkey installation		

GRANT TOTAL PROPOSAL IMPROVEMENTS: (Items 1-\_\_\_): \$ \_\_\_\_\_

The undersigned agrees, unless hereinafter stated otherwise to furnish all materials as shown and specified in the Plans and Specifications.

Bidder hereby agrees to commence work under this contract within 10 days after “NOTICE TO PROCEED” is issued, and to complete all the work in the Contract within **60 Calendar Days**.

**CSP 20-75, BARRIENTES MIDDLE SCHOOL GYM AIR CONDITIONER INSTALLATION**

The undersigned bidder acknowledges the receipt of the following addenda:

<b>ADDENDUM NO.</b>	<b>DATE</b>	<b>BY</b>
ADDENDUM NO. 1		
ADDENDUM NO. 2		
ADDENDUM NO. 3		
ADDENDUM NO. 4		

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

By: \_\_\_\_\_  
(Signature)

\_\_\_\_\_  
(Type or Print Name)

\_\_\_\_\_  
(Title)

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

\_\_\_\_\_  
(Address)

\_\_\_\_\_  
(City, State, Zip)

\_\_\_\_\_  
(Phone Number)

\_\_\_\_\_  
(Fax Number)

(Seal – if Bidder is a Corporation)

**REQUEST FOR COMPETITIVE SEALED PROPOSALS**

---

PROJECT: **CSP 20-75, Barrientes Middle School Gym Air Conditioner Installation**

OWNER: Edinburg Consolidated Independent School District  
411 North 8<sup>th</sup> Avenue  
Edinburg, TX 78541

ENGINEER: Edinburg CISD District Graduate Engineer, Carlos Lima  
1305 East Schunior  
Edinburg, Texas 78541

RFCSP DEADLINE: **March 27, 2020 @ 4:00 P.M.**

INVITATION: Your firm is invited to submit Competitive Sealed Proposals to the Owner, at the Owner's address indicated above, for the work described above, on or before the RFCSP deadline indicated above.

PRE-BID CONFERENCE: A Pre-Bid Conference will be conducted at the office of the District Architect, at 1305 East Schunior, Edinburg, Texas on **March 24, 2020 @ 2:00 P.M.** All contractors proposing to submit competitive sealed proposals on this project are strongly encouraged to attend.

INSPECTION OF SITE: The site is also accessible for inspection after the pre-bid meeting. Proposers are encouraged to visit the site and assess existing conditions.

BID DOCUMENTS: Proposal documents can be downloaded from the ECISD Purchasing website from the Vendor CSP/RFP/RFQ Calendar. Vendors will be required to submit the Intent to Bid form to the Purchasing Department once they have downloaded the proposal. Failure to submit the Intent to Bid form to the Purchasing Department will cause the vendor from receiving any further documentation regarding this proposal. Hard copies of the proposal documents, including Drawings and Project Manual, may be obtained from the following: MEP Solutions, 600 E. Beaumont Ave., STE 2, McAllen, TX, PH: 956-664-2727 for a non-refundable fee of \$100.

BID SECURITY: Proposers will be required to provide Bid Security in the form of a Bid Bond in the amount of 5 percent of the largest possible total bid, including consideration of alternates, with each bid. A Bid Bond shall be issued by a Surety acceptable to the Owner and meeting the requirements of General Conditions of the Contract for Construction. Bid Bonds shall be prepared on forms meeting all the requirements of applicable States of Texas statutes. Bid Bonds shall be issued on forms acceptable to the Owner and shall include, as a minimum standard, the information, requirements and standard illustrated by AIA Document A310, latest revised edition available. Failure to provide the Bid Bond with the bid will constitute a non-responsive bid and the bid will not be considered.

PERFORMANCE AND LABOR AND MATERIAL PAYMENT BONDS: The successful offeror will be required to provide 100% Performance and Labor and Materials Payment Bonds in strict conformance with all the requirements of the Contract Documents. Failure to do so will result in cancellation of the contract award and forfeiture of the Bid Bond security as liquidated damages.

Bid withdrawal: Bids will be required to be submitted under a condition of irrevocability for a period of 60 days after submission. No bid may be withdrawn for a period of 60 days.

OWNER'S RIGHT OF REJECTION: The owner reserves the right to accept or reject any or all offers (competitive sealed proposals).

**AGREEMENT (STIPULATED SUM)**

---

GENERAL

1.1 AGREEMENT FORM

- A. The “Standard Form of Agreement Between Owner and Contractor where the Basis of Payment is a Stipulated Sum, AIA Document A101, 2007 Electronic Format Edition, will be the form used as a Contract for this Project.
- B. General Condition AIA – A201 will be used in this project.
- C. A copy of the Standard AIA Document may be examined at the office of the Architect. Copies may be purchased from the American Institute of Architects, 1735 New York Avenue, N.W., Washington, D.C. 20006.
- D. Modification may be made to the above Agreement & General Conditions A201 form or an Owner provided agreement and general conditions may be utilized. Either of which will be provided to contractor for review upon award of project, for the final execution of the contract.

**PERFORMANCE BOND AND LABOR AND MATERIAL PAYMENT BOND**

---

GENERAL

RELATED DOCUMENTS: PERFORMANCE BOND AND LABOR AND MATERIAL PAYMENT BOND:

The Contractor shall, prior to the execution of the Contract, furnish bonds covering the faithful performance of the Contract and the payment of all obligations arising thereunder in the amount of 100% of the Contract Price covering 100% performance and 100% payment, and with such sureties secured through the contractor's usual sources as may be agreeable to the parties.

The Contractor shall deliver the required bonds to the Owner not later than the date of execution of the Contract, or if the work is commenced prior thereto in response to a letter of intent, the Contractor shall, prior to commencement of the Work, submit evidence satisfactory to the Owner that such bonds will be furnished.

The Contractor shall require the Attorney-In-Fact who executes the required bonds on behalf of the surety to affix hereto a certificate and current copy of his Power of Attorney.

Any Payment and Performance Bond furnished pursuant to the provisions of Art. 5160, Vernon's Texas Civil Statutes, connected with this project, shall be furnished by a corporate surety or corporate or corporate sureties in accordance with Article 7.19-1, Vernon's Texas Insurance Code, that has stated capital and surplus (as reported by it to the Texas Insurance Commission in its most recent report) that is in excess of ten times the stated amount of the Payment Bond or the Performance Bond. Provided however, that if any Payment Bond or any Performance Bond is in an amount in excess to ten percent (10%) of the surety company's capital and surplus (as reported to the Texas Insurance Commission in its most recent report), as a condition to accepting the bond, the Owner must receive written certification and information, satisfactory in form and substance to the Owner, that the surety company has reinsured the portion of the risk that exceeds ten percent (10%) of the surety company's capital and surplus, with one or more reinsurers who are duly authorized, accredited or trusted to do business in the State of Texas. For the purpose of this requirement, any amount reinsured by any reinsurer may not exceed ten percent (10%) of the reinsurer's capital and surplus (as reported to the Texas Insurance Commission by the reinsurer in its most recent report). In the event there is one or more reinsurer, the surety company must provide all necessary information and certification related to the current financial condition of the surety company and any and all reinsurers required by the Owner, together with copies of all reinsurance contracts with the surety company, before any such Payment Bond and Performance Bond is eligible to be considered acceptable by the Owner.

**ALL CONTRACTORS SHALL SUBMIT THE NAME, ADDRESS AND TELEPHONE NUMBER OF THE CORPORATED SURETIES PROVIDING THE PAYMENT BOND AND PERFORMANCE BOND AND THE LOCAL AGENT.**

**RANKING/SELECTION CRITERIA**

---

The selection of offeror will be based on the following: Ranking/Selection Criteria. The District retains the right to apply the selection criteria as allowed in **Educational Code 44.031 section (B)**.

**The following support information must be submitted in sealed envelope with proposal and labeled (tabs) as followed:**

1. Proposal Price: 30 Points Max
  - 1.1 Base Bid (Bid Proposal Form).
2. Qualifications/Experience: 30 Points Max
  - 2.1 Number of years in business.
  - 2.2 List at least five (5) similar projects, client and construction cost.
  - 2.3 Provide contractor's qualification statement form AIA 305.
3. Past Performance: 15 Points Max
  - 3.1 List ten (10) projects for which company have provided services in the past five years. Provide name, telephone number of contact person.
  - 3.2 Describe history of change order and proposed method for detailing cost of change orders.
  - 3.3 Were the projects completed on schedule and were warranty items completed timely.
4. Contractor Management/Personnel: 15 Points Max
  - 4.1 Provided resume of proposed project manager, project superintendent and other key personnel.
  - 4.2 Provide proposed project team structure.
  - 4.3 Requests for Proposal completeness.
5. Sub-Contractors List: 10 Points Max
  - 5.1 List proposed Subcontractors for this Project.
6. Insurance Policies
  - 6.1 Provide a copy of the following insurance policies: Professional Liability Insurance, General Liability, Workers Compensation and Automobile Insurance Policies.
7. Required Forms
  - FORM A – Fully completed and signed
  - STANDARD TERMS & CONDITIONS – Fully completed and signed
  - FELON CONVICTION FORM – Fully completed and signed
  - CONFLICT OF INTEREST QUESTIONNAIRE – Fully completed and signed
  - CERTIFICATION OF INTERESTED PARTIES (FORM 1295) – Follow instructions indicated on page 28. Form to be filled out online, printed and submitted with your proposal.
  - DEVIATION FORM – Fully completed and signed
  - WAGE RATE
  - ECISD AUTHORIZATION FOR W-9/DIRECT DEPOSIT – Fully completed and signed
  - TAX EXEMPT ORGANIZATION CERTIFICATION



# FORM A

## Edinburg Consolidated Independent School District

### 1. GENERAL INFORMATION

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

FIRM NAME: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

CITY: \_\_\_\_\_

### 2. CONTACT PERSON:

(Limited to two person per firm/application)

NAME: \_\_\_\_\_

TITLE: \_\_\_\_\_

TELEPHONE: \_\_\_\_\_

INTERNET ADDRESS: \_\_\_\_\_

NAME: \_\_\_\_\_

TITLE: \_\_\_\_\_

TELEPHONE: \_\_\_\_\_

INTERNET ADDRESS: \_\_\_\_\_

### 3. TYPE OF ORGANIZATION:

a. \_\_\_\_\_ Sole proprietorship (individual)

b. \_\_\_\_\_ Partnership

c. \_\_\_\_\_ Professional Corporation

d. \_\_\_\_\_ Corporation

e. \_\_\_\_\_ Joint venture

f. \_\_\_\_\_ Other \_\_\_\_\_

**4. FIRM BACKGROUND AND STAFF**

Year present firm established \_\_\_\_\_

Name of parent company, if any \_\_\_\_\_

Address \_\_\_\_\_

Year parent firm established \_\_\_\_\_

Former company name(s), if any, and year(s) established

Name \_\_\_\_\_ Year \_\_\_\_\_

\_\_\_\_\_ Year \_\_\_\_\_

\_\_\_\_\_ Year \_\_\_\_\_

Number of employees in firm \_\_\_\_\_

Total employees in firm (all office locations) \_\_\_\_\_

**5. EXPERIENCE PROFILE**

**PROFILE OF FIRM'S PROJECT EXPERIENCE FOR LAST FIVE YEARS**

List the total number of projects for the last five years.

	<b>Project Type</b>	<b>New Construction</b>	<b>Renovation/Addition</b>
A.	High Schools		
B.	Middle Schools		
C.	Elementary Schools		
D.	Athletic Facilities/Stadium Parking Lots		

**6. CURRENT CLIENTS AND PROJECTS**

Please list three of your current clients whose projects reflect the scope of your present workload.

A. Project \_\_\_\_\_

Client \_\_\_\_\_

Contact person/title \_\_\_\_\_

Phone number \_\_\_\_\_

Services provided \_\_\_\_\_

B. Project \_\_\_\_\_  
Client \_\_\_\_\_  
Contact person/title \_\_\_\_\_  
Phone number \_\_\_\_\_  
Services provided \_\_\_\_\_

C. Project \_\_\_\_\_  
Client \_\_\_\_\_  
Contact person/title \_\_\_\_\_  
Phone number \_\_\_\_\_  
Services provided \_\_\_\_\_

**7. APPLICATION SIGNATURE**

The information provided on this application I believe to be true and representative of the firm for which it is submitted

\_\_\_\_\_  
Signature of firm's contact person

\_\_\_\_\_  
Date

**STANDARD TERMS & CONDITIONS**

(REVISED SEPTEMBER 2018)

**PLEASE READ THE FOLLOWING CAREFULLY, AND RETURN THE SIGNATURE PAGE WITH YOUR BID OR PROPOSAL.**

The following terms and conditions are requirements that are binding upon the vendor awarded the bid and they communicate the Edinburg School District's expectations in regard to the bidder's performance in connection with the district's purchase.

1. **Seller of Package Goods:** Seller will package goods in accordance with good commercial practice. Each shipping container shall be clearly and permanently packed as follows:
  - a. Seller's name and address:
  - b. Consignee's name, address and purchase order or purchase release number and the supply agreement number if applicable;
  - c. Container number and total number of containers, e.g. box 1 of 4 boxes; and the number of the container bearing the packing slip.
  - d. Seller shall bear cost of packaging unless otherwise provided.
  - e. Goods shall be suitably packed to secure lowest transportation costs and to conform to requirements of common carriers and any applicable specifications.
  - f. Buyer's count or weight shall be final and conclusive on shipments not accompanied by packing lists.
2. **Shipment under Reservation Prohibited:** Seller is not authorized to ship the goods under reservation and no tender of a bill of lading will operate as a tender of goods.
3. **Title and Risk of Loss:** The title and risk of loss of the goods shall not pass to Buyer until Buyer actually receives and takes possession of the goods at the point or points of delivery.
4. **Delivery Terms and Transportation Charges:** F.O.B. Destination Freight Prepaid unless terms are specified otherwise in bid:
5. **No Placement of Defective Tender:** Every tender or delivery of goods must fully comply with all provisions of this contract as to time of delivery, quality and the like. If a tender is made which does not fully conform, this shall constitute a breach and Seller shall not have the right to substitute a conforming tender provided, where the time for performance has not yet expired, the Seller may reasonably notify Buyer of his intention to cure and may then make a conforming tender within the contract time but not afterward.
6. **Place of Delivery:** The place of delivery shall be that set forth on the purchase order. Any change thereto shall be effected by modification as provided for in Clause 20, "Modifications," hereof. The terms of this agreement are "no arrival, no sale."
7. **Invoices:** Seller shall submit separate invoices, in duplicate, on each purchase order after each delivery. Invoices shall indicate the purchase order number, shall be itemized and transportation charges, if any, shall be listed separately. A copy of the bill of lading, and the freight weight bill when applicable, should be attached to the invoice. Mail to:

**Edinburg Consolidated Independent School District  
Attn.: Accounts Payable Department  
Drawer 990  
Edinburg, Texas 78540-0990**
8. **Payments:** The payment shall not be due until the above instruments are submitted after delivery. Suppliers should keep the Accounts Payable Department advised of any changes in your remittance addresses.
9. **Taxes:** Do not include Federal Excise, State or City Sales Tax. School District shall furnish tax exemption certificate, if required.
10. **Gratuities:** The Buyer may, by written notice to the Seller, cancel this contract without liability to Seller if it is determined by Buyer that gratuities, in the form of entertainment, gifts, or otherwise, were offered or given by the Seller, or any agent, or representative of the Seller, to any officer or employee of the School District with a view toward securing a contract or securing favorable treatment with respect to the awarding or amending or the making or any determinations with respect to the performing of such a contract. In the event this contract is canceled by Buyer pursuant to this provision, Buyer shall be entitled, in addition to any other rights and remedies, to recover or withhold the amount of the cost incurred by Seller in providing such gratuities.
11. **Special Tools and Test Equipment:** If the price stated on the face hereof includes the cost of any special tooling or special test equipment fabricated or required by Seller for the purpose of filling this order, such special tooling equipment and any process sheets related thereto shall become the property of the Buyer and to the extent feasible shall be identified by the Seller as such.
12. **Warranty Price:** The price to be paid by the Buyer shall be that contained in Seller's bid which Seller warrants to be no higher than Seller's current prices on orders by others for products of the kind and specification covered by this agreement for similar quantities under similar or like conditions and methods of purchase. In the event Seller breaches this warranty, the prices of the items shall be reduced to the Seller's current prices on orders by others, or in the alternative, Buyer may cancel this contract without liability to Seller for breach or Seller's actual expense. The Seller warrants that no person or selling agency has been employed or retained to solicit or secure this contract upon an agreement or understanding for commission, percentage, brokerage, or contingent fee excepting bona fide employees of bona fide established commercial or selling agencies maintained by the Seller for the purpose of securing business. For breach or violation of this warranty, the Buyer shall have the right in addition to any other right or rights to cancel this contract without liability and to deduct from the contract price, or otherwise recover the full amount of such commission, percentage, brokerage or contingent fee.

13. **Warranty Products:** Seller warrants that the goods furnished will conform to the specifications, drawings and descriptions listed in the bid invitation and to the sample(s) furnished by Seller, if any. In the event of a conflict between the specifications, drawings and descriptions, the specifications shall govern. Seller shall not limit or exclude any implied warranties and any attempt to do so shall render this contract voidable at the option of the Buyer.
14. **Safety Warranty:** Seller warrants that the product sold to Buyer shall conform to the standards promulgated by the U.S. Department of Labor under the Occupational Safety and Health Act (OSHA) of 1970. In the event the product does not conform to OSHA standards, Buyer may return the product for correction or replacement at the Seller's expense. In the event Seller fails to make the appropriate correction within 15 working days, correction made by Buyer will be at Seller's expense.
15. **No Warranty by Buyer against Infringements:** As part of this contract for sale, Seller agrees to ascertain whether goods manufactured in accordance with the specifications attached to this agreement will give rise to the rightful claim of any third person by way of infringement or the like. Buyer makes no warranty that the production of goods according to the specification will not give rise to such a claim, and in no event shall Buyer be liable to Seller for indemnification in the event that Seller is sued on the grounds of infringement or the like. If Seller is of the opinion that an infringement or the like will result, the Seller will notify Buyer to this effect in writing within two weeks after the signing of this agreement. If Buyer does not receive notice and is subsequently held liable for the infringement or the like, Seller will hold Buyer harmless. If Seller in good faith ascertains that production of the goods in accordance with the specifications will result in infringement or the like, this contract shall be null and void except that Buyer will pay Seller the reasonable cost of his search as to infringements.
16. **Right of Inspection:** Buyer shall have the right to inspect the goods at delivery before accepting them.
17. **Cancellation:** Buyer shall have the right to cancel for default all or any part of the undelivered portion of this order if Seller breaches any of the terms hereof including warranties of Seller or if the Seller becomes insolvent or commits acts of bankruptcy. Such right of cancellation is in addition to and not in lieu of any other remedies, which Buyer may have in law or equity.
18. **Termination:** The performance of work under this order may be terminated in whole or in part by the Buyer in accordance with this provision. Termination of work there under shall be effected by the delivery to the Seller of a "Notice of Termination" specifying the extent to which performance of work under the order is terminated and the date upon which such termination becomes effective. Such right of termination is in addition to and not in lieu of rights of Buyer set forth in Clause 15, herein.
19. **Force Majeure:** If by reason of Force Majeure, either party hereto shall be rendered unable wholly or in part to carry out its obligations under this Agreement then such party shall give notice and full particulars of Force Majeure in writing to the other party within a reasonable time after occurrence of the event or cause relied upon, and the obligation of the party giving such notice, so far as it is affected by such Force Majeure, shall be suspended during the continuance of the inability then claimed, except as hereinafter provided, but for no longer period, and such party shall endeavor to remove or overcome such inability with all reasonable dispatch. The term Force Majeure as employed herein, shall mean acts of God, strikes, lockouts, or other industrial disturbances, act of public enemy, orders of any kind of government of the United States or the State of Texas or any civil or military authority; insurrections; riots; epidemics; landslides; land sinkage; lighting; earthquake; fires; hurricanes; storms; floods; washouts; droughts; arrests; restraint of government and people; civil disturbances; explosions, breakage or accidents to machinery, pipelines or canals, or other causes not reasonably within the control of the party claiming such inability. It is understood and agreed that the settlement of strikes and lockouts shall be entirely within the discretion of the party having the difficulty, and that the above requirement that any Force Majeure shall be remedied with all reasonable dispatch shall not require the settlement of strikes and lockouts by acceding to the demands of the opposing party or parties when such settlement is unfavorable in the judgment of the party having the difficulty.
20. **Assignment Delegation:** No right or interest in this contract shall be assigned or delegation of any obligation made by Seller without the written permission of the Buyer. Any attempted assignment or delegation by Seller shall be wholly void and totally ineffective for all purposes unless made in conformity with this paragraph.
21. **Waiver:** No claim or right arising out of a breach of this contract can be discharged in whole or in part by a waiver or renunciation of the claim or right unless the waiver or renunciation is supported by consideration and is in writing signed by the aggrieved.
22. **Modifications:** This contract can be modified or rescinded only by a writing signed by both parties to the contract or their duly authorized agents.
23. **Interpretation Parole Evidence:** This writing is intended by the parties as a final expression of their agreement and is intended also as a complete and exclusive statement of the terms of their agreement. No course of prior dealings between the parties and no usage of the trade shall be relevant to supplement or explain any term used in this agreement. Acceptance or acquiescence in a course of performance rendered under this agreement shall not be relevant to determine the meaning of this agreement even though the accepting or acquiescing party has knowledge of the performance and opportunity for objection. Whenever a term defined by the Uniform Commercial Code is used in this agreement, the definition contained in the Code is to control.
24. **Applicable Law:** This agreement shall be governed by the Uniform Commercial Code. Wherever the term "Uniform Commercial Code" is used, it shall be construed as meaning the Uniform Commercial Code as adopted in the State of Texas effective and in force on the date of this agreement.
25. **Advertising:** Seller shall not advertise or publish, without Buyer's prior consent, the fact that Buyer has entered into this contract, except to the extent necessary to comply with proper requests for information from an authorized representative of the federal, state or local government.

## CSP 20-75, BARRIENTES MIDDLE SCHOOL GYM AIR CONDITIONER INSTALLATION

26. **Right to Assurance:** Whenever one party to this contract in good faith has reason to question the other party's intent to perform, he/she may demand that the other party give written assurance of his/hers business intent to perform. In the event that a demand is made, and no assurance is given within five (5) days, the demanding party may treat this failure as an anticipatory repudiation of the contract.
27. **Venue:** Both parties agree that venue for any litigation arising from this contract shall lie in Hidalgo County, Texas.
28. **Prohibition Against Personal Interest in Contracts:** Any board member which has any substantial interest, either direct or indirect, in any business entity seeking to contract with the district, shall, before any vote or decision on any matter involving the business entity, file an affidavit stating the nature and extent of interest and shall abstain from any participation in the matter. This is not required if the vote or decision will not have any special effect on the entity other than its effect on the public. However, if a majority of the governing body are also required to file, and do file similar affidavits, then the member is not required to abstain from further participation. Vernon's Texas Codes Annotated, Local Government Code. Chapter 171.
29. **Penalties for Non-Performance:** If, at any time, the contractor fails to fulfill or abide by the terms, conditions, or specifications of the contract, the Edinburg Consolidated Independent School District reserves the right to:
- Purchase on the open market and charge the contractor the difference between contract and actual purchase price, or
  - Deduct such charges from existing invoice totals due at the time, or
  - Cancel the contract within thirty (30) days written notification of intent
30. **Right to Investigate:**
- Capacity
  - Financial Information
  - Business Records (Federally Funded Contracts)
31. **Bidder Qualification:** Bidders not on the District's bid list, may be required to prove their qualifications concerning the following criteria:
- Financial capabilities
  - Bonding status
  - Contractual history (references)
  - Ability to fulfill and abide by the terms and specifications
  - Quality and stability of product and sources
32. **District Bid Forms:** Bid proposal not submitted on District's bid forms will be rejected. Faxed or e-mail submittals will not be accepted. These forms of submittals will be destroyed or deleted, and the vendor will be notified immediately.
33. **Addendums:** It will be the Vendors responsibility to check the Purchasing website periodically for any and all addendums. It is also at the Districts discretion to fax or email addendums as deemed necessary.
34. **Delinquent School Taxes:** The Edinburg CISD shall not do business with any individual or company that is delinquent in the payment of their school taxes. In accordance with law, the District shall not enter into a contract or other transaction with a person indebted to the District, nor shall the District award a contract to or enter into a transaction with an apparent low Contractor or successful proposer indebted to the District.
- \_\_\_\_\_ I am not a delinquent taxpayer to the Edinburg CISD.
- \_\_\_\_\_ I am a delinquent taxpayer to Edinburg ISD (your bid may be disqualified if your debt is not cleared prior to award.)
35. **"OR EQUAL" Products:** Whenever an article or material is defined by describing a proprietary product or by using the name of a manufacturer, the term "or equal", if not inserted, shall be implied. The specified article or material shall be understood as indicating the type, function, minimum standard of design, efficiency, and quality desired and shall not be construed as to exclude other manufactured products of comparable quality, design and efficiency. The District reserves the right to waive any or all technicalities, and shall be the sole judge in determining equality, technicalities and formalities. Bidders offering substitute items must indicate manufacturer's name and model number.
36. **Deviation(s) –** Any deviation(s) to the specification(s) shall be listed on a separate sheet(s) of paper and attached to the bid response form identifying the section number, component(s) with deviation(s) and a clearly defined explanation for the deviation(s). It is the bidder's responsibility to submit a bid that meets all mandatory specifications stated within. Because of the variations in manufacturer's construction, the bidder must compare their product bid with the required listed minimum specifications and identify any deviations. Failure to properly identify deviations may render the bidder's proposal non-responsive and not capable of consideration for award. Bidders should note that a descriptive brochure of the model bid may not be sufficient or acceptable as proper identification of deviations from the written specifications.
37. **Right to award:** The District reserves the right to award the bid in its entirety, partially, or reject it. The District reserves the right to buy any and/or all supplies from any vendor.
38. **Right to increase or decrease quantities:** The District reserves the right to increase or decrease the number of articles called for in any item of the specifications or to eliminate items entirely. Bidder's proposal will be adjusted in accordance with the unit price quoted therein.
39. **Renewal Option for Term Contracts:** There will be a renewal option to extend this term contracts, if applicable, for an additional one (1) year period if all parties agree to the renewal in writing and all bid prices, discounts, terms and conditions remain the same. In no instance shall this extension be considered automatic.

**CSP 20-75, BARRIENTES MIDDLE SCHOOL GYM AIR CONDITIONER INSTALLATION**

- 40. **Warranty & Guarantees:** Except as otherwise specified, the bidder warrants and guarantees all work against defects in materials, equipment or workmanship for one (1) year from the date of final acceptance. Upon receipt of written notice from the District of the discovery of any defects, the bidder shall remedy the defects and replace any property damaged there from occurring within the warranty and guarantee period.
- 41. **Evaluation Factors:** The bid award shall be based on the following evaluation factors:
  - a. the purchase price;
  - b. the reputation of the vendor and of the vendor's goods or services;
  - c. the quality of the vendor's goods or services;
  - d. the extent to which the goods or services meet the district's needs;
  - e. the vendor's past relationship with the district;
  - f. the total long-term cost to the district to acquire the vendor's goods or services
- 42. **Non-Collusive Bidding Certification:** By submission of this bid or proposal, the bidder certifies that:
  - a. This bid or proposal has been independently arrived at without collusion with any other bidder or with any competitor.
  - b. This bid or proposal has not been knowingly disclosed and will not be knowingly disclosed, prior to the opening of bids, or proposals for this project, to any other bidder, competitor or potential competitor.
  - c. No attempt has been or will be made to induce any other person, partnership or corporation to submit or not to submit a bid or proposal.
  - d. The person signing this bid or proposal certifies that he has fully informed himself regarding the accuracy of the statements contained in this certification, and under the penalties being applicable to the bidder as well as to the person signing in its behalf.
- 43. **EEOC Non-Discrimination Statement:** It is the policy of Edinburg CISD not to discriminate on the basis of sex, age, handicap, religion, race, color, or national origin in its educational programs.
- 44. **Conflict of Interest Disclosure:** Pursuant to Chapter 176, Texas Local Government Code, vendors doing or seeking to do business with Edinburg CISD must submit a Conflict of Interest disclosure form if they have a business relationship as defined by Section 176.001 (1-a) with a local government entity and meet the disclosure requirements of Section 176.006(a). A person commits an offense (Class C misdemeanor) if they knowingly violate Section 176.006, Local Government Code.
- 45. **Certificate of Interested Parties:** All Bids, CSPs, RFPs, RFQs prior to award or award of Contract by the School Board will require that the Texas Ethics Commission (TEC) Form 1295 Electronic (online) Vendor filing procedure be completed by Vendor. All Vendors being recommended to the Board of Trustees for award or renewal of award on Agenda must register and obtain a TEC Certification for the specific award. This certification Form 1295 must be electronically submitted, printed and notarized. Notarized form must be submitted as a required form for this solicitation. There is no charge for this TEC online process.  
  
Texas Ethics Commission (TEC) Form 1295 must be completed (by firm – on line “New Form 1295 Certificate of Interested Parties Electronic Filing Application” site at: [https://www.ethics.state.tx.us/whatsnew/elf\\_info\\_form1295.htm](https://www.ethics.state.tx.us/whatsnew/elf_info_form1295.htm)). The TEC website includes Question/Answers and Video instructions.
- 46. **Declaration of Business Location** – Texas Education Code 44.031 (b)(8). By signing below, Contractor certified the Contractor's or the Contractor's ultimate parent company or majority owner:  
  
\_\_\_\_ A. Has its principal place of business in the State of Texas; OR \_\_\_\_ B. Employs at least 500 persons in the State of Texas  
\_\_\_\_ C. Principal Place of business is not in the State of Texas: \_\_\_\_\_ (City,State)
- 47. **Owner(s) Name of Business:** By signing below, Contractor certified the owner(s) name of the business submitting bid is/are: (Please print name(s) below. If not applicable, please indicate N/A.)  
  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- 48. **Texas Historically Underutilized Business (HUB)** - Texas Education Code 44.031(b)(6) or Small and Minority Firms, Women's Business Enterprises and Labor Surplus Area Firm: Contractor certified the Bidder's company is HUB certified with the State of Texas.  
  
\_\_\_\_ I am an Active certified HUB vendor. HUB expiration date: \_\_\_\_\_  
\_\_\_\_ Small and Minority Firms, Women's Business Enterprises and Labor Surplus Area Firms  
\_\_\_\_ I am neither.
- 49. **Criminal History Record Information Review of Certain Contract Employees:** By signing below, the Contractor agrees to comply with Section 22.0834. Criminal History Record Information Review of Certain Contract Employees, Texas Education Code if awarded a contract through this solicitation. The undersigned Contractor, if awarded a contract, shall obtain criminal history record information through the



## CSP 20-75, BARRIENTES MIDDLE SCHOOL GYM AIR CONDITIONER INSTALLATION

criminal history clearinghouse as provided by Section 411.0845, Government Code relating to an employee or applicant who has or will have continuing duties related to the contracted services; and the employee or applicant has or will have direct contact with students. The contractor agrees to certify of the receipt of criminal history record information before or immediately after employing or securing the services of the employee or applicant that has or will have continuing duties related to the contracted services if the employee or applicant has or will have direct contact with students. The Contractor further agrees that if awarded a contract, shall assume all expenses associated with the criminal background check and shall immediately remove any employee or agent who was convicted of a felony, or misdemeanor involving moral turpitude, as defined by Texas law, from District property or the location where students are present.

\_\_\_\_\_ None of my employees and any of the subcontractors has or will have continuing duties related to the contracted services; and has or will have direct contact with students. I further certify that my company has taken precautions or imposed conditions to ensure that my employees and any subcontractor will not have continuing duties related to the contracted services; and will not have direct contact with students throughout the term of the Contract.

**OR**

\_\_\_\_\_ Some or all of my employees and/or my subcontractors will have continuing duties related to the contracted services; and will have direct contact with students. I further certify that:

1. I have obtained all required criminal history record information regarding all of my employees and/or my subcontractors. None of my employees and/or my subcontractors has any conviction or other criminal history information if a the time of the offense, the victim was under 18 or enrolled in a public school: (a) a felony offense under Title 5, Texas Penal Code; (b) an offense for which a defendant is required to register as a sex offender under Chapter 62, Texas Code of Criminal Procedures; or (c) an equivalent offense under federal law or the laws of another state. IF AVAILABLE, ATTACH A COPY OF YOUR FAST PASS RECEIPT.
2. If you received information that any of my employees and/or subcontractors subsequently has a reported criminal history, I will immediately remove the covered employee from contract duties and notify the District in writing immediately.
3. I will provide the District with the names and any other requested information regarding any of my employees and/or subcontractors so the District may obtain criminal history record information if awarded a contract.
4. If the District objects to the assignment of any of my employees and/or subcontractors, I agree to discontinue using the individual to provide services to the District.

50. **Contract Provisions for contracts under Federal Awards:** By submission of this bid, Contractor agrees to comply with the following provisions.

- 50.1 Contracts for more than the simplified acquisition threshold currently set at \$150,000, which is the inflation adjusted amount determined by the Civilian Agency Acquisition Council and the Defense Acquisition Regulation Council (Councils) as authorized by 41 U.S.C.1908, must address administrative, contractual, or legal remedies in instances where contractors violate or breach contract terms, and provide for such sanctions and penalties as appropriate.
- 50.2 All contracts in excess of \$10,000 must address termination for cause and for convenience including the manner by which it will be effected and the basis for settlement.
- 50.3 Equal Employment Opportunity. Except as otherwise provided under 41 CFR Part 60, all contracts that meet the definition of "federally assisted construction contract" in 41 CFR Part 60-1.3 must include the equal opportunity clause provided under 41 CFR 60-1.4(b), in accordance with Executive Order 11246, "Equal Employment Opportunity" (30 FR 12319, 12935, 3 CFR Part, 1964-1965 Comp., p. 339), as amended by Executive Order 11375, "Amending Executive Order 11246 Relating to Equal Employment Opportunity," and implementing regulations at 41 CFR part 60, "Office of Federal Contract Compliance Programs, Equal Employment Opportunity, Department of Labor."
- 50.4 Davis-Bacon Act, as amended (40 U.S.C. 3141-3148). When required by Federal program legislation, all prime construction contracts in excess of \$12,000 must include a provision for compliance with the Davis-Bacon Act (40 U.S.C 3141-3144, and 3146-3148 as supplemented by Department of Labor regulations (29 CFR Part 5, "Labor Standards Provisions Applicable to Contracts Covering Federally Finance and Assisted Construction"). In accordance with the statute, contractors must be required to pay wages to laborers and mechanics at a rate not less than the prevailing wages specified in a wage determination made by the Secretary of Labor. In addition, contractors must be required to pay wages not less than once a week. The non-Federal entity must place a copy of the current prevailing wage determination issued by the Department of Labor in each solicitation. The decision to award a contract or subcontract must be conditioned upon the acceptance of the wage determination. The entity must report all suspected or reported violations to the Federal awarding agency. The contracts must also include a provision for compliance with the Copeland "Anti-Kickback" Act (40 U.S.C. 3145) as supplemented by Department of Labor regulations (20 CFR Part 3, "Contractors and Subcontractors on Public Building or Public Work Financed in Whole or in Part by Loans or Grants from the United States"). The Act provides that each contractor or sub-recipient must be prohibited from including, by any means, any person employed in the construction, completion, or repair of public work, to give up any part of the compensation to which he or she is otherwise entitled. The entity must repair all suspected or reported violation to the Federal awarding agency.
- 50.5 Contract Work Hours and Safety Standards Act (40 U.S.C. 3701-3708). Where applicable, all contracts awarded in excess of \$100,000 that involve the employment of mechanics or laborers must include a provision for compliance with 40 U.S.C. 3702 and 3704, as supplemented by Department of Labor regulations (29 CFR Part 5). Under 40 U.S.C. 3702 of the Act, each contractor must be required to compute the wages of every mechanic and laborer on the basis of a standard work week of 40 hours. Work in excess of the standard work week is permissible provided that the worker is compensated at a rate of not less than one and a half times the basic rate of pay for all hours worked in excess of 40 hours in the work week. The requirements of 40 U.S.C. 3704 are applicable to construction work and provide that no



## CSP 20-75, BARRIENTES MIDDLE SCHOOL GYM AIR CONDITIONER INSTALLATION

laborer or mechanic must be required to work in surroundings or under working conditions which are unsanitary, hazardous or dangerous. These requirements do not apply to the purchases of supplies or materials or articles ordinarily available on the open market, or contracts for transportation or transmission of intelligence.

- 50.6 Rights to Inventions Made Under a Contract or Agreement. If the Federal award meets the definition of “funding agreement” under 37 CFR §401.2 (a) and the recipient or sub recipient wishes to enter into a contract with a small business firm or nonprofit organization regarding the substitution of parties, assignment or performance of experimental, developmental, or research work under that “funding agreement,” the recipient or sub recipient must comply with the requirements of 37 CFR Part 401, “Rights to Inventions Made by Nonprofit Organizations and Small Business Firms Under Government Grants, Contracts and Cooperative Agreements,” and any implementing regulations issued by the awarding agency.
- 50.7 Clean Air Act (42 U.S.C. 7401-7671q.) and the Federal Water Pollution Control Act (33 U.S.C. 1251-1387), as amended—Contracts and sub grants of amounts in excess of \$150,000 must contain a provision that requires the award to agree to comply with all applicable standards, orders or regulations issued pursuant to the Clean Air Act (42 U.S.C. 7401-7671q) and the Federal Water Pollution Control Act as amended (33 U.S.C. 1251-1387). Violations must be reported to the Federal awarding agency and the Regional Office of the Environmental Protection Agency (EPA).
- 50.8 Debarment and Suspension (Executive Orders 12549 and 12689)—A contract award (see 2 CFR 180.220) must not be made to parties listed on the government wide exclusions in the System for Award Management (SAM), in accordance with the OMB guidelines at 2 CFR 180 that implement Executive Orders 12549 (3 CFR part 1986 Comp., p. 189) and 12689 (3 CFR part 1989 Comp., p. 235), “Debarment and Suspension.” SAM Exclusions contains the names of parties debarred, suspended, or otherwise excluded by agencies, as well as parties declared ineligible under statutory or regulatory authority other than Executive Order 12549.
- 50.9 Byrd Anti-Lobbying Amendment (31 U.S.C. 1352)—Contractors that apply or bid for an award exceeding \$100,000 must file the required certification. Each tier certifies to the tier above that it will not and has not used Federal appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a member of Congress, officer or employee of Congress, or an employee of a member of Congress in connection with obtaining any Federal contract, grant or any other award covered by 31 U.S.C. 1352. Each tier must also disclose any lobbying with non-Federal funds that takes place in connection with obtaining any Federal award. Such disclosures are forwarded from tier to tier up to the award.
- 50.10 A an entity that is a state agency or agency of a political subdivision of a state and its contractors must comply with section 6002 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act. The requirements of Section 6002 include procuring only items designated in guidelines of the Environmental Protection Agency (EPA) at 40 CFR part 247 that contain the highest percentage of recovered materials practicable, consistent with maintaining a satisfactory level of competition, where the purchase price of the item exceeds \$10,000 or the value of the quantity acquired during the preceding fiscal year exceeded \$10,000; procuring solid waste management services in a manner that maximizes energy and resource recovery; and establishing an affirmative procurement program for procurement of recovered materials identified in the EPA guidelines.
51. Debarment and Suspension (Executive Orders 12549 and 12689): By signing below Contractor certified that neither it nor its principals are currently listed on the government-wide exclusions in SAM as debarred, suspended, or otherwise excluded by agencies or declared ineligible under statutory or regulatory authority other than Executive Order 12549. Contractor further agrees to immediately notify the District if he/she is later listed on the government-wide exclusions in SAM, or is debarred, suspended, or otherwise excluded by agencies or declared ineligible under statutory or regulatory authority other than Executive Order 12549.
52. Vendor must comply with H.B. No. 89 Chapter 2270. Prohibition on Contracts with Companies Boycotting Israel.

**I, the undersigned authorize agent for the company named below, certify that the information concerning Section 1-52 listed above has been reviewed by me and the information furnished is true to the best of my knowledge. I further certify that I agree to comply with Sections 1-52 listed above.**

\_\_\_\_\_  
Print/Type Signature Name

\_\_\_\_\_  
Official Title

\_\_\_\_\_  
Authorized Signature

\_\_\_\_\_  
Date

**FELONY CONVICTION NOTIFICATION**

State of Texas Legislative Senate Bill No. 1, Section 44.034, Notification of Criminal History, Subsection (a), states "a person or business entity that enters into a contract with a school district must give advance notice to the district if the person or an owner or operator of the business entity has been convicted of a felony. The notice must include a general description of the conduct resulting in the conviction of a felony."

Subsection (b) states "a school district may terminate a contract with a person or business entity if the district determines that the person or the person or business entity failed to give notice as required by Subsection (a) or misrepresented the conduct resulting in the conviction. The district must compensate the person or business entity for services performed before the termination of the contract."

This Notice Is Not Required of a Publicly-Held Corporation

I, the undersigned agent for the firm named below, certify that the information concerning notification of felony convictions has been reviewed by me and the following information furnished is true to the best of my knowledge.

\_\_\_\_\_  
Vendor's Name

\_\_\_\_\_  
Authorized Company Official's Name (Printed)

A. My firm is a publicly-held corporation; therefore, this reporting requirement is not applicable.

\_\_\_\_\_  
Signature of Company Official

B. My firm is not owned nor operated by anyone who has been convicted of a felony:

\_\_\_\_\_  
Signature of Company Official

C. My firm is owned or operated by the following individual(s) who has/have been convicted of a felony:

\_\_\_\_\_  
Names of Felon(s)

\_\_\_\_\_  
Details of Conviction(s)

\_\_\_\_\_  
Signature of Company Official

# CONFLICT OF INTEREST QUESTIONNAIRE

FORM CIQ

For vendor or other person doing business with local governmental entity

This questionnaire reflects changes made to the law by the H.B. 1491 80<sup>th</sup> Leg., Regular Session.

This questionnaire is being filed in accordance with Chapter 176, Local Government Code by a person who has a business relationship as defined by Section 176.001(1-a) with a local governmental entity and the person meets requirements under Section 176.006(a).

By law this questionnaire must be filed with the records administrator of the local governmental entity not later than the 7<sup>th</sup> business day after the date the person becomes aware of facts that require the statement to be filed. See Section 176.006, Local Government Code.

A person commits an offense if the person knowingly violates Section 176.006, Local Government Code. An offense under this section is a Class C misdemeanor.

**OFFICE USE ONLY**

Date Received

1 Name of person doing business with local governmental entity.

2

Check this box if you are filing an update to a previously filed questionnaire.

(The law requires that you file an updated completed questionnaire with the appropriate filing authority not later than September 1 of the year for which an activity described in Section 176.006 (a), Local Government Code, is pending and not later than the 7<sup>th</sup> business day after the date the originally filed questionnaire becomes incomplete or inaccurate.)

3

Name of local government officer with whom filer has employment or business relationship.

\_\_\_\_\_ Name of Officer

This section (item 3 including subparts A, B, C & D) must be completed for each officer with whom the filer has an employment or other business relationship as defined by Section 176.001(1-a), Local Government Code. Attached additional pages to this form CIQ as necessary.

- A. Is the local government officer named in this section receiving or likely to receive taxable income, other than investment income, from the filer of the questionnaire?  
 Yes     No
- B. Is the filer of the questionnaire receiving or likely to receive taxable income, other than investment income,  
 Yes     No
- C. Is the filer of this questionnaire employed by a corporation or other business entity with respect to which the local government officer serves as an officer or director, or holds an ownership of 10 percent or more?  
 Yes     No
- D. Describe each employment or business relationship with the local government officer named in this section

4

\_\_\_\_\_ Signature of person doing business with the governmental entity

\_\_\_\_\_ Date

## CERTIFICATION OF INTERESTED PARTIES – FORM 1295

### Definitions and Instructions for Completing Form 1295

Edinburg Consolidated Independent School District is required to comply with House Bill 1295, which amended the Texas Government Code by adding Section 2252.908, Disclosure of Interested Parties. Section 2252.908 prohibits Edinburg CISD from entering into a contract resulting from a Bid, CSP, RFP, RFQ, Inter-local Cooperative Quote with a business entity unless the business entity submits a Disclosure of Interested Parties – Form 1295 to Edinburg CISD at the time the business entity submits the signed contract. The Texas Ethics Commission has adopted rules requiring the business entity to file Form 1295 electronically with the Texas Ethics Commission.

**As a “business entity,” vendors must electronically complete, print, manually fill out Unsworn Declaration portion and sign. Once form is completed, submit with your proposals or contracts even if no interested parties exist.**

Proposers must file Certificate of Interested Parties – Form 1295 with the Texas Ethics Commission using the following online application: [https://www.ethics.state.tx.us/whatsnew/elf\\_info\\_form1295.htm](https://www.ethics.state.tx.us/whatsnew/elf_info_form1295.htm)

- Proposers must use the filing application on the Texas Ethics Commission’s website (see link above) to enter the required information on Form 1295.
- Proposers must print a copy of the completed form, which will include a certification of filing containing a unique certification number.
- The Form 1295 must be printed and then signed by an authorized agent of the business entity.
- The completed Form 1295 with the certification of filing must be filed with Edinburg Consolidated Independent School District by including a copy of the completed form with the proposal response.
- Edinburg CISD must acknowledge the receipt of the filed Form 1295 by notifying the Texas Ethics Commission of the receipt of the filed Form 1295 no later than the 30<sup>th</sup> day after the date the contract binds all parties to the contract.
- After Edinburg CISD acknowledges the Form 1295, the Texas Ethics Commission will post the completed Form 1295 to its website within seven (7) business days after receiving notice from Edinburg CISD.

### Instructions to Vendors:

1. Read these instructions,
2. Go to the Ethics Commission Website [https://www.ethics.state.tx.us/whatsnew/elf\\_info\\_form1295.htm](https://www.ethics.state.tx.us/whatsnew/elf_info_form1295.htm),
3. Register and complete Form 1295 online - include the bid/proposal # and the contract/(Bid,CSP,RFQ,RFP name),
4. Print a copy of the submitted Form 1295 and sign - it will have a certification # in the top right corner,
5. Include a copy of the completed, signed Form 1295 with the proposal response.

### Definitions:

- **Interested Party:** a person who:
  - 1) has controlling interest in a business entity with whom Edinburg CISD contracts; or
  - 2) actively participates in facilitating a contract or negotiating the terms of a contract, including a broker, intermediary, adviser, or attorney for the business entity.
- **Controlling Interest** means:
  - 1) an ownership interest or participating interest in a business entity by virtue of units, percentage, shares, stock, or otherwise that exceeds 10 percent;
  - 2) membership on the board of directors or other governing body of a business entity of which the board or other governing body is composed of not more than 10 members; or
  - 3) service as an officer of a business entity that has four or fewer officers, or service as one of the four officers most highly compensated by a business entity that has more than four officers.
- **Intermediary:** a person who actively participates in the facilitation of the contract or negotiating the contract, including a broker, advisor, attorney, or representative of or agent for the business entity who:
  - 1) receives compensation from the business entity for the person’s participation;
  - 2) communicates directly with the governmental entity or state agency on behalf of the business entity regarding the contract; and
  - 3) is not an employee of the business entity.
- **Business Entity:** includes an entity through which business is conducted with a governmental entity or state agency, regardless of whether the entity is a for-profit or nonprofit entity.

### Resources:

#### Form 1295 Frequently Asked Questions:

- [https://www.ethics.state.tx.us/whatsnew/FAQ\\_Form1295.html](https://www.ethics.state.tx.us/whatsnew/FAQ_Form1295.html)

#### Instructional Video – First Time Business User:

- <https://www.ethics.state.tx.us/filinginfo/videos/Form1295/FirstLogin-Business/Form1295Login-Business.html>

#### Instructional Video – How to Create a Certificate:

- <https://www.ethics.state.tx.us/filinginfo/videos/Form1295/CreateCertificate/CreateCertificate.html>

**CSP 20-75, BARRIENTES MIDDLE SCHOOL GYM AIR CONDITIONER INSTALLATION**

A person or business entity entering into a contract and/or agreement with ECISD is required by the new Government Code Statute 2252.908, to complete Form 1295 "Certificate of Interested Parties". This form must be submitted online at [http://www.ethics.state.tx.us/whatsnew/elf\\_info\\_form1295.htm](http://www.ethics.state.tx.us/whatsnew/elf_info_form1295.htm). Once the online submission has been processed and a claim number has been issued, the form must be printed with the claim number, Unsworn Declaration must be manually filled out and signed. Submit form along with this solicitation documents. IF Form 1295 is not submitted along with this solicitation documents, your response may be considered "non-responsive" and may be disqualified.

<b>CERTIFICATE OF INTERESTED PARTIES</b>		<b>FORM 1295</b>		
		1 of 1		
Complete Nos. 1 - 4 and 6 if there are interested parties. Complete Nos. 1, 2, 3, 5, and 6 if there are no interested parties.		<b>OFFICE USE ONLY</b>		
<b>1</b> Name of business entity filing form, and the city, state and country of the business entity's place of business.		<b>CERTIFICATION OF FILING</b>		
<b>Vendor Name</b>		Certificate Number:		
<b>2</b> Name of governmental entity or state agency that is a party to the contract for which the form is being filed.		Date Filed:		
<b>Edinburg CISD</b>		Date Acknowledged:		
<b>3</b> Provide the identification number used by the governmental entity or state agency to track or identify the contract, and provide a description of the services, goods, or other property to be provided under the contract.				
<b>Use District's Proposal # &amp; Proposal Title located on cover page of solicitation</b>				
4	Name of Interested Party	City, State, Country (place of business)		Nature of interest (check applicable)
		Controlling	Intermediary	
Example				
<b>5</b> Check only if there is NO Interested Party. <input type="checkbox"/>				
<b>6 UNSWORN DECLARATION</b>				
My name is _____, and my date of birth is _____.				
My address is _____, _____, _____, _____, _____. <small>(street) (city) (state) (zip code) (country)</small>				
I declare under penalty of perjury that the foregoing is true and correct.				
Executed in _____ County, State of _____, on the _____ day of _____, 20____. <small>(month) (year)</small>				
_____ Signature of authorized agent of contracting business entity (Declarant)				

**DEVIATION FORM**

**(This form must be signed)**

1. DEVIATION(S) – Any deviations to the attached specifications shall be listed below, or on a separate sheet of paper, and attached to the bid response form identifying the section number, item number and a clearly defined explanation for the deviations.
2. It is the bidder’s responsibility to submit a bid that meets all mandatory specifications stated within. Because of the variations in manufacturer’s construction, the bidder must compare their product bid with the required listed minimum specifications and identify any deviations.
3. Failure to properly identify deviations may render the bidder’s proposal non-responsive and not capable of consideration for award.
4. Bidders should note that a descriptive brochure of the model bid may not be sufficient or acceptable as proper identification of deviations from the written specifications.

NO - Deviations: \_\_\_\_\_ YES - Deviations: \_\_\_\_\_

**List any deviations your company is submitting below: (List on separate page, if necessary)**

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

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

\_\_\_\_\_  
Print Name of Authorized Company Official

\_\_\_\_\_  
Signature of Authorized Company Official

**WAGE RATE**

---

**GENERAL**

**1.1 PREVAILING WAGE RATE DETERMINATION INFORMATION**

- A. The following information is from Chapter 2258 Texas Government Code:
  - 1. 2258.021 Right to be Paid Prevailing Wage Rates
    - a. A worker employed on a public work by or on behalf of the state or a political subdivision of the state shall be paid:
      - 1). Not less than the general prevailing rate of per diem wages for work of a similar character in the locality in which the work is performed; and
      - 2). Not less than the general prevailing rate of per diem wages for legal holiday and overtime work.
    - b. Subsection (a) does not apply to maintenance work.
    - c. A worker is employed on a public work for the purposes of this section if the worker is employed by a subdivision of the state.
  - 2. 2.2258.023 Prevailing Wage Rates to be paid by Contractor and Subcontractor; penalty
    - a. The Contractor who is awarded a contract by a public body or a subcontractor of the contractor shall pay not less than the rates determined under Section 2258.022 to a worker employed by it in the execution of the contract.
    - b. A contractor or subcontractor who violates this section shall pay to the state or a political subdivision of the state on whose behalf the contract is made, \$60 for each worker employed for each calendar day or part of the day that the worker is paid less than the wage rates stipulated in the contract. A public body awarding a contract shall specify this penalty in the contract.
    - c. A contractor or subcontractor does not violate this section if a public body awarding a contract does not determine the prevailing wage rates and specify the rates in the contract as provided by Section 2258.022.
    - d. The public body shall use any money collected under this section to offset the costs incurred in the administration of this chapter.
    - e. A municipality is entitled to collect a penalty under this section only if the municipality has a population of more than 10,000.
  - 3. 2258.051 Duty of Public Body to Hear Complaints and Withhold Payment
    - a. A public body awarding a contract, and an agent or officer of the public body, shall:
      - 1). Take organization to complaints of all violations of this chapter committed in the execution of the contract of the contract; and
      - 2). Withhold money forfeited or the contact to be withheld under this Chapter from the payments to the contractor under the contract; except that the public body may not withhold money from other than the final payment without determination by the public body that there is good cause to believe that the contractor has violated this chapter.

**1.2 PREVAILING WAGE RATES**

- A. Comply with the requirements of the Vernon's civil statues of the State of Texas, Annotated, revised 1995, Article 5159.
- B. In no case shall any laborer, workman or mechanic employed by the General Contractor or any Subcontractor, for the execution of the project, be paid less than the current federal minimum wage.
- C. Work Classification Definition: See Texas Government Code

## Edinburg Consolidated Independent School District

Texas Building Construction Trades  
Prevailing Wage Rates Determination  
4/26/2016

<b>Code</b>	<b>Worker Classification</b>	<b>Prevailing Wage Rate</b>
A-001	Carpenter	12.71
A-002	Floor Installer	12.63
A-003	Concrete Finisher	11.10
A-004	Datacom/Telecom	13.17
A-005	Drywall/Ceiling Installer/Insulator	10.45
A-006	Electrician (Journeyman)	15.67
A-007	Electrician (Apprentice)	10.65
A-008	HVAC Mechanic	16.42
A-009	HVAC Mechanic (Helper)	11.80
A-010	Glazier	10.60
A-011	Heavy Equipment Operator	12.75
A-012	Piping/Ductwork Insulator	11.61
A-013	Iron Worker	10.63
A-014	Laborer	8.98
A-015	Lather/Plasterer	11.00
A-016	Light Equipment Operator	10.95
A-017	Mason/Bricklayer	12.25
A-018	Pipefitter (Inc. Fire Protection)	15.21
A-019	Plumber (Journeyman/Master)	15.61
A-020	Plumber (Apprentice/Helper)	11.86
A-021	Roofer	10.25
A-022	Sheetmetal Worker	11.77
A-023	Tile Setter	15.38
A-024	Waterproof	10.38
A-025	Painter (Brush, Roller, and Sprayer)	13.17
A-026	Mill Work	10.50



**Edinburg Consolidated Independent School District Substitute W-9  
& Direct Deposit Authorization Form**

Complete form if: 1. You are a U.S. entity (including a resident alien) 2. You are a vendor that provides goods or services to ECISD; AND 3. You will receive payment from the Edinburg Consolidated ISD	New Request <input type="checkbox"/>	Update – Select from the following: Tax ID <input type="checkbox"/> Legal Name <input type="checkbox"/> Vendor Order Address <input type="checkbox"/> Direct Deposit <input type="checkbox"/> Contact Information <input type="checkbox"/> Vendor Payment Address <input type="checkbox"/>
Individual/Company/Entity Legal Name (Must match TIN below): _____ Taxpayer Identification Number (TIN) _____ - _____ Federal Tax ID Number (FID) _____ - _____		DBA Name (IF Applicable): _____ OR SSN – Individual/Sole Proprietor _____ - _____
<b>Vendor Contact Information:</b>		
Name: _____	Title: _____	Phone: _____ Fax: _____
<b>Vendor Type – Select 5 only one of the following boxes:</b>		
<input type="checkbox"/> Individual/Sole Proprietorship <input type="checkbox"/> C-Corporation <input type="checkbox"/> S-Corporation <input type="checkbox"/> Partnership <input type="checkbox"/> Trust/Estate <input type="checkbox"/> Other: Explain _____ <input type="checkbox"/> Limited Liability Company (LLC). Enter the tax classification (C=C corporation, S=S corporation, P=Partnership) _____ <input type="checkbox"/> Exempt payee code (if any) _____ <input type="checkbox"/> Exemption from FATCA reporting code (if any) _____		
<b>Order Address:</b>  Street/PO Box: _____ Second Line: _____ City: _____ State: _____ Zip Code: _____	<b>Payment Remittance Address:</b> <input type="checkbox"/> Check if Order Address is same as Payment Address Street/PO Box: _____ Second Line: _____ City: _____ State: _____ Zip Code: _____	
<b>Banking Information:</b>		
In an effort to process your payment faster, we request that you complete the ACH enrollment section below. All fields must be completed for direct deposit setup. Attach a voided check or letter from your financial institution.		
Account Type:      Checking <input type="checkbox"/> Savings <input type="checkbox"/>  Bank Name: _____ Bank Address: _____ City: _____ State: _____ Zip Code: _____	Email for Direct Deposit Notification: _____  ABA Routing Number: _____ Account Number: _____ Phone: _____ Fax: _____	
<b>W-9 Certification</b> 1. The number shown on this form is my correct taxpayer identification number (or I am waiting for a number to be issued to me), AND 2. I am not subject to backup withholding because: (a) I am exempt from backup withholding, or (b) I have not been notified by the Internal Revenue Services (IRS) that I am subject to backup withholding as a result of a failure to report all interest or dividends, or (c) the IRS has notified me that I am no longer subject to backup withholding, AND 3. I am a U.S. citizen or other U.S. person. <b>Certification Instructions:</b> You must cross out item 2 above if you have been notified by the IRS that you are currently subject to backup withholding because you have failed to report all interest and dividends on your tax return. For real estate transactions, item 2 does not apply. For mortgage interest paid, acquisition or abandonment of secured property, cancellation of debt, contributions, to an individual retirement arrangement (IRA), and generally, payments other than interest and dividends, you are not required to sign the Certification, but you must provide your correct TIN.  Signature: _____ Date: _____ Print Name/Title: _____	<b>Direct Deposit Authorization and Agreement</b> I authorize Edinburg Consolidated Independent School District (ECISD) to initiate direct deposit of funds to the account and financial institution indicated above, and to recover funds deposited in error in necessary, in compliance with Texas and U.S. Law, and the Automatic Clearing House (ACH) rules. I understand that:  1. It is my responsibility to provide accurate and current banking information. Notification of direct deposits will be by e-mail; and it is my responsibility to provide a valid e-mail address. 2. It is my responsibility to verify payment has been credited to my account, and that ECISD assumes no liability for overdrafts for any reasons. 3. This authorization will remain in effect until; (a) a written request is received from a vendor officer to change or terminate direct deposit agreement; (b) notification is sent by my bank that the account is no longer valid.  Signature: _____ Date: _____ Print Name/Title: _____	
Send completed form to: ECISD requestor or: Mail to: Edinburg Consolidated Independent School District, ATTN: Accounts Payable, PO Box 990, Edinburg, TX 78540 OR; E-mail: <a href="mailto:ECISDInvoice@ecisd.us">ECISDInvoice@ecisd.us</a> , OR; Fax: 956-383-4354. Any Questions on this form, call 956-289-2300 ext. 2074		
<b>Finance Office Use Only: Updated Record on:</b>	<b>Updated by:</b>	<b>Bank Code:      Vendor #:</b>

**TAX EXEMPT ORGANIZATION**

---

**CERTIFICATE PART 1 – GENERAL**

**1.1 DEFINITION**

- A. This Contract is to be performed for an exempt organization as defined by Title 2; Subtitle E; Chapter 150 of the Texas Limited Sales, Excise and Use Tax Act and Section 151.311 of the State Statutes. The Owner will furnish the Contractor proof or Certificate of Exemption upon award of contract.
  
- B. Proposer shall not include sales tax in their Proposal.

**ECISD BARRIENTES MIDDLE SCHOOL GYM A/C IMPROVEMENTS**  
**Edinburg, TX**  
**Table of Contents**

Division	Section Title
----------	---------------

DIVISION 1 – GENERAL REQUIREMENTS

011000	SUMMARY
012100	ALLOWANCES
012600	CONTRACT MODIFICATION PROCEDURES
012900	PAYMENT PROCEDURES
013100	PROJECT MANAGEMENT AND COORDINATION
013300	SUBMITTAL PROCEDURES
014000	QUALITY REQUIREMENTS
015000	TEMPROARY FACILITIES AND CONTROLS
016000	PRODUCT REQUIREMENTS
017300	EXECUTION
017320	SELECTIVE DEMOLITION
017329	CUTTING AND PATCHING
017700	CLOSEOUT PROCEDURES
017823	OPERATION AND MAINTENANCE DATA
017839	PROJECT RECORD DOCUMENTS
017900	DEMONSTRATION AND TRAINING

Division	Section Title
----------	---------------

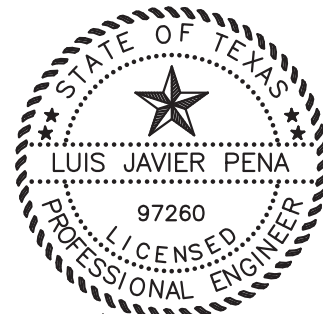
DIVISION 9 – FINISHES

09911	EXTERIOR PAINTING
09912	INTERIOR PAINTING

Division	Section Title
----------	---------------

DIVISION 15 – MECHANICAL

15010	MECHANICAL GENERAL REQUIREMENTS
15050	MECHANICAL MATERIALS AND METHODS
15067	HANGERS AND SUPPORTS
15077	MECHANICAL IDENTIFICATION
15080	MECHANICAL INSULATION
15110	VALVES
15181	HYDRONIC PIPING
15189	HVAC WATER TREATMENT
15269	VARIABLE FREQUENCY CONTROLS
15725	MODULAR AIR HANDLING UNITS
15815	METAL DUCTS
15820	DUCT ACCESSORIES
15950	TESTING ADJUSTING AND BALANCING
15990	FACILITY MANAGEMENT SYSTEM



*Luis Javier Pena*

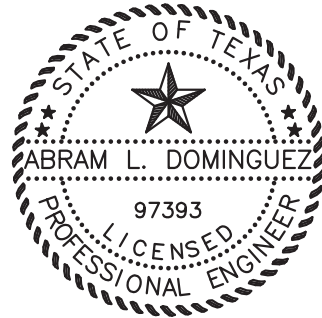
02/19/2020



MECHANICAL, ELECTRICAL, PLUMBING ENGINEERS  
 600 E. BEAUMONT AVE. SUITE 2 McALLEN, TX 78501 (956) 664-2727  
 TEXAS BOARD OF PROFESSIONAL ENGINEERS REGISTRATION # F-9748

Division	Section Title
----------	---------------

DIVISION 16 – ELECTRICAL  
 16051 COMMON WORK RESULTS FOR ELECTRICAL  
 16060 GROUNDING AND BONDING  
 16075 ELECTRICAL IDENTIFICATION  
 16120 CONDUCTORS AND CABLES  
 16130 RACEWAYS AND BOXES



*Abram L. Dominguez*

02/19/2020



MECHANICAL, ELECTRICAL, PLUMBING ENGINEERS  
 600 E. BEAUMONT AVE. SUITE 2 McALLEN, TX 78501 (956) 664-2727  
 TEXAS BOARD OF PROFESSIONAL ENGINEERS REGISTRATION # F-9748

## **SECTION 011000 - SUMMARY**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Work covered by the Contract Documents.
  - 2. Use of premises.
  - 3. Owner's occupancy requirements.
  - 4. Specification formats and conventions.

#### **1.2 WORK COVERED BY CONTRACT DOCUMENTS**

- A. Project Identification: Edinburg C.I.S.D. – Barrientes MS Gym AC Improvements.
  - 1. Project Location: 1100 E Ebony Ln, Edinburg, Tx. 78539.
- B. Owner: Edinburg C.I.S.D.
  - 1. Owner's Representative: Carlos Lima, Construction Project Director.
- C. Engineer: MEP Solutions Engineering. 600 E. Beaumont Ave. Suite 2 McAllen Tx. 78501
- D. The Work consists of the following:
  - 1. The Work includes the substantial upgrade of the existing AC system.
- E. Project will be constructed under a single prime contract.

#### **1.3 WORK PHASES**

- A. The Work shall be conducted in a single phases in the following order.

#### **1.4 WORK UNDER OTHER CONTRACTS**

- A. None.

#### **1.5 USE OF PREMISES**

- A. General: Contractor shall have full use of premises for construction operations, including use of Project site, during construction period. Contractor's use of premises is limited only by Owner's right to perform work or to retain other contractors on portions of Project.
- B. Use of Existing Building: Maintain existing building in a weathertight condition throughout construction period. Repair damage caused by construction operations. Protect building and its occupants during construction period.

## 1.6 OWNER'S OCCUPANCY REQUIREMENTS

- A. Owner Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed areas of building, before Substantial Completion, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and partial occupancy shall not constitute acceptance of the total Work. Subparagraphs below describe procedures and requirements necessary before partial occupancy of portions of Project.

## 1.7 SPECIFICATION FORMATS AND CONVENTIONS

- A. Specification Format: The Specifications are organized into Divisions and Sections using the 16-division format and CSI/CSC's "MasterFormat" numbering system.
  - 1. Division 01: Sections in Division 01 govern the execution of the Work of all Sections in the Specifications.
- B. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
  - 1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.
  - 2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.
    - a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

## SECTION 012100 - ALLOWANCES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes administrative and procedural requirements governing the following:
  - 1. Contingency allowances.
- B. See Division 01 Section "Quality Requirements" for procedures governing the use of allowances for testing and inspecting.

#### 1.2 SELECTION AND PURCHASE

- A. At the earliest practical date after award of the Contract, advise Architect of the date when final selection and purchase of each product or system described by an allowance must be completed 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.

#### 1.3 SUBMITTALS

- A. Submit proposals for purchase of products or systems included in allowances, in the form specified for Change Orders.
- B. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.
- C. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

#### 1.4 COORDINATION

- A. Coordinate allowance items with other portions of the Work. Furnish templates as required to coordinate installation.

#### 1.5 CONTINGENCY ALLOWANCES

- A. Use the contingency 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 contingency 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 contingency allowance will include Contractor's related costs and reasonable overhead and profit margins.
- D. At Project closeout, credit unused amounts remaining in the contingency allowance to Owner by Change Order.

#### 1.6 UNUSED MATERIALS

- A. Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.
  - 1. If requested by Architect, prepare unused material for storage by Owner when it is not economically practical to return the material for credit. If directed by Architect, deliver unused material to Owner's storage space. Otherwise, disposal of unused material is Contractor's responsibility.

#### 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. One: Include contingency allowance of \$3,000.00.
- B. Allowance No. Two: Include Test and Balance allowance of \$2,000.00.

END OF SECTION 012100



## **SECTION 012600 - CONTRACT MODIFICATION PROCEDURES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section specifies administrative and procedural requirements for handling and processing Contract modifications.
- B. See Division 01 Section "Allowances" for procedural requirements for handling and processing allowances.

#### **1.2 MINOR CHANGES IN THE WORK**

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

#### **1.3 PROPOSAL REQUESTS**

- A. Owner-Initiated Proposal Requests: Engineer will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
  - 1. Proposal Requests issued by Engineer are for information only. Do not consider them instructions either to stop work in progress or to execute the proposed change.
  - 2. Within time specified in Proposal Request after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
    - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
    - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
    - c. Include costs of labor and supervision directly attributable to the change.
    - d. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
- B. Contractor-Initiated Proposals: If latent or unforeseen conditions require modifications to the Contract, Contractor may propose changes by submitting a request for a change to Engineer.
  - 1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.

2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Include costs of labor and supervision directly attributable to the change.
5. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Division 01 Section "Product Requirements" if the proposed change requires substitution of one product or system for product or system specified.

#### 1.4 ALLOWANCES

- A. Allowance Adjustment: To adjust allowance amounts, base each Change Order proposal on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.
  1. Include installation costs in purchase amount only where indicated as part of the allowance.
  2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other margins claimed.
  3. Submit substantiation of a change in scope of work, if any, claimed in Change Orders related to unit-cost allowances.
  4. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.
- B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the Purchase Order amount or Contractor's handling, labor, installation, overhead, and profit. Submit claims within 21 days of receipt of the Change Order or Construction Change Directive authorizing work to proceed. Owner will reject claims submitted later than 21 days after such authorization.
  1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of work has changed from what could have been foreseen from information in the Contract Documents.
  2. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

#### 1.5 CHANGE ORDER PROCEDURES

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

## 1.6 CONSTRUCTION CHANGE DIRECTIVE

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012600

## **SECTION 012900 - PAYMENT PROCEDURES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

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

#### **1.2 SCHEDULE OF VALUES**

- A. Coordination: Coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule.
  - 1. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including Application for Payment forms with Continuation Sheets.
  - 2. Submit the Schedule of Values to Engineer at earliest possible date but no later than 7 days before the date scheduled for submittal of initial Applications for Payment.
- B. Format and Content: Use the Project Manual table of contents as a guide to establish line items for the Schedule of Values. Provide at least one line item for each Specification Section.
  - 1. Identification: Include the following Project identification on the Schedule of Values:
    - a. Project name and location.
    - b. Name of Engineer.
    - c. Contractor's name and address.
    - d. Date of submittal.
  - 2. Submit draft of AIA Document G703 Continuation Sheets
  - 3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Provide several line items for principal subcontract amounts, where appropriate. Include separate line items under required principal subcontracts for operation and maintenance manuals, punch list activities, Project Record Documents, and demonstration and training in the amount of 5 percent of the Contract Sum.
  - 4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
  - 5. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
  - 6. Provide separate line items in the Schedule of Values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
  - 7. Allowances: Provide a separate line item in the Schedule of Values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit

cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.

8. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
  - a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at Contractor's option.
9. Schedule Updating: Update and resubmit the Schedule of Values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

### 1.3 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment shall be consistent with previous applications and payments as certified by Engineer and paid for by Owner.
  1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.
- B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction Work covered by each Application for Payment is the period indicated in the Agreement.
- C. Payment Application Times: Progress payments shall be submitted to Engineer by the third of the month. The period covered by each Application for Payment is one month, ending on the last day of the month.
- D. Payment Application Forms: Use AIA Document G702 and AIA Document G703 Continuation Sheets as form for Applications for Payment.
- E. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Engineer will return incomplete applications without action.
  1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions were made.
  2. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
- F. Transmittal: Submit 3 signed and notarized original copies of each Application for Payment to Engineer by a method ensuring receipt. One copy shall include waivers of lien and similar attachments if required.
  1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

- G. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from every entity who is lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.
1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
  2. When an application shows completion of an item, submit final or full waivers.
  3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
  4. Waiver Forms: Submit waivers of lien on forms, executed in a manner acceptable to Owner.
- H. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.
  2. Schedule of Values.
  3. Contractor's Construction Schedule (preliminary if not final).
  4. Submittals Schedule (preliminary if not final).
  5. List of Contractor's staff assignments.
  6. List of Contractor's principal consultants.
  7. Copies of building permits.
  8. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
  9. Initial progress report.
  10. Report of preconstruction conference.
  11. Certificates of insurance and insurance policies.
- I. Application for Payment at Substantial Completion: After issuing the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
  2. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
- J. Final Payment Application: Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of Project closeout requirements.
  2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
  3. Updated final statement, accounting for final changes to the Contract Sum.
  4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
  5. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
  6. AIA Document G707, "Consent of Surety to Final Payment."
  7. Evidence that claims have been settled.

8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
9. Final, liquidated damages settlement statement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

**END OF SECTION 012900**

## **SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
  - 1. Coordination Drawings.
  - 2. Project meetings.
  - 3. Requests for Interpretation (RFIs).
- B. See Division 01 Section "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.

#### **1.2 DEFINITIONS**

- A. RFI: Request from Contractor seeking interpretation or clarification of the Contract Documents.

#### **1.3 COORDINATION**

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation.
  - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
  - 2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
  - 3. Make adequate provisions to accommodate items scheduled for later installation.
  - 4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
  - 1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other



contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's Construction Schedule.
2. Preparation of the Schedule of Values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Preinstallation conferences.
7. Project closeout activities.
8. Startup and adjustment of systems.
9. Project closeout activities.

#### 1.4 SUBMITTALS

- A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.
1. Content: Project-specific information, drawn accurately to scale. Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:
    - a. Indicate functional and spatial relationships of components of Engineerural, structural, civil, mechanical, and electrical systems.
    - b. Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Engineer for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
  2. Sheet Size: At least 8-1/2 by 11 inches (215 by 280 mm) but no larger than 30 by 40 inches (750 by 1000 mm).
  3. Number of Copies: Submit two opaque copies of each submittal. Engineer will return one copy.
  4. Refer to individual Sections for Coordination Drawing requirements for Work in those Sections.

#### 1.5 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated.
1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Engineer of scheduled meeting dates and times.
  2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.

3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Engineer, within three days of the meeting.
- B. Preconstruction Conference: Schedule a preconstruction conference before starting construction, at a time convenient to Owner and Engineer, but no later than 15 days after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.
1. Attendees: Authorized representatives of Owner, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
  2. Agenda: Discuss items of significance that could affect progress, including the following:
    - a. Tentative construction schedule.
    - b. Phasing.
    - c. Critical work sequencing and long-lead items.
    - d. Designation of key personnel and their duties.
    - e. Procedures for processing field decisions and Change Orders.
    - f. Procedures for RFIs.
    - g. Procedures for testing and inspecting.
    - h. Procedures for processing Applications for Payment.
    - i. Distribution of the Contract Documents.
    - j. Submittal procedures.
    - k. Preparation of Record Documents.
    - l. Use of the premises and existing building.
    - m. Work restrictions.
    - n. Owner's occupancy requirements.
    - o. Responsibility for temporary facilities and controls.
    - p. Construction waste management and recycling.
    - q. Parking availability.
    - r. Office, work, and storage areas.
    - s. Equipment deliveries and priorities.
    - t. First aid.
    - u. Security.
    - v. Progress cleaning.
    - w. Working hours.
  3. Minutes: Record and distribute meeting minutes.
- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.
- D. Progress Meetings: Conduct progress meetings at regular intervals. Coordinate dates of meetings with preparation of payment requests.

## 1.6 REQUESTS FOR INTERPRETATION (RFIs)

- A. Procedure: Immediately on discovery of the need for interpretation of the Contract Documents, and if not possible to request interpretation at Project meeting, prepare and submit an RFI in the form specified.
1. RFIs shall originate with Contractor. RFIs submitted by entities other than Contractor will be returned with no response.
  2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing interpretation and the following:
1. Project name.
  2. Date.
  3. Name of Contractor.
  4. Name of Engineer.
  5. RFI number, numbered sequentially.
  6. Specification Section number and title and related paragraphs, as appropriate.
  7. Drawing number and detail references, as appropriate.
  8. Field dimensions and conditions, as appropriate.
  9. Contractor's suggested solution(s). If Contractor's solution(s) impact the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
  10. Contractor's signature.
  11. Attachments: Include drawings, descriptions, measurements, photos, Product Data, Shop Drawings, and other information necessary to fully describe items needing interpretation.
- C. Hard-Copy RFIs:
1. Identify each page of attachments with the RFI number and sequential page number.
- D. Engineer's Action: Engineer will review each RFI, determine action required, and return it. Allow seven working days for Engineer's response for each RFI. RFIs received after 1:00 p.m. will be considered as received the following working day.
1. The following RFIs will be returned without action:
    - a. Requests for approval of submittals.
    - b. Requests for approval of substitutions.
    - c. Requests for coordination information already indicated in the Contract Documents.
    - d. Requests for adjustments in the Contract Time or the Contract Sum.
    - e. Requests for interpretation of Engineer's actions on submittals.
    - f. Incomplete RFIs or RFIs with numerous errors.
  2. Engineer's action may include a request for additional information, in which case Engineer's time for response will start again.

3. Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Division 01 Section "Contract Modification Procedures."
  - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Engineer in writing within 10 days of receipt of the RFI response.
- E. On receipt of Engineer's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Engineer within 7 days if Contractor disagrees with response.
- F. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

**END OF SECTION 013100**

## **SECTION 013300 - SUBMITTAL PROCEDURES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
- B. See Division 01 Section "Quality Requirements" for submitting test and inspection reports.
- C. See Division 01 Section "Closeout Procedures" for submitting warranties.
- D. See Division 01 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
- E. See Division 01 Section "Operation and Maintenance Data" for submitting operation and maintenance manuals.
- F. See Division 01 Section "Demonstration and Training" for submitting videotapes of demonstration of equipment and training of Owner's personnel.

#### **1.2 DEFINITIONS**

- A. Action Submittals: Written and graphic information that requires Engineer's responsive action.
- B. Informational Submittals: Written information that does not require Engineer's responsive action. Submittals may be rejected for not complying with requirements.

#### **1.3 SUBMITTAL PROCEDURES**

- A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
  - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
  - 2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
    - a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- B. Submittals Schedule: Comply with requirements in Division 01 Section "Construction Progress Documentation" for list of submittals and time requirements for scheduled performance of related construction activities.
- C. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of

submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
  2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
  3. Resubmittal Review: Allow 15 days for review of each resubmittal.
- D. Identification: Place a permanent label or title block on each submittal for identification.
1. Indicate name of firm or entity that prepared each submittal on label or title block.
  2. Provide a space on label or beside title block to record Contractor's review and approval markings and action taken by Engineer.
  3. Include the following information on label for processing and recording action taken:
    - a. Project name.
    - b. Date.
    - c. Name and address of Engineer.
    - d. Name and address of Contractor.
    - e. Name and address of subcontractor.
    - f. Name and address of supplier.
    - g. Name of manufacturer.
    - h. Submittal number or other unique identifier, including revision identifier.
      - 1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 06100.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 06100.01.A).
    - i. Number and title of appropriate Specification Section.
    - j. Drawing number and detail references, as appropriate.
    - k. Location(s) where product is to be installed, as appropriate.
    - l. Other necessary identification.
- E. Deviations: Highlight, encircle, or otherwise specifically identify deviations from the Contract Documents on submittals.
- F. Additional Copies: Unless additional copies are required for final submittal, and unless Engineer observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
1. Additional copies submitted for maintenance manuals will[ not] be marked with action taken and will be returned.
- G. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Engineer will return submittals, without review received from sources other than Contractor.

- H. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
- I. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- J. Use for Construction: Use only final submittals.

## PART 2 - PRODUCTS

### 2.1 ACTION SUBMITTALS

- A. General: Prepare and submit Action Submittals required by individual Specification Sections.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
  - 1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
  - 2. Mark each copy of each submittal to show which products and options are applicable.
  - 3. Include the following information, as applicable:
    - a. Manufacturer's written recommendations.
    - b. Manufacturer's product specifications.
    - c. Manufacturer's installation instructions.
    - d. Manufacturer's catalog cuts.
    - e. Wiring diagrams showing factory-installed wiring.
    - f. Printed performance curves.
    - g. Operational range diagrams.
    - h. Compliance with specified referenced standards.
    - i. Testing by recognized testing agency.
  - 4. Number of Copies: Submit 3 copies of Product Data, unless otherwise indicated. Engineer will return 2 copies. Mark up and retain one returned copy as a Project Record Document.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
  - 1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
    - a. Dimensions.
    - b. Identification of products.
    - c. Fabrication and installation drawings.
    - d. Roughing-in and setting diagrams.

- e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
  - f. Shopwork manufacturing instructions.
  - g. Templates and patterns.
  - h. Schedules.
  - i. Notation of coordination requirements.
  - j. Notation of dimensions established by field measurement.
  - k. Relationship to adjoining construction clearly indicated.
  - l. Seal and signature of professional engineer if specified.
  - m. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.
2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches (215 by 280 mm) but no larger than 30 by 40 inches (750 by 1000 mm) at 1/4" = 1'0" scale.
  3. Number of Copies: Submit two opaque (bond) copies of each submittal. Engineer will return one copy.
- D. Product Schedule or List: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location.
1. Number of Copies: Submit three copies of product schedule or list, unless otherwise indicated. Engineer will return two copies.
- E. Submittals Schedule: Comply with requirements specified in Division 01 Section "Construction Progress Documentation."
- F. Application for Payment: Comply with requirements specified in Division 01 Section "Payment Procedures."
- G. Schedule of Values: Comply with requirements specified in Division 01 Section "Payment Procedures."
- H. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design.
1. Number of Copies: Submit three copies of subcontractor list, unless otherwise indicated. Engineer will return two copies.

## 2.2 INFORMATIONAL SUBMITTALS

- A. General: Prepare and submit Informational Submittals required by other Specification Sections.
1. Number of Copies: Submit two copies of each submittal, unless otherwise indicated. Engineer will not return copies.
  2. Certificates and Certifications: Provide a notarized statement that includes signature of entity responsible for preparing certification. Certificates and



certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

3. Test and Inspection Reports: Comply with requirements specified in Division 01 Section "Quality Requirements."
- B. Coordination Drawings: Comply with requirements specified in Division 01 Section "Project Management and Coordination."
- C. Contractor's Construction Schedule: Comply with requirements specified in Division 01 Section "Construction Progress Documentation."
- D. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of Engineers and owners, and other information specified.
- E. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.
- F. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- G. Manufacturer Certificates: Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- H. Product Certificates: Prepare written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- I. Material Certificates: Prepare written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- J. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- K. Product Test Reports: Prepare written reports indicating current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- L. Research/Evaluation Reports: Prepare written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project.
- M. Preconstruction Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed

before installation of product, for compliance with performance requirements in the Contract Documents.

- N. Compatibility Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- O. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- P. Maintenance Data: Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements specified in Division 01 Section "Operation and Maintenance Data."
- Q. Design Data: Prepare written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.
- R. Manufacturer's Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer.
- S. Manufacturer's Field Reports: Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:
  - 1. Statement on condition of substrates and their acceptability for installation of product.
  - 2. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
  - 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
- T. Insurance Certificates and Bonds: Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.
- U. Material Safety Data Sheets (MSDSs): Submit information directly to Owner; do not submit to Engineer.
  - 1. Engineer will not review submittals that include MSDSs and will return them for resubmittal.

## 2.3 DELEGATED DESIGN

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
  - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.
- B. Delegated-Design Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit three copies of a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
  - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

## PART 3 - EXECUTION

### 3.1 CONTRACTOR'S REVIEW

- A. Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.
- B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

### 3.2 ENGINEER'S ACTION

- A. General: Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Action Submittals: Engineer will review each submittal, make marks to indicate corrections or modifications required, and return it. Engineer will stamp each submittal with an action stamp and will mark stamp appropriately, to indicate action taken.
- C. Informational Submittals: Engineer will review each submittal and will not return it, or will return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.
- D. Partial submittals are not acceptable, will be considered nonresponsive, and will be returned without review.
- E. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

**END OF SECTION 013300**

## **SECTION 014000 - QUALITY REQUIREMENTS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
  - 1. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
  - 2. Requirements for Contractor to provide quality-assurance and -control services required by Engineer, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
- C. See Divisions 02 through 49 Sections for specific test and inspection requirements.

#### **1.2 DEFINITIONS**

- A. **Quality-Assurance Services:** Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- B. **Quality-Control Services:** Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Engineer.
- C. **Preconstruction Testing:** Tests and inspections that are performed specifically for the Project before products and materials are incorporated into the Work to verify performance or compliance with specified criteria.
- D. **Product Testing:** Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with industry standards.
- E. **Source Quality-Control Testing:** Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.
- F. **Field Quality-Control Testing:** Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- G. **Testing Agency:** An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

- H. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
  - 1. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to tradespeople of the corresponding generic name.
- I. Experienced: When used with an entity, "experienced" means having successfully completed a minimum of five previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

### 1.3 CONFLICTING REQUIREMENTS

- A. General: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Engineer for a decision before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

### 1.4 SUBMITTALS

- A. Qualification Data: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- B. Reports: Prepare and submit certified written reports that include the following:
  - 1. Date of issue.
  - 2. Project title and number.
  - 3. Name, address, and telephone number of testing agency.
  - 4. Dates and locations of samples and tests or inspections.
  - 5. Names of individuals making tests and inspections.
  - 6. Description of the Work and test and inspection method.
  - 7. Identification of product and Specification Section.
  - 8. Complete test or inspection data.
  - 9. Test and inspection results and an interpretation of test results.
  - 10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
  - 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.

12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

C. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

## 1.5 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this Article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

C. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar to those indicated for this Project in material, design, and extent.

F. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.

1. Requirement for specialists shall not supersede building codes and regulations governing the Work.

G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 548; and with additional qualifications specified in individual Sections; and where required by authorities having jurisdiction, that is acceptable to authorities.

1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

- H. **Factory-Authorized Service Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

## 1.6 QUALITY CONTROL

- A. **Owner Responsibilities:** Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
  - 1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
  - 2. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.
- B. **Tests and inspections not explicitly assigned to Owner are Contractor's responsibility.** Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
  - 1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
    - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
  - 2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
  - 3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
  - 4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
  - 5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. **Manufacturer's Field Services:** Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Division 01 Section "Submittal Procedures."
- D. **Retesting/Reinspecting:** Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- E. **Testing Agency Responsibilities:** Cooperate with Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.



1. Notify Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform any duties of Contractor.

F. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspecting equipment at Project site.

G. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

## 1.7 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Conducted by a qualified **testing agency** as required by authorities having jurisdiction, as indicated in individual Specification Sections, and as follows:

1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
2. Notifying Engineer and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
3. Submitting a certified written report of each test, inspection, and similar quality-control service to Engineer with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.

5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
6. Retesting and reinspecting corrected work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
  1. Provide materials and comply with installation requirements specified in other Specification Sections. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible.
  2. Comply with the Contract Document requirements for Division 01 Section "Cutting and Patching."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

**END OF SECTION 014000**

## SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. See Division 01 Section "Execution" for progress cleaning requirements.

#### 1.2 DEFINITIONS

- A. Permanent Enclosure: As determined by Engineer, permanent or temporary roofing is complete, insulated, and weathertight; exterior walls are insulated and weathertight; and all openings are closed with permanent construction or substantial temporary closures.

#### 1.3 USE CHARGES

- A. Water Service: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
- B. Electric Power Service: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

#### 1.4 SUBMITTALS

- A. Site Plan: Show temporary facilities, staging areas, and parking areas for construction personnel.

#### 1.5 QUALITY ASSURANCE

- A. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

#### 1.6 PROJECT CONDITIONS

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

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Portable Chain-Link Fencing: Minimum 2-inch (50-mm), 9-gage, galvanized steel, chain-link fabric fencing; minimum 6 feet (1.8 m) high with galvanized steel pipe posts;

minimum 2-3/8-inch- (60-mm-) OD line posts and 2-7/8-inch- (73-mm-) OD corner and pull posts, with 1-5/8-inch- (42-mm-) OD top and bottom rails. Provide galvanized steel bases for supporting posts.

## 2.2 TEMPORARY FACILITIES

- A. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.

## 2.3 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

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

### 3.2 TEMPORARY UTILITY INSTALLATION

- A. Water Service: Use of Owner's existing water service facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
  - 1. Where installations below an outlet might be damaged by spillage or leakage, provide a drip pan of suitable size to minimize water damage. Drain accumulated water promptly from pans.
- B. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
  - 1. Toilets: Use of Owner's existing toilet facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
- C. Electric Power Service: Use of Owner's existing electric power service will be permitted, as long as equipment is maintained in a condition acceptable to Owner.

### 3.3 SUPPORT FACILITIES INSTALLATION

- A. General: Comply with the following:

1. Provide incombustible construction for offices, shops, and sheds located within construction area or within **30 feet (9 m)** of building lines. Comply with NFPA 241.
  2. Maintain support facilities until near Substantial Completion. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
- B. Traffic Controls: Comply with requirements of authorities having jurisdiction.
1. Protect existing site improvements to remain including curbs, pavement, and utilities.
  2. Maintain access for fire-fighting equipment and access to fire hydrants.
- C. Parking: Use designated areas of Owner's existing parking areas for construction personnel.
- D. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties nor endanger permanent Work or temporary facilities.
  2. Remove snow and ice as required to minimize accumulations.
- E. Project Identification and Temporary Signs: Provide Project identification and other signs. Install signs where indicated to inform public and individuals seeking entrance to Project. Unauthorized signs are not permitted.
1. Provide temporary, directional signs for construction personnel and visitors.
  2. Maintain and touchup signs so they are legible at all times.
- 3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION
- A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
- B. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.
- C. Stormwater Control: Comply with authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- D. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
- E. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform

extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Obtain extended warranty for Owner. Perform control operations lawfully, using environmentally safe materials.

- F. Site Enclosure Fence: Before construction operations begin furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.
  - 1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
  - 2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Provide Owner with one set of keys.
- G. Security Enclosure and Lockup: Install substantial temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.
- H. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- I. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
- J. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241.
  - 1. Prohibit smoking in construction areas.
  - 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
  - 3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
  - 4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

### 3.5 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
  - 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
  - 1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
  - 2. At Substantial Completion, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements specified in Division 01 Section "Closeout Procedures."

**END OF SECTION 015000**

## **SECTION 016000 - PRODUCT REQUIREMENTS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products.
- B. See Division 01 Section "Closeout Procedures" for submitting warranties for Contract closeout.

#### **1.2 DEFINITIONS**

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

#### **1.3 SUBMITTALS**

- A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.



1. Substitution Request Form: Use CSI Form 13.1A.
  2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
    - a. Statement indicating why specified material or product cannot be provided.
    - b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
    - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
    - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
    - e. Samples, where applicable or requested.
    - f. List of similar installations for completed projects with project names and addresses and names and addresses of Engineers and owners.
    - g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
    - h. Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
    - i. Detailed comparison of Contractor's Construction Schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery.
    - j. Cost information, including a proposal of change, if any, in the Contract Sum.
    - k. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
    - l. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
  3. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within 7 days of receipt of a request for substitution. Engineer will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
    - a. Form of Acceptance: Change Order.
    - b. Use product specified if Engineer cannot make a decision on use of a proposed substitution within time allocated.
- B. Comparable Product Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Engineer will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
  - a. Form of Approval: As specified in Division 01 Section "Submittal Procedures."
  - b. Use product specified if Engineer cannot make a decision on use of a comparable product request within time allocated.
- C. Basis-of-Design Product Specification Submittal: Comply with requirements in Division 01 Section "Submittal Procedures." Show compliance with requirements.

#### 1.4 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

#### 1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

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

6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.

## 1.6 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
  1. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
  2. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
  1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
  2. Specified Form: When specified forms are included with the Specifications, prepare a written document using appropriate form properly executed.
  3. Refer to Divisions 2 through 16 Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Division 01 Section "Closeout Procedures."

## PART 2 - PRODUCTS

### 2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, that are new at time of installation.
  1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
  2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
  3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
  4. Where products are accompanied by the term "as selected," Engineer will make selection.
  5. Where products are accompanied by the term "match sample," sample to be matched is Engineer's.

6. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.

B. Product Selection Procedures:

1. Product: Where Specifications name a single product and manufacturer, provide the named product that complies with requirements.
2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements.
3. Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.
4. Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
5. Available Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product.
6. Available Manufacturers: Where Specifications include a list of manufacturers, provide a product by one of the manufacturers listed, or an unnamed manufacturer, that complies with requirements. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product.
7. Product Options: Where Specifications indicate that sizes, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide the specified product or system. Comply with provisions in Part 2 "Product Substitutions" Article for consideration of an unnamed product or system.
8. Basis-of-Design Product: Where Specifications name a product and include a list of manufacturers, provide the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product by the other named manufacturers.
9. Visual Matching Specification: Where Specifications require matching an established Sample, select a product that complies with requirements and matches Engineer's sample. Engineer's decision will be final on whether a proposed product matches.
  - a. If no product available within specified category matches and complies with other specified requirements, comply with provisions in Part 2 "Product Substitutions" Article for proposal of product.
10. Visual Selection Specification: Where Specifications include the phrase "as selected from manufacturer's colors, patterns, textures" or a similar phrase, select a product that complies with other specified requirements.
  - a. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Engineer will select color,

pattern, density, or texture from manufacturer's product line that does not include premium items.

- b. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Engineer will select color, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

## 2.2 PRODUCT SUBSTITUTIONS

- A. Timing: Engineer will consider requests for substitution if received within 30 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Engineer.
- B. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
  - 1. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
  - 2. Requested substitution does not require extensive revisions to the Contract Documents.
  - 3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
  - 4. Substitution request is fully documented and properly submitted.
  - 5. Requested substitution will not adversely affect Contractor's Construction Schedule.
  - 6. Requested substitution has received necessary approvals of authorities having jurisdiction.
  - 7. Requested substitution is compatible with other portions of the Work.
  - 8. Requested substitution has been coordinated with other portions of the Work.
  - 9. Requested substitution provides specified warranty.

## 2.3 COMPARABLE PRODUCTS

- A. Conditions: Engineer will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
  - 1. Evidence that the proposed product does not require extensive revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
  - 2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.

3. Evidence that proposed product provides specified warranty.
4. List of similar installations for completed projects with project names and addresses and names and addresses of Engineers and owners, if requested.
5. Samples, if requested.

PART 3 - EXECUTION (Not Used)

**END OF SECTION 016000**

## **SECTION 017300 - EXECUTION**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:
  - 1. General installation of products.
  - 2. Progress cleaning.
  - 3. Starting and adjusting.
  - 4. Protection of installed construction.
  - 5. Correction of the Work.
  
- B. See Division 01 Section "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.

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

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Existing Conditions: The existence and location of site improvements, utilities, and other construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the Work.
  - 1. Before construction, verify the location and points of connection of utility services.
  
- B. Acceptance of Conditions: Examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
  - 1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
  - 2. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
  - 3. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
  - 4. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

#### **3.2 PREPARATION**

- A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility

appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Engineer. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents.

### 3.3 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
  - 1. Make vertical work plumb and make horizontal work level.
  - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
  - 3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
- F. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- G. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.



1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Engineer.
  2. Allow for building movement, including thermal expansion and contraction.
  3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- H. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.
- ### 3.4 PROGRESS CLEANING
- A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.
1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
  2. Do not hold materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80 deg F (27 deg C).
  3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
1. Remove liquid spills promptly.
  2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

- G. Waste Disposal: Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

### 3.5 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: If a factory-authorized service representative is required to inspect field-assembled components and equipment installation, comply with qualification requirements in Division 01 Section "Quality Requirements."

### 3.6 PROTECTION OF INSTALLED CONSTRUCTION

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

### 3.7 CORRECTION OF THE WORK

- A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Division 01 Section "Cutting and Patching."
  - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Restore permanent facilities used during construction to their specified condition.
- C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.

E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

**END OF SECTION 017300**

## SECTION 017320 - SELECTIVE DEMOLITION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

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

- B. Related Requirements:

- 1. Division 1 Section "Summary" for restrictions on the use of the premises, Owner-occupancy requirements, and phasing requirements.
- 2. Division 1 Section "Special Procedures for Historic Treatment" for historic removal and dismantling.
- 3. Division 1 Section "Execution Requirements" for cutting and patching procedures.
- 4. Division 2 Section "Site Clearing" for site clearing and removal of above- and below-grade improvements.
- 5. Division 2 Section "Tree Protection and Trimming" for temporary protection of existing trees and plants that are affected by selective demolition.

#### 1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner storage facility as directed.
- C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

#### 1.4 MATERIALS OWNERSHIP

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

#### 1.5 PREINSTALLATION MEETINGS

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

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For refrigerant recovery technician.
- B. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.
- C. Schedule of Selective Demolition Activities: Indicate the following:
  - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
  - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
  - 3. Coordination for shutoff, capping, and continuation of utility services.
  - 4. Use of elevator and stairs.
  - 5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- D. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.

- E. Pre-demolition Photographs or Video: Contractor shall prepare and submit before Work begins.
- F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.
- G. Warranties: Documentation indicated that existing warranties are still in effect after completion of selective demolition.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.
- B. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

#### 1.8 QUALITY ASSURANCE

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

#### 1.9 FIELD CONDITIONS

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

for review and use. Examine report to become aware of locations where hazardous materials are present.

1. Hazardous material remediation is specified elsewhere in the Contract Documents.
2. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
3. Owner will provide material safety data sheets for suspected hazardous materials that are known to be present in buildings and structures to be selectively demolished because of building operations or processes performed there.

F. Storage or sale of removed items or materials is not permitted.

G. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

#### 1.10 WARRANTY

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

1. **None**

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

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

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

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

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review record documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in record documents.
- C. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to the Project Architect/Engineer.
- E. **Engage a professional engineer to perform** an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
  - 1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.
  - 2. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.
- F. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs.
  - 1. Comply with requirements specified in Division 1 Section "Photographic Documentation."
  - 2. Inventory and record the condition of items to be removed and salvaged. Provide photographs of conditions that might be misconstrued as damage caused by salvage operations.
  - 3. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

### 3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
  - 1. Comply with requirements for existing services/systems interruptions specified in Division 1 Section "Summary."



- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
1. Coordinate the shutting off of indicated services/systems with the Owner prior to doing so.
  2. Arrange to shut off indicated utilities with utility companies.
  3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
  4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated to be removed.
    - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
    - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
    - d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
    - e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
    - f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
    - g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
- C. Refrigerant: Remove refrigerant from mechanical equipment to be selectively demolished according to 40 CFR 82 and regulations of authorities having jurisdiction.

### 3.3 PREPARATION

- A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
1. Comply with requirements for access and protection specified in Division 1 Section "Temporary Facilities and Controls."
- B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
  2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.

3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
  4. Cover and protect furniture, furnishings, and equipment that have not been removed.
  5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Division 1 Section "Temporary Facilities and Controls."
- C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
1. Strengthen or add new supports when required during progress of selective demolition.

### 3.4 SELECTIVE DEMOLITION, GENERAL

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

5. Protect items from damage during transport and storage.

C. Removed and Reinstalled Items:

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

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

### 3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch (19 mm) at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.

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

C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.

D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

E. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings." Do not use methods requiring solvent-based adhesive strippers.

F. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight. See Division 7 for new roofing requirements.

1. Remove existing roof membrane, flashings, copings, and roof accessories.
2. Remove existing roofing system down to substrate.

### 3.6 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
  - 1. Do not allow demolished materials to accumulate on-site.
  - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
  - 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
  - 4. Comply with requirements specified in Division 1 Section "Construction Waste Management."
- B. Burning: Burning of demolished materials will NOT be permitted on the Owner's property.
- C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

### 3.7 CLEANING

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

### 3.8 SELECTIVE DEMOLITION SCHEDULE SHALL INCLUDE:

- A. Existing Items to Be Removed.
- B. Existing Items to Be Removed and Salvaged.
- C. Existing Items to Be Removed and Reinstalled.
- D. Existing Items to Remain.

END OF SECTION 01732

## **SECTION 017329 - CUTTING AND PATCHING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes procedural requirements for cutting and patching.
- B. See Divisions 2 through 16 Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.

#### **1.2 SUBMITTALS**

- A. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:
  - 1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
  - 2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
  - 3. Products: List products to be used and firms or entities that will perform the Work.
  - 4. Dates: Indicate when cutting and patching will be performed.
  - 5. Utility Services and Mechanical/Electrical Systems: List services/systems that cutting and patching procedures will disturb or affect. List services/systems that will be relocated and those that will be temporarily out of service. Indicate how long services/systems will be disrupted.
  - 6. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.
  - 7. Engineer's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

#### **1.3 QUALITY ASSURANCE**

- A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.
- B. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
  - 1. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.

- C. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

#### 1.4 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

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

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.
  - 1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with in-place finishes or primers.
  - 2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Temporary Support: Provide temporary support of Work to be cut.
- B. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- D. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.

### 3.3 PERFORMANCE

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
  2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
  3. Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
  4. Excavating and Backfilling: Comply with requirements in applicable Division 31 Sections where required by cutting and patching operations.
  5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
  6. Proceed with patching after construction operations requiring cutting are complete.
- C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
  2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
  3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
  4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
  5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.

- D. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

**END OF SECTION 017329**



## **SECTION 017700 - CLOSEOUT PROCEDURES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
  - 1. Inspection procedures.
  - 2. Warranties.
  - 3. Final cleaning.
- B. See Division 01 Section "Payment Procedures" for requirements for Applications for Payment for Substantial and Final Completion.
- C. See Division 01 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
- D. See Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
- E. See Division 01 Section "Demonstration and Training" for requirements for instructing Owner's personnel.

#### **1.2 SUBSTANTIAL COMPLETION**

- A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.
  - 1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
  - 2. Advise Owner of pending insurance changeover requirements.
  - 3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
  - 4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
  - 5. Prepare and submit Project Record Documents, operation and maintenance manuals, Final Completion construction photographs damage or settlement surveys, property surveys, and similar final record information.
  - 6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
  - 7. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
  - 8. Complete startup testing of systems.
  - 9. Submit test/adjust/balance records.

10. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
  11. Advise Owner of changeover in heat and other utilities.
  12. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
  13. Complete final cleaning requirements, including touchup painting.
  14. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.
1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
  2. Results of completed inspection will form the basis of requirements for Final Completion.

### 1.3 FINAL COMPLETION

- A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:
1. Submit a final Application for Payment according to Division 01 Section "Payment Procedures."
  2. Submit certified copy of Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
  3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
  4. Submit pest-control final inspection report and warranty.
  5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
- B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

### 1.4 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Preparation: Submit three copies of list. Include name and identification of each space and area affected by construction operations for incomplete items and items needing

correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize list of spaces in sequential order.
2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.

## 1.5 WARRANTIES

- A. Submittal Time: Submit written warranties on request of Engineer for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.
- B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
  1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch (215-by-280-mm) paper.
  2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
  3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- C. Provide additional copies of each warranty to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

## PART 3 - EXECUTION

### 3.1 FINAL CLEANING

- A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
  1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:

- a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
  - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
  - c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
  - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
  - e. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
  - f. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
  - g. Sweep concrete floors broom clean in unoccupied spaces.
  - h. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
  - i. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
  - j. Remove labels that are not permanent.
  - k. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
    - 1) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
  - l. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
  - m. Replace parts subject to unusual operating conditions.
  - n. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
  - o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
  - p. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
  - q. Leave Project clean and ready for occupancy.
- C. Pest Control: Engage an experienced, licensed exterminator to make a final inspection and rid Project of rodents, insects, and other pests. Prepare a report.
- D. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or

dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

**END OF SECTION 017700**

## **SECTION 017823 - OPERATION AND MAINTENANCE DATA**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
  - 1. Emergency manuals.
  - 2. Operation manuals for systems, subsystems, and equipment.
  - 3. Maintenance manuals for the care and maintenance of systems and equipment.
- B. See Divisions 02 through 49 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

#### **1.2 SUBMITTALS**

- A. Manual: Submit one copy of each manual in final form at least 15 days before final inspection. Engineer will return copy with comments within 15 days after final inspection.
  - 1. Correct or modify each manual to comply with Engineer's comments. Submit 3 copies of each corrected manual within 15 days of receipt of Engineer's comments.

### **PART 2 - PRODUCTS**

#### **2.1 MANUALS, GENERAL**

- A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain a title page, table of contents, and manual contents.
- B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information:
  - 1. Subject matter included in manual.
  - 2. Name and address of Project.
  - 3. Name and address of Owner.
  - 4. Date of submittal.
  - 5. Name, address, and telephone number of Contractor.
  - 6. Name and address of Engineer.
  - 7. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold **8-1/2-by-11-inch (215-by-280-mm)** paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
    - a. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
  2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
  3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.
  4. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
    - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
    - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

## 2.2 EMERGENCY MANUALS

- A. Content: Organize manual into a separate section for type of emergency, emergency instructions, and emergency procedures.
- B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component for [fire] [flood] [gas leak] [water leak] [power failure][equipment failure] [and] [chemical release or spill].
- C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- D. Emergency Procedures: Include instructions on stopping, shutdown instructions for each type of emergency, operating instructions for conditions outside normal operating limits, and required sequences for electric or electronic systems.

## 2.3 OPERATION MANUALS

- A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and equipment descriptions, operating standards, operating procedures, operating logs, wiring and control diagrams, and license requirements.
- B. Descriptions: Include the following:
  - 1. Product name and model number.
  - 2. Manufacturer's name.
  - 3. Equipment identification with serial number of each component.
  - 4. Equipment function.
  - 5. Operating characteristics.
  - 6. Limiting conditions.
  - 7. Performance curves.
  - 8. Engineering data and tests.
  - 9. Complete nomenclature and number of replacement parts.
- C. Operating Procedures: Include start-up, break-in, and control procedures; stopping and normal shutdown instructions; routine, normal, seasonal, and weekend operating instructions; and required sequences for electric or electronic systems.
- D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

## 2.4 PRODUCT MAINTENANCE MANUAL

- A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Product Information: Include the following, as applicable:
  - 1. Product name and model number.
  - 2. Manufacturer's name.
  - 3. Color, pattern, and texture.
  - 4. Material and chemical composition.
  - 5. Reordering information for specially manufactured products.
- D. Maintenance Procedures: Include manufacturer's written recommendations and inspection procedures, types of cleaning agents, methods of cleaning, schedule for cleaning and maintenance, and repair instructions.



- E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

## 2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

- A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
- B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including maintenance instructions, drawings and diagrams for maintenance, nomenclature of parts and components, and recommended spare parts for each component part or piece of equipment:
- D. Maintenance Procedures: Include test and inspection instructions, troubleshooting guide, disassembly instructions, and adjusting instructions that detail essential maintenance procedures:
- E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
- F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

## PART 3 - EXECUTION

### 3.1 MANUAL PREPARATION

- A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

- B. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- C. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
- D. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
- E. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.
  - 1. Do not use original Project Record Documents as part of operation and maintenance manuals.
- F. Comply with Division 01 Section "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

**END OF SECTION 017823**

## **SECTION 017839 - PROJECT RECORD DOCUMENTS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes administrative and procedural requirements for Project Record Documents, including the following:
  - 1. Record Drawings.
  - 2. Record Specifications.
  - 3. Record Product Data.
- B. See Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
- C. See Divisions 02 through 49 Sections for specific requirements for Project Record Documents of the Work in those Sections.

#### **1.2 SUBMITTALS**

- A. Record Drawings: Comply with the following:
  - 1. Number of Copies: Submit one set of marked-up Record Prints.
  - 2. Number of Copies: Submit copies of Record Drawings as follows:
- B. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit one copy of each Product Data submittal.

### **PART 2 - PRODUCTS**

#### **2.1 RECORD DRAWINGS**

- A. Record Prints: Maintain one set of blue- or black-line white prints of the Contract Drawings and Shop Drawings.
  - 1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
    - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    - b. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
  - 2. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.

3. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
  4. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize Record Prints and newly prepared Record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
  2. Identification: As follows:
    - a. Project name.
    - b. Date.
    - c. Designation "PROJECT RECORD DRAWINGS."
    - d. Name of Engineer.
    - e. Name of Contractor.

## 2.2 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
  2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
  3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
  4. Note related Change Orders and Record Drawings where applicable.

## 2.3 RECORD PRODUCT DATA

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

## 2.4 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

## PART 3 - EXECUTION

### 3.1 RECORDING AND MAINTENANCE

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

**END OF SECTION 017839**

## **SECTION 017900 - DEMONSTRATION AND TRAINING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

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

#### **1.2 SUBMITTALS**

- A. Instruction Program: Submit two copies of outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.

#### **1.3 QUALITY ASSURANCE**

- A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Division 01 Section "Quality Requirements," experienced in operation and maintenance procedures and training.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Engineer.

### **PART 2 - PRODUCTS**

#### **2.1 INSTRUCTION PROGRAM**

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following:
  - 1. Basis of System Design, Operational Requirements, and Criteria: Include system and equipment descriptions, operating standards, regulatory requirements, equipment function, operating characteristics, limiting conditions, and performance curves.

2. Documentation: Review emergency, operations, and maintenance manuals; Project Record Documents; identification systems; warranties and bonds; and maintenance service agreements.
3. Emergencies: Include instructions on stopping; shutdown instructions; operating instructions for conditions outside normal operating limits; instructions on meaning of warnings, trouble indications, and error messages; and required sequences for electric or electronic systems.
4. Operations: Include startup, break-in, control, and safety procedures; stopping and normal shutdown instructions; routine, normal, seasonal, and weekend operating instructions; operating procedures for emergencies and equipment failure; and required sequences for electric or electronic systems.
5. Adjustments: Include alignments and checking, noise, vibration, economy, and efficiency adjustments.
6. Troubleshooting: Include diagnostic instructions and test and inspection procedures.
7. Maintenance: Include inspection procedures, types of cleaning agents, methods of cleaning, procedures for preventive and routine maintenance, and instruction on use of special tools.
8. Repairs: Include diagnosis, repair, and disassembly instructions; instructions for identifying parts; and review of spare parts needed for operation and maintenance.

## PART 3 - EXECUTION

### 3.1 INSTRUCTION

- A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.
- B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
- C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
  1. Schedule training with Owner with at least seven days' advance notice.
- D. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a demonstration performance-based test.

## END OF SECTION 017900

## SECTION 09911 - EXTERIOR PAINTING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes surface preparation and the application of paint systems on **the following substrates:**
1. Concrete.
  2. Clay masonry.
  3. Concrete masonry units (CMU).
  4. Steel.
  5. Galvanized metal.
  6. Aluminum (not anodized or otherwise coated).
  7. Stainless-steel flashing.
  8. Wood.
  9. Plastic trim fabrications.
  10. Exterior portland cement plaster (stucco).
  11. Exterior gypsum board.

#### 1.2 DEFINITIONS

- A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- D. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- E. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- F. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Samples: For each type of paint system and each color and gloss of topcoat.



- C. Product List: For each product indicated. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.

#### 1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, **from the same product run**, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Paint: **5** percent, but not less than **1 gal.** of each material and color applied.

#### 1.5 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
  - 1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
    - a. Vertical and Horizontal Surfaces: Provide samples of at least **100 sq. ft. (9 sq. m)**.
    - b. Other Items: Architect will designate items or areas required.
  - 2. Final approval of color selections will be based on mockups.
    - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, **provide products** listed in other Part 2 articles for the paint category indicated.

#### 2.2 PAINT, GENERAL

- A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- B. Material Compatibility:
  - 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- C. VOC Content: Provide materials that comply with VOC limits of authorities having jurisdiction.
- D. Colors: **As selected by Architect from manufacturer's full range**

### 2.3 EXTERIOR FINISHES:

- A. Concrete/Cement (Stucco.& Masonry):
1. Primer: Sherwin Williams A24W08300 Loxon Exterior Acrylic masonry Primer
  2. Finish: A82W00151 A-100 Exterior Latex Satin
- B. Concrete Block (CMU)Primer:
1. Primer: Sherwin Williams B25W00025 - PrepRite® Block Filler
  2. Finish: A82W00151 - A-100® Exterior Latex Satin
- C. Steel (Ferrous & Galvanized):
1. Primer: Sherwin Williams B66W00310 - Pro Industrial Pro-Cryl® Universal Primer
  2. Finish: B54W00101 - Industrial Enamel Alkyd Gloss.

### 2.4 Interior Finishes:

- A. Concrete Block (CMU):
1. Primer: Sherwin Williams B25W00025 - PrepRite® Block Filler
  2. Finish: B20W02651 - ProMar® 200 Zero VOC Interior Latex Eg-Shel.
- B. Drywall( Ceilings / Horizontal Surfaces):
1. Primer: B28W08601 - High Build Interior Latex Primer.
  2. Finish: B30W02651 - ProMar® 200 Zero VOC Interior Latex Flat .
- C. Concrete/Cement ( Stucco & Masonry):

1. Primer: A24W08300 - Loxon® Exterior Acrylic Masonry Primer.
2. Finish: B20W02651 - ProMar® 200 Zero VOC Interior Latex Eg-Shel.

D. Drywall ( Walls & Vertical Surfaces):

1. Primer: B28W08601 - High Build Interior Latex Primer.
2. Finish: B20W02651 - ProMar® 200 Zero VOC Interior Latex Eg-Shel.

E. Wood:

1. Primer: B79W08810 - ProBlock® Interior Oil-Based Primer.
2. Finish: B34W00251 - ProMar® 200 Interior Alkyd Semi-Gloss.

F. Steel ( Ferrous & Galvanized):

1. Primer: B66W00310 - Pro Industrial Pro-Cryl® Universal Primer.
2. Finish: B34W00251 - ProMar® 200 Interior Alkyd Semi-Gloss.

## 2.5 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
  1. Concrete: 12 percent.
  2. Masonry (Clay and CMU): 12 percent.
  3. Wood: 15 percent.
  4. Portland Cement Plaster: 12 percent.
  5. Gypsum Board: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Proceed with coating application only after unsatisfactory conditions have been corrected.
  1. Application of coating indicates acceptance of surfaces and conditions.

## 2.6 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates and paint systems indicated.
- B. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
  - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

## 2.7 APPLICATION

- A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Manual."
- B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

## 2.8 CLEANING AND PROTECTION

- A. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- B. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

END OF SECTION 09911

## SECTION 09912 - INTERIOR PAINTING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes surface preparation and the application of paint systems on interior substrates.
  - 1. Concrete.
  - 2. Concrete masonry units (CMU).
  - 3. Steel.
  - 4. Galvanized metal.
  - 5. Aluminum (not anodized or otherwise coated).
  - 6. Wood.
  - 7. Gypsum board.
  - 8. Plaster.

#### 1.3 DEFINITIONS

- A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- D. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- E. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- F. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- G. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.

## 1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Paint: 2 percent, but not less than **1 gal. (3.8 L)** of each material and color applied.

## 1.6 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
  - 1. Final approval of color selections will be based on mockups.
    - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
  - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect/Engineer specifically approves such deviations in writing.
  - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than **45 deg F (7 deg C)**.
  - 1. Maintain containers in clean condition, free of foreign materials and residue.
  - 2. Remove rags and waste from storage areas daily.

## 1.8 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between **50 and 95 deg F (10 and 35 deg C)**.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than **5 deg F (3 deg C)** above the dew point; or to damp or wet surfaces.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Benjamin Moore & Co.
  2. BLP Mobile Paint Manufacturing.
  3. ICI Paints.
  4. PPG Architectural Finishes, Inc.
  5. Sherwin Williams.
- B. Products: Subject to compliance with requirements available products that may be incorporated into the Work include, but are not limited to products listed in other Part 2 articles for the paint category indicated.

### 2.2 PAINT, GENERAL

- A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- B. Material Compatibility:
1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
  2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- C. VOC Content: Products shall comply with the following VOC limits:
1. Flat Paints and Coatings: 50 g/L.
  2. Nonflat Paints and Coatings: 150 g/L.
  3. Dry-Fog Coatings: 400 g/L.
  4. Primers, Sealers, and Undercoaters: 200 g/L.
  5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
  6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
  7. Pretreatment Wash Primers: 420 g/L.
  8. Floor Coatings: 100 g/L.
  9. Shellacs, Clear: 730 g/L.
  10. Shellacs, Pigmented: 550 g/L.
- D. Low-Emitting Materials: Interior paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard

Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Colors: As selected from manufacturer's full range.

## 2.3 PAINTING SCHEDULE

A. CONCRETE - (Walls & Ceilings, Poured Concrete, Precast Concrete, Unglazed Brick, Cement Board, Tilt-Up, Cast-In-Place) including PLASTER - (Walls, Ceilings)

### 1. Latex Systems

#### a. Gloss Finish

1st Coat: S-W Loxon Concrete & Masonry Primer Sealer, A24W8300  
(8 mils wet, 3.2 mils dry)  
2nd Coat: S-W ProMar 200 Latex Gloss B21-2200 Series  
3rd Coat: S-W ProMar 200 Latex Gloss B21-2200 Series  
(4 mils wet, 1.5 mils dry per coat)

#### b. Semi-Gloss Finish

1st Coat: S-W Loxon Concrete & Masonry Primer Sealer, A24W8300  
(8 mils wet, 3.2 mils dry)  
2nd Coat: S-W Harmony Interior Latex Semi-Gloss, B10 Series  
3rd Coat: S-W Harmony Interior Latex Semi-Gloss, B10 Series  
(4 mils wet, 1.6 mils dry per coat)

#### c. Eg-Shel Finish

1st Coat: S-W Loxon Concrete & Masonry Primer Sealer, A24W8300  
(8 mils wet, 3.2 mils dry)  
2nd Coat: S-W Harmony Interior Latex Eg-Shel, B9 Series  
3rd Coat: S-W Harmony Interior Latex Eg-Shel, B9 Series  
(4 mils wet, 1.7 mils dry per coat)

#### d. Low Sheen Finish

1st Coat: S-W Loxon Concrete & Masonry Primer Sealer, A24W8300  
(8 mils wet, 3.2 mils dry)  
2nd Coat: S-W ProMar 200 Zero VOC Latex Low Sheen Enamel, B24-2600 Series  
3rd Coat: S-W ProMar 200 Zero VOC Latex Low Sheen Enamel, B24-2600 Series  
(4 mils wet, 1.6 mils dry per coat)

#### e. Flat Finish

1st Coat: S-W Loxon Concrete & Masonry Primer Sealer, A24W8300  
(8 mils wet, 3.2 mils dry)  
2nd Coat: S-W Harmony Interior Latex Flat, B5 Series  
3rd Coat: S-W Harmony Interior Latex Flat, B5 Series  
(4 mils wet, 1.8 mils dry per coat)

### 2. Alkyd System (Waterbased Acrylic-Alkyd)



a. Gloss Finish

1st Coat: S-W Loxon Concrete & Masonry Primer Sealer, A24W8300  
(8 mils wet, 3.2 mils dry)

2nd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Gloss, B35-8200 Series

3rd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Gloss, B35-8200 Series  
(4 mils wet, 1.7 mils dry per coat)

b. Semi-Gloss Finish

1st Coat: S-W Loxon Concrete & Masonry Primer Sealer, A24W8300  
(8 mils wet, 3.2 mils dry)

2nd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Semi-Gloss, B34-8200 Series

3rd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Semi-Gloss, B34-8200 Series  
(4 mils wet, 1.7 mils dry per coat)

c. Eg-Shel Finish

1st Coat: S-W Loxon Concrete & Masonry Primer Sealer, A24W8300  
(8 mils wet, 3.2 mils dry)

2nd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Eg-Shel, B33-8200 Series

3rd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Eg-Shel, B33-8200 Series  
(4 mils wet, 1.4 mils dry per coat)

3. Epoxy Systems (Water Base)

a. Gloss Finish

1st Coat: S-W Pro Industrial Water Based Catalyzed Epoxy Gloss, B73-300 Series

2nd Coat: S-W Pro Industrial Water Based Catalyzed Epoxy Gloss, B73-300 Series  
(2.0- 4 mils dry per coat)

c. Eg-Shel Finish

1st Coat: S-W Pro Industrial Water Based Catalyzed Epoxy Eg-Shel, B73-300 Series

2nd Coat: S-W Pro Industrial Water Based Catalyzed Epoxy Eg-Shel, B73-300 Series  
(2.0- 4 mils dry per coat)

C. MASONRY - (CMU - Concrete, Split Face, Scored, Smooth, High / Low Density, Fluted)

1. Latex Systems

a. Gloss Finish

1st Coat: S-W PrepRite® Block Filler, B25W25  
(75-125 sq ft/gal)

2nd Coat: S-W ProMar 200 Latex Gloss B21-2200 Series

3rd Coat: S-W ProMar 200 Latex Gloss B21-2200 Series  
(4 mils wet, 1.5 mils dry per coat)

b. Semi-Gloss Finish

1st Coat: S-W PrepRite Block Filler, B25W25  
(75-125 sq ft/gal)

2nd Coat: S-W Harmony Interior Latex Semi-Gloss, B10 Series

3rd Coat: S-W Harmony Interior Latex Semi-Gloss, B10 Series  
(4 mils wet, 1.6 mils dry per coat)

c. Eg-Shel Finish

1st Coat: S-W PrepRite Block Filler, B25W25  
(75-125 sq ft/gal)

2nd Coat: S-W Harmony Interior Latex Eg-Shel, B9 Series

3rd Coat: S-W Harmony Interior Latex Eg-Shel, B9 Series  
(4 mils wet, 1.7 mils dry per coat)

d. Low Sheen Finish

1st Coat: S-W PrepRite Block Filler, B25W25  
(75-125 sq ft/gal)

2nd Coat: S-W ProMar 200 Zero VOC Latex Low Sheen Enamel, B24-2600 Series

3rd Coat: S-W ProMar 200 Zero VOC Latex Low Sheen Enamel, B24-2600 Series  
(4 mils wet, 1.6 mils dry per coat)

e. Flat Finish

1st Coat: S-W PrepRite Block Filler, B25W25  
(75-125 sq ft/gal)

2nd Coat: S-W Harmony Interior Latex Flat, B5 Series

3rd Coat: S-W Harmony Interior Latex Flat, B5 Series  
(4 mils wet, 1.6 mils dry per coat)

## 2. Alkyd System (Waterbased Acrylic-Alkyd)

a. Gloss Finish

1st Coat: S-W PrepRite Block Filler, B25W25  
(75-125 sq ft/gal)

2nd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Gloss, B35-8200 Series

3rd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Gloss, B35-8200 Series  
(4 mils wet, 1.7 mils dry per coat)

b. Semi-Gloss Finish

1st Coat: S-W PrepRite Block Filler, B25W25  
(75-125 sq ft/gal)

2nd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Semi-Gloss, B34-8200 Series

3rd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Semi-Gloss, B34-8200 Series  
(4 mils wet, 1.7 mils dry per coat)

c. Eg-Shel Finish

1st Coat: S-W PrepRite Block Filler, B25W25  
(75-125 sq ft/gal)

2nd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Eg-Shel, B33-8200 Series

3rd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Eg-Shel, B33-8200 Series  
(4 mils wet, 1.4 mils dry per coat)

## 3. Epoxy System (Water Base)

a. Gloss Finish

1st Coat: S-W Heavy Duty Block Filler, B42W46

(50-88 sq ft/gal)

2nd Coat: S-W Pro Industrial Water Based Catalyzed Epoxy Gloss, B73-300 Series

3rd Coat: S-W Pro Industrial Water Based Catalyzed Epoxy Gloss, B73-300 Series  
(2.0- 4 mils dry per coat)

b. Semi -Gloss Finish

1st Coat: S-W Heavy Duty Block Filler, B42W46

(50-88 sq ft/gal)

2nd Coat: S-W Waterbased Catalyzed Epoxy Semi-Gloss, B70W211/ B60V25

3rd Coat: S-W Waterbased Catalyzed Epoxy Semi-Gloss, B70W211/ B60V25  
(2.5 - 3 mils dry per coat)

D. METAL - (Aluminum, Galvanized)

1. Latex Systems

a. Gloss Finish

1st Coat: S-W Pro Industrial Pro-Cryl® Universal Primer, B66-310 Series

(5-10 mils wet, 2-4 mils dry)

2nd Coat: S-W ProMar 200 Latex Gloss Enamel, B21-2200 Series

3rd Coat: S-W ProMar 200 Latex Gloss Enamel, B21-2200 Series  
(4 mils wet, 1.5 mils dry per coat)

b. Semi-Gloss Finish

1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series

(5-10 mils wet, 2-4 mils dry)

2nd Coat: S-W ProClassic Waterbased Acrylic Semi-Gloss, B31 Series

3rd Coat: S-W ProClassic Waterbased Acrylic Semi-Gloss, B31 Series  
(4 mils wet, 1.4 mils dry per coat)

c. Eg-Shel / Satin Finish

1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series

(5-10 mils wet, 2-4 mils dry)

2nd Coat: S-W ProClassic® Waterbased Acrylic Satin, B20 Series

3rd Coat: S-W ProClassic Waterbased Acrylic Satin, B20 Series  
(4 mils wet, 1.4 mils dry per coat)

d. Low Sheen Finish

1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series

(5-10 mils wet, 2-4 mils dry)

2nd Coat: S-W ProMar 200 Zero VOC Latex Low Sheen Enamel, B24-2600 Series

3rd Coat: S-W ProMar 200 Zero VOC Latex Low Sheen Enamel, B24-2600 Series  
(4 mils wet, 1.6 mils dry per coat)

e. Flat Finish

1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series

(5-10 mils wet, 2-4 mils dry)

2nd Coat: S-W ProMar 200 Zero VOC Latex Flat, B30-2600 Series  
3rd Coat: S-W ProMar 200 Zero VOC Latex Flat, B30-2600 Series  
(4 mils wet, 1.6 mils dry per coat)

## 2. Alkyd System (Waterbased Acrylic-Alkyd)

### a. Gloss Finish

1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series  
(5-10 mils wet, 2-4 mils dry)  
2nd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Gloss, B35-8200 Series  
3rd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Gloss, B35-8200 Series  
(4 mils wet, 1.7 mils dry per coat)

### b. Semi-Gloss Finish

1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series  
(5-10 mils wet, 2-4 mils dry)  
2nd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Semi-Gloss, B34-8200 Series  
3rd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Semi-Gloss, B34-8200 Series  
(4 mils wet, 1.7 mils dry per coat)

## 3. Epoxy System (Water Base)

### a. Gloss Finish

1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series  
(5-10 mils wet, 2-4 mils dry)  
2nd Coat: S-W Pro Industrial Water Based Catalyzed Epoxy Gloss, B73-300 Series  
3rd Coat: S-W Pro Industrial Water Based Catalyzed Epoxy Gloss, B73-300 Series  
(2.0- 4 mils dry per coat)

### b. Semi -Gloss Finish

1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series  
(5-10 mils wet, 2-4 mils dry)  
2nd Coat: S-W Waterbased Catalyzed Epoxy Semi-Gloss, B70W211/ B60V25  
3rd Coat: S-W Waterbased Catalyzed Epoxy Semi-Gloss, B70W211/ B60V25  
(2.5 - 3 mils dry per coat)

### c. Eg-Shel Finish

1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series  
(5-10 mils wet, 2-4 mils dry)  
2nd Coat: S-W Pro Industrial Water Based Catalyzed Epoxy, B73-360 Series  
3rd Coat: S-W Pro Industrial Water Based Catalyzed Epoxy, B73-360 Series  
(2.0- 4 mils dry per coat)

## E. METAL - (Galvanized; Ceilings, Duct work)

### 1. Dryfall Waterbased Topcoats:

a. Semi-Gloss Finish

1st Coat: S-W Pro Industrial Waterbased Acrylic Dryfall, B42-80 Series  
2nd Coat: S-W Pro Industrial Waterbased Acrylic Dryfall, B42-80 Series  
(5.8 mils wet, 2.3 mils dry per coat)

b. Eg-Shel Finish

1st Coat: S-W Pro Industrial Waterbased Acrylic Dryfall, B42-80 Series  
2nd Coat: S-W Pro Industrial Waterbased Acrylic Dryfall, B42-80 Series  
(6.0 mils wet, 1.9 mils dry per coat)

c. Flat Finish

1st Coat: S-W Pro Industrial Waterbased Acrylic Dryfall, B42-80 Series  
2nd Coat: S-W Pro Industrial Waterbased Acrylic Dryfall, B42-80 Series  
(6.0 mils wet, 1.7 mils dry per coat)

F. METAL Ferrous - (Structural Steel Columns, Joists, Trusses, Beams, Miscellaneous & Ornamental Iron, Structural Iron)

1. Latex Systems

a. Gloss Finish

1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series  
(5-10 mils wet, 2-4 mils dry)  
2nd Coat: S-W ProClassic Waterbased Acrylic Gloss, B21-51 Series  
3rd Coat: S-W ProClassic Waterbased Acrylic Gloss, B21-51 Series  
(4 mils wet, 1.6 mils dry per coat)

b. Semi-Gloss Finish

1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series  
(5-10 mils wet, 2-4 mils dry)  
2nd Coat: S-W ProClassic Waterbased Acrylic Semi-Gloss, B31 Series  
3rd Coat: S-W ProClassic Waterbased Acrylic Semi-Gloss, B31 Series  
(4 mils wet, 1.3 mils dry per coat)

c. Eg-Shel / Satin Finish

1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series  
(5-10 mils wet, 2-4 mils dry)  
2nd Coat: S-W ProClassic Waterbased Acrylic Satin, B20 Series  
3rd Coat: S-W ProClassic Waterbased Acrylic Satin, B20 Series  
(4 mils wet, 1.2 mils dry per coat)

d. Low Sheen Finish

1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series  
(2-4 mils dry)  
2nd Coat: S-W ProMar 200 Zero VOC Latex Low Sheen Enamel, B24-2600 Series  
3rd Coat: S-W ProMar 200 Zero VOC Latex Low Sheen Enamel, B24-2600 Series  
(4 mils wet, 1.6 mils dry per coat)

e. Flat Finish

1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series  
(5-10 mils wet, 2-4 mils dry)  
2nd Coat: S-W Harmony Interior Latex Flat, B5 Series  
3rd Coat: S-W Harmony Interior Latex Flat, B5 Series  
(4 mils wet, 1.6 mils dry per coat)

2. Alkyd System (Waterbased Acrylic-Alkyd)

a. Gloss Finish

1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series  
(5-10 mils wet, 2-4 mils dry)  
2nd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Gloss, B35-8200 Series  
3rd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Gloss, B35-8200 Series  
  
(4 mils wet, 1.7 mils dry per coat)

b. Semi-Gloss Finish

1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series  
(5-10 mils wet, 2-4 mils dry)  
2nd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Semi-Gloss, B34-8200 Series  
3rd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Semi-Gloss, B34-8200 Series  
(4 mils wet, 1.7 mils dry per coat)

3. Epoxy System (Water Base)

a. Gloss Finish

1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series  
(5-10 mils wet, 2-4 mils dry)  
2nd Coat:  
S-W Pro Industrial Water Based Catalyzed Epoxy Gloss, B73-300 Series  
3rd Coat:  
S-W Pro Industrial Water Based Catalyzed Epoxy Gloss, B73-300 Series  
(2.0- 4 mils dry per coat)

b. Semi -Gloss Finish

1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series  
(5-10 mils wet, 2-4 mils dry)  
2nd Coat: S-W Waterbased Catalyzed Epoxy Semi-Gloss, B70W211/ B60V25  
3rd Coat: S-W Waterbased Catalyzed Epoxy Semi-Gloss, B70W211/ B60V25  
(2.5 - 3 mils dry per coat)

c. Eg-Shel Finish

1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series  
(5-10 mils wet, 2-4 mils dry)  
2nd Coat:  
S-W Pro Industrial Water Based Catalyzed Epoxy Eg-Shel, B73-360 Series  
3rd Coat:  
S-W Pro Industrial Water Based Catalyzed Epoxy Eg-Shel, B73-360 Series

(2.0- 4 mils dry per coat)

#### 4. Urethane System (Water Base)

##### a. Gloss Finish

1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series  
(5-10 mils wet, 2-4 mils dry)

2nd Coat:

S-W Waterbased Acrolon 100, B65W720 series

3rd Coat:

S-W Waterbased Acrolon 100, B65W720 series  
(2-4 mils dry per coat)

#### 5. Dryfall Waterbased Topcoats

##### a. Semi-Gloss Finish

1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series  
(5-10 mils wet, 2-4 mils dry)

2nd Coat: S-W Pro Industrial Waterbased Acrylic Dryfall Semi-Gloss, B42-80 Series

3rd Coat: Optional

(5.8 mils wet, 2.3 Mils dry per coat)

##### b. Eg-Shel Finish

1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series  
(5-10 mils wet, 2-4 mils dry)

2nd Coat: S-W Pro Industrial Waterbased Acrylic Dryfall Eg-Shel, B42-80 Series

3rd Coat: Optional

(6.0 mils wet, 1.9 mils dry per coat)

##### c. Flat Finish

1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series  
(5-10 mils wet, 2-4 mils dry)

2nd Coat: S-W Pro Industrial Waterbased Acrylic Dryfall Flat, B42-80 Series

3rd Coat: Optional

(6.0 mils wet, 1.7 mils dry per coat)

#### G. WOOD - (Walls, Ceilings, Doors, Trim,)

##### 1. Latex Systems

##### a. Gloss Finish

1st Coat: S-W Premium Wall & Wood Primer, B28W8111  
(4 mils wet, 1.8 mils dry)

2nd Coat: S-W Pro Classic Waterbased Acrylic Gloss, B21-51 Series

3rd Coat: S-W Pro Classic Waterbased Acrylic Gloss, B21-51 Series  
(4 mils wet, 1.5 mils dry per coat)

##### b. Semi - Gloss Finish

1st Coat: S-W Premium Wall & Wood Primer, B28W8111  
(4 mils wet, 1.8 mils dry)  
2nd Coat: S-W Pro Classic Waterbased Acrylic Semi-Gloss, B31 Series  
3rd Coat: S-W Pro Classic Waterbased Acrylic Semi-Gloss, B31 Series  
(4 mils wet, 1.3 mils dry per coat)

c. Satin Finish

1st Coat: S-W Premium Wall & Wood Primer, B28W8111  
(4 mils wet, 1.8 mils dry)  
2nd Coat: S-W Pro Classic Waterbased Acrylic Satin, B20 Series  
3rd Coat: S-W Pro Classic Waterbased Acrylic Satin, B20 Series  
(4 mils wet, 1.2 mils dry per coat)

d. Flat Finish

1st Coat: S-W Premium Wall & Wood Primer, B28W8111  
(4 mils wet, 1.8 mils dry)  
2nd Coat: S-W ProMar 200 Zero VOC Latex Flat, B30-2600 Series  
3rd Coat: S-W ProMar 200 Zero VOC Latex Flat, B30-2600 Series  
(4 mils wet, 1.6 mils dry per coat)

## 2. Alkyd System (Waterbased Acrylic-Alkyd)

a. Gloss Finish

1st Coat: S-W Premium Wall & Wood Primer, B28W8111  
(4 mils wet, 1.8 mils dry)  
2nd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Gloss, B35-8200 Series  
3rd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Gloss, B35-8200 Series  
(4 mils wet, 1.7 mils dry per coat)

b. Semi-Gloss Finish

1st Coat: S-W Premium Wall & Wood Primer, B28W8111  
(4 mils wet, 1.8 mils dry)  
2nd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Semi-Gloss, B34-8200 Series  
3rd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Semi-Gloss, B34-8200 Series  
(4 mils wet, 1.7 mils dry per coat)

c. Eg-Shel Finish

1st Coat: S-W Premium Wall & Wood Primer, B28W8111  
(4 mils wet, 1.8 mils dry)  
2nd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Eg-Shel, B33-8200 Series  
3rd Coat: S-W ProMar 200 Waterbased Acrylic-Alkyd Eg-Shel, B33-8200 Series  
(4 mils wet, 1.4 mils dry per coat)

## 3. Stain and Varnish System

a. Gloss Finish

1st Coat: S-W Wood Classics 250 Stains  
2nd Coat: S-W Wood Classics Waterbased Polyurethane Varnish Gloss, A68 Series  
3rd Coat: S-W Wood Classics Waterbased Polyurethane Varnish Gloss, A68 Series



(4 mils wet, 1.0 mil dry per coat)

b. Satin Finish

1st Coat: S-W Wood Classics 250 Stains

2nd Coat: S-W Wood Classics Waterbased Polyurethane Varnish Satin, A68 Series

3rd Coat: S-W Wood Classics Waterbased Polyurethane Varnish Satin, A68 Series

(4 mils wet, 1.0 mil dry per coat)

H. DRYWALL - (Walls, Ceilings, Gypsum Board, etc.)

1. Latex Systems

a. Semi-Gloss Finish

1st Coat: S-W Harmony Interior Latex Primer, B11

(4 mils wet, 1.3 mils dry)

2nd Coat: S-W Harmony Interior Latex Semi-Gloss, B10 Series

3rd Coat: S-W Harmony Interior Latex Semi-Gloss, B10 Series

(4 mils wet, 1.6 mils dry per coat)

b. Eg-Shel Finish

1st Coat: S-W Harmony Interior Latex Primer, B11

(4 mils wet, 1.3 mils dry)

2nd Coat: S-W Harmony Interior Latex Eg-Shel, B9 Series

3rd Coat: S-W Harmony Interior Latex Eg-Shel, B9 Series

(4 mils wet, 1.7 mils dry per coat)

c. Low Sheen Finish

1st Coat: S-W Harmony Interior Latex Primer, B11

(4 mils wet, 1.3 mils dry)

2nd Coat: S-W ProMar 200 Zero VOC Latex Low Sheen Enamel, B24-2600 Series

3rd Coat: S-W ProMar 200 Zero VOC Latex Low Sheen Enamel, B24-2600 Series

(4 mils wet, 1.6 mils dry per coat)

d. Flat Finish

1st Coat: S-W Harmony Interior Latex Primer, B11

(4 mils wet, 1.3 mils dry)

2nd Coat: S-W Harmony Interior Latex Flat, B5 Series

3rd Coat: S-W Harmony Interior Latex Flat, B5 Series

(4 mils wet, 1.8 mils dry per coat)

2. Epoxy System (Water Base)

a. Gloss Finish

1st Coat: S-W Harmony Interior Latex Primer, B11

(4 mils wet, 1.3 mils dry)

2nd Coat: S-W Pro Industrial Water Based Catalyzed Epoxy Gloss, B73-300 Series

3rd Coat: S-W Pro Industrial Water Based Catalyzed Epoxy Gloss, B73-300 Series

(2.0- 4 mils dry per coat)

b. Semi -Gloss Finish

1st Coat: S-W Harmony Interior Latex Primer, B11

(4 mils wet, 1.3 mils dry)

2nd Coat: S-W Waterbased Catalyzed Epoxy Semi-Gloss, B70W211/ B60V25

3rd Coat: S-W Waterbased Catalyzed Epoxy Semi-Gloss, B70W211/ B60V25

(2.5 - 3 mils dry per coat)

c. Eg-Shel Finish

1st Coat: S-W Harmony Interior Latex Primer, B11

(4 mils wet, 1.3 mils dry)

2nd Coat: S-W Pro Industrial Water Based Catalyzed Epoxy Eg-Shel, B73-360 Series

3rd Coat: S-W Pro Industrial Water Based Catalyzed Epoxy Eg-Shel, B73-360 Series

2.3 (2.0- 4 mils dry per coat)SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
1. Concrete: 12 percent.
  2. Masonry (Clay and CMU): 12 percent.
  3. Wood: 15 percent.
  4. Gypsum Board: 12 percent.
  5. Plaster: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

- D. Plaster Substrates: Verify that plaster is fully cured.
- E. Spray-Textured Ceiling Substrates: Verify that surfaces are dry.
- F. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- G. Proceed with coating application only after unsatisfactory conditions have been corrected.
  - 1. Application of coating indicates acceptance of surfaces and conditions.

### 3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
  - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
  - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceed that permitted in manufacturer's written instructions.
- F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer.
  - 1. SSPC-SP 2, "Hand Tool Cleaning."
  - 2. SSPC-SP 3, "Power Tool Cleaning."
  - 3. SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
  - 4. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."
- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

- H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- I. Aluminum Substrates: Remove loose surface oxidation.
- J. Wood Substrates:
  - 1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
  - 2. Sand surfaces that will be exposed to view, and dust off.
  - 3. Prime edges, ends, faces, undersides, and backsides of wood.
  - 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- K. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

### 3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
  - 1. Use applicators and techniques suited for paint and substrate indicated.
  - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
  - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
  - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
  - 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

### 3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

### 3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

END OF SECTION

## **SECTION 15010 - MECHANICAL GENERAL REQUIREMENTS**

### **PART 1 - GENERAL**

#### **1.1 GENERAL**

- A. Drawings and general provisions of contract, including General and Supplementary Conditions, and Division 1 Specification Section apply to this and other sections of Division 15.
- B. Before submitting his proposal, each bidder shall examine all plans and specifications relating to the work, visit the site(s) of the proposed project, and become fully informed of the extent and character of the work required.

#### **1.2 REFERENCE STANDARDS**

- A. Perform all Division 15 work in strict accordance with the Laws and Regulations of the State of Texas, and County and City codes/ordinances having jurisdiction over the project.

#### **1.3 COORDINATION**

- A. Coordinate work under this Division to avoid conflicts and to attain satisfactory and complementary systems.
- B. Coordinate work under this Division with work under other Divisions to avoid conflicts and to allow for adequate installation, maintenance, and operating space. Obtain the Architect's approval for penetrations of other parts of the Work prior to affecting them.
- C. Prepare coordination drawings in accordance with Division 1 to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the work.

#### **1.4 DEFINITIONS**

Specific meanings used in Division 15 (variant forms are inferred):

- A. Work: This project, or the reference part.
- B. Provide:
  - 1. Furnish and install, complete with necessary appurtenances.
  - 2. "Provide" is implied throughout this Division unless language is specific.
- C. Required: Required by the contract Documents.
- D. Necessary: Necessary in order to obtain a finished system in satisfactory operating condition, and meeting all requirements.

- E. Furnish: Procure and deliver, ready for installation, necessary and/or required.
- F. Install: Receive, place securely, ready for connection to work specified elsewhere, and bring into satisfactory operating condition, as necessary and/or required.
- G. Connect: Connect properly to mechanical work. This includes non-physical “connections” such as indirect waste drains.
- H. Architect, Project Architect or Architect/Engineer Team.

#### 1.5 SCOPE OF WORK

- A. The work under this Division includes providing complete mechanical systems for the project.
- B. All items of labor, material or equipment not required in detail by the specifications or plans, but incidental to, or necessary for the complete installation and proper operation of all phases of work described herein, or reasonably implied in connection therewith, shall be furnished as if called for in detail by the Contract Documents.

#### 1.6 WORKMANSHIP

- A. All labor shall be performed in a workmanlike manner by mechanics skilled in their particular trades. All installations shall be complete in both effectiveness and appearance whether finally enclosed or left exposed. The architect reserves the right to direct the removal or replacement of any item which in his opinion shall not present a reasonable neat or workmanlike appearance, providing that same can be properly installed in an orderly way.

#### 1.7 MANUFACTURER’S INSTRUCTIONS

- A. All equipment and devices shall be installed in accordance with the plans and specifications, manufacturer’s instructions and applicable codes. Contractor shall obtain written recommendations of installation and start-up instructions from material vendors and comply, unless otherwise required. Bring discrepancies between these instructions and project requirements to the attention of the Architect, and resolve prior to construction. Provide signed inspection report by manufacturer’s representative at system start-up to verify all is in compliant for product warranty.

#### 1.8 WARRANTY

- A. The contractor shall warranty his work against defective materials and workmanship for a period of 1-year from date of acceptance of the job.

#### 1.9 TRAINING

- A. Upon completion of the work and at a time designated by the Owner's representative, provide a formal training session for the Owner's operating personnel to include location, operation, and maintenance of all mechanical equipment and systems.

#### 1.10 PERMITS AND FEES

- A. Permits: Obtain special permits necessary for this portion of the Work.
- B. Fees: Pay any fees associated with permits, required inspections, and permanent utility connections to this part of the work.

#### 1.11 LICENSES

- A. Work under this Division shall be performed by organizations and individuals holding a current license to perform such type of work by the authority having jurisdiction. "License" in this sense means any process, regardless of its appellation, which is normally mandated by the authority in order to perform such type of work within its jurisdiction. The stipulation of this paragraph applies even if the work is located physically on property owned or controlled by a higher authority. E.G., to work within the city limits of Corpus Christi, Texas, on a Federal project, State of Texas and City of Corpus Christi licenses which would be mandated to work on a private project shall be required even though the City and State may have no jurisdiction over the higher government.
- B. In the event that the licensed organization loses its license or is unable to obtain one, or the licensed individual performing the work becomes unlicensed or departs the organization, notify Architect immediately in writing.

#### 1.12 UTILITY COORDINATION

- A. Permanent: Provide all ancillary work necessary to obtain utility connections. Pay connection fees. Arrange for connection in a timely manner. Coordinate time and arrangement of other work with the serving utility, and comply with utility standards.
- B. Temporary: Refer to Division 1.
- C. General: The contractor shall verify to his own satisfaction the location, elevation and availability of all utilities and services required, and shall adequately inform himself as to their relation to the work. The contractor shall also verify location, conduct all necessary tests, inspections, coordinate with owner's representatives and utilities, and check or existing underground utilities and lines before ditching. Repair of any cut or damaged lines or utilities shall be the sole responsibility of the contractor.

#### 1.13 LISTING AND LABELING



Materials required to be listed shall be listed and labeled for the particular service if a listing is available. Obtain and comply with the terms of listings. Listed material include.

- A. NSF: Potable water and sanitary waste systems components.
- B. UL: Electrical materials.
- C. AMCA: Air moving devices and related accessory items.
- D. ARI: HVAC equipment.
- E. FM or UL: Hazardous fluid and fire protection system components.
- F. FIA, FM or AGA: Fuel gas system components.

#### 1.14 MATERIALS AND EQUIPMENT

- A. All materials and equipment shall be new. Products shall be currently manufactured.
- B. All materials and equipment shall be clearly marked, stamped or labeled for identification. Do not obscure nameplates. Where manufactures nameplates do not meet the requirements of the mechanical identification specification provide nameplates in accordance with the specification.
- C. All products of similar type shall be provided by a single manufacturer throughout the project.

#### 1.15 SUBMITTALS AND REVIEW

- A. Contractor shall furnish to the Architect, within a reasonable time after award of contract, and prior to commencing any work, complete brochures in quadruplicate (plus quantity required by the Contractor) of all materials and equipment which the contractor proposes to furnish on the project. Data shall include descriptive literature, performance data, diagrams, capacity information, etc., to substantiate that proposed equipment will meet all of the requirements of the plans and specifications.
- B. All data must be checked and any required changes noted thereon by the contractor, signed and dated prior to furnishing same to the Architect for approval. Contractor's attention is directed that it is mandatory that he thoroughly review data prior to furnishing same to assure that equipment is in accordance with plans and specifications and to assure prompt return of the data.
- C. Deviations: Specifically call to the attention of the Architect every proposed deviation from the Contract Document requirements. Failure to identify deviations as such constitutes a representation that all requirements are not met.
- D. Review: Review of submittals shall not be constructed as releasing the Contractor from responsibility, but rather as a means to facilitate coordination of the work and the

proper selection and installation of the products. All work shall be subject to final acceptance by the Architect at the completion of the project.

- E. If above information is not provided complete as specified above and within the allocated time, all equipment shall be furnished exactly as specified without any substitutions.

#### 1.16 SUBSTITUTIONS

- A. Refer to the Conditions of the Contract.
- B. Where one vendor is indicated for a product, it is to establish a level of quality and performance; provide a product equal to that product in all respects from a vendor of equivalent performance.
- C. Where multiple vendors are indicated for a product, any of those vendors meeting the requirements may be submitted.
- D. Some product specifications in this Division are of the Acceptable Manufacturer type. Vendors listed as Acceptable Manufacturers are acceptable as vendors. However, the product submitted is subject to review as being fully equivalent in detail to the basis of design.
- E. Where multiple vendors are listed with product model numbers, each model and vendor is acceptable, provide all requirements are met. Model numbers are indicated to the extent believe necessary to identify a type and are not necessary completely.
- F. The architectural/engineering team has designed the facility using requirements of the Basis of Design equipment. Any substitutions from the basis of design, which will require additional A/E design and/or coordination, shall include the cost of necessary redesign by professionals licensed in the respective disciplines and the approval of the professional of record.

#### 1.17 DRAWINGS AND SPECIFICATIONS

- A. These specifications are accompanied by Drawings. The Drawings and Specifications are complementary each to the other, and what is called for by one shall be as binding as if called for by both.
- B. The Drawings are generally diagrammatic. Lay out work at the site to conform to existing conditions; architectural, structural, mechanical, and electrical conditions; to avoid all obstructions; and to conform to details of installation as required. Provide an integrated satisfactorily operating installation. All necessary offsets in piping, fittings, duct, etc., required to avoid interferences between piping, equipment, architectural, and

structural elements shall be provided by the Contractor. Provide all necessary routing and offsets to avoid conflict.

- C. Verify and arrange that sufficient space is provided for the installation of proposed products and that adequate access will exist for service and maintenance of equipment. For this work, adequate access shall be defined as meaning that service personnel can access and maintain a piece of equipment without having to alter permanent construction. Further, for equipment located above ceilings, access shall be available within 3 feet of ceiling opening or lay-in ceiling.

#### 1.18 COMPLEMENTARY DOCUMENTS

- A. Contract documents are complementary; requirements are not necessarily repetitively stated at each possible subject; consider that a requirement applies wherever applicable.
- B. In the event of conflicting requirements in different parts of the Documents, the more expensive shall be presumed to apply, unless the Architect clarifies the requirement in a less expensive manner and waives the more expensive requirement in writing.  
Since codes and standards are incorporated by reference, a particular conflict may appear in that a reference may use language that implies that a particular requirement in the Construction Documents is waived under the reference. This is not the case, unless specifically so clarified by the Architect. Generally, the specific Drawings and Specifications take precedence over waivers in multi-purpose reference documents.
- C. Because of licensure and workmanship requirements, persons performing the work are presumed to be familiar with applicable codes, ordinances, laws, regulations and standards. Therefore, details of materials, methods, arrangements and size contained in such publications are not necessarily replicated in the Contract Documents. This in no way deletes the requirement of the Contractor to comply. In the event of an apparent conflict between such publications and the Contract Documents, request clarification from the Architect prior to construction.

#### 1.19 PROTECTION

- A. All work, equipment and materials shall be protected at all times to prevent damage or breakage either in transit, storage, installation or testing. All openings shall be closed with caps or plugs during installation. All materials and equipment shall be covered and protected against dirt, water, chemicals or mechanical injury.

#### 1.20 CUTTING AND PATCHING

- A. All subcontractors shall notify the General Contractor sufficiently ahead of construction of any floor, walls, ceiling, roof, etc., of any openings that will be required for his work. All necessary cutting of walls, floors, partitions, ceilings, etc., as required for the proper installation of the work under this Contract shall be done at the Subcontractor's expense in a neat and workmanlike manner.

#### 1.21 DEMOLITION

- A. It shall be the responsibility of the contractor to see that all demolition and remodeling work involving his trade is accomplished in a manner and completeness to provide the appearance of new construction work.
- B. Coordinate with other divisions before commencing work.
- C. Abandoned air conditioning units shall be removed and disposed of off site in a legal manner.
- D. All abandoned and/or otherwise unused piping shall be securely capped using materials of the same composition as the original piping.

#### 1.22 RECORD DOCUMENTS

- A. Drawings: The Contractor shall maintain and update daily a set of "blueprint" prints in the Field Office for the sole purpose of recording "installed" conditions. Revise the drawings to reflect as-built conditions, including all addenda, change orders, final shop drawing reviews, and field routing. Underground utilities shall be dimensionally located relative to readily accessible and identifiable permanent reference points, with accurate slope and elevation indicated. Submit prints for review. Revise, certify accuracy, and provide two final sets to the Architect.
- B. Owner's Manual: Prior to final acceptance, provide two bound volumes to the Architect. Index by subject. Include corrected submittals and shop drawings that reflect final review comments; installation, operation and maintenance instructions, parts lists, wiring diagrams, and piping diagrams; warranties.

#### 1.23 INSPECTION, OBSERVATION, AND TESTING

- A. Cooperate with Architect's representative and authorities having jurisdiction. Provide complete access to the work at reasonable times.
- B. Cover-up: Prior to covering up work, or conducting observed tests, request observation as appropriate. Provide adequate advance notice defined as a minimum of five working days. In some cases the Architect's representative may waive observation; otherwise arrange for observed construction and testing prior to cover-up.

Should minimize required notice not to be provided and the contractor covers up work requiring observation, such work shall be uncovered at contractor's expense.

- C. Pre-Testing: Self-inspect, pre-test, and remedy work prior to performing observed test.
- D. Sectional Work: In circumstances where a requirement for phased construction or other considerations dictate sectional construction and/or testing, notify the Architect when construction begins on the first section of a system, and when the first section will be ready for observed testing, as well as subsequent sections. Test in the largest practical sections.

#### 1.24 WORK PERFORMED UNDER OTHER DIVISIONS

- A. Refer to Division 2 for piped utilities beyond 5 feet from the building.
- B. Refer to Division 16 for power wiring systems external to equipment and control panels; starters in motor centers; safety switches not integral to equipment or starters provided under Division 15.
- C. Refer to Division 14 for kitchen, laboratory, medical and like equipment.

#### 1.25 REFERENCE TO OTHER DIVISIONS

- A. Refer to Division 16 for additional material requirements of electrical components provided under Division 15, such as loose starters, wiring and devices integral to equipment.
- B. Refer to Division 2 for additional requirements governing excavation and backfill, supplemental to the requirements stated in this Division 15.
- C. Comply with all requirements applicable to work required under this Division.

#### 1.26 TESTING SERVICES

- A. Additional Testing: In addition to any specified testing, the Architect may cause additional testing to be performed by an independent testing laboratory or any other qualified party. If such testing reveals deficient work by the Contractor, the Contractor shall pay for both the testing and remedial work. If such testing does not reveal deficient work by the Contractor, the Owner shall pay for the testing and the cost of repairing any damage caused by such testing.
- B. Specified Testing Services: If independent testing services are specified regarding work under this Division, cooperate fully with the testing agency. Provide access to the work. Provide test holes and taps necessary. Remove work that is not tested on site, deliver to testing agency, and reinstall if undamaged; replace if damaged. Provide utilities, operational capability, and facilities for on-site testing as necessary.

#### 1.27 WORK BY OWNER

- A. The owner will award contracts on work which includes:
  - 1. None.

#### 1.28 OWNER FURNISHED PRODUCTS

- A. Products furnished to the site and paid for by the Owner.
  - 1. None.

END OF SECTION 15010

## SECTION 15050 - MECHANICAL MATERIALS AND METHODS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following basic mechanical materials and methods to complement other Division 15 Sections.

1. Piping materials and installation instructions common to most piping systems.
2. Concrete base construction requirements.
3. Escutcheons.
4. Dielectric fittings.
5. Flexible connectors.
6. Mechanical sleeve seals.
7. Equipment nameplate data requirements.
8. Labeling and identifying mechanical systems and equipment is specified in Division 15 Section "Mechanical Identification."
9. Nonshrink grout for equipment installations.
10. Field-fabricated metal and wood equipment supports.
11. Installation requirements common to equipment specification sections.
12. Mechanical demolition.
13. Cutting and patching.
14. Touchup painting and finishing.

- B. Pipe and pipe fitting materials are specified in Division 15 piping system Sections.

#### 1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
  - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
  - 2. CPVC: Chlorinated polyvinyl chloride plastic.
  - 3. NP: Nylon plastic.
  - 4. PE: Polyethylene plastic.
  - 5. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
  - 1. CR: Chlorosulfonated polyethylene synthetic rubber.
  - 2. EPDM: Ethylene propylene diene terpolymer rubber.

#### 1.4 SUBMITTALS

- A. Product Data Book: Submit product data for all Division 15 items in a single reinforced 3-ring binder. Organize product data by specification section number. Provide table of contents showing the following:
  - 1. Specification Section
  - 2. Description of item
  - 3. Submission number (1st submission, 2nd submission, etc.)
  - 4. Submittal status (Approved, Revise and Resubmit, etc.)
- B. Product Data: For dielectric fittings, flexible connectors, mechanical sleeve seals, and identification materials and devices.
- C. Shop Drawings: Detail fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.
- D. Coordination Drawings: For access panel and door locations.
- E. Coordination Drawings: Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
  - 1. Planned piping layout, including valve and specialty locations and valve-stem movement.
  - 2. Clearances for installing and maintaining insulation.
  - 3. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
  - 4. Equipment and accessory service connections and support details.
  - 5. Exterior wall and foundation penetrations.
  - 6. Fire-rated wall and floor penetrations.
  - 7. Sizes and location of required concrete pads and bases.



8. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
  9. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
  10. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.
- F. Samples: Of color, lettering style, and other graphic representation required for each identification material and device.

#### 1.5 QUALITY ASSURANCE

- A. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.
- B. Equipment Selection: Equipment of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. Additional costs shall be approved in advance by appropriate Contract Modification for these increases. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design and commissioning requirements.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.
- C. Protect flanges, fittings, and piping specialties from moisture and dirt.
- D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

#### 1.7 SEQUENCING AND SCHEDULING

- A. Coordinate mechanical equipment installation with other building components.
- B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
- C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.

- D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.
- E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- F. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors."
- G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Dielectric Unions:
    - a. Capitol Manufacturing Co.
    - b. Central Plastics Co.
    - c. Eclipse, Inc.; Rockford-Eclipse Div.
    - d. Epco Sales Inc.
    - e. Hart Industries International, Inc.
    - f. Watts Industries, Inc.; Water Products Div.
    - g. Zurn Industries, Inc.; Wilkins Div.
  - 2. Dielectric Flanges:
    - a. Capitol Manufacturing Co.
    - b. Central Plastics Co.
    - c. Epco Sales Inc.
    - d. Watts Industries, Inc.; Water Products Div.
  - 3. Dielectric-Flange Insulating Kits:
    - a. Calpico, Inc.
    - b. Central Plastics Co.
  - 4. Dielectric Couplings:

- a. Calpico, Inc.
  - b. Lochinvar Corp.
5. Dielectric Nipples:
- a. Grinnell Corp.; Grinnell Supply Sales Co.
  - b. Perfection Corp.
  - c. Victaulic Co. of America.
6. Metal, Flexible Connectors:
- a. ANAMET Industrial, Inc.
  - b. Central Sprink, Inc.
  - c. Flexicraft Industries.
  - d. Flex-Weld, Inc.
  - e. Grinnell Corp.; Grinnell Supply Sales Co.
  - f. Hyspan Precision Products, Inc.
  - g. McWane, Inc.; Tyler Pipe; Gustin-Bacon Div.
  - h. Mercer Rubber Co.
  - i. Metraflex Co.
  - j. Proco Products, Inc.
  - k. Uniflex, Inc.
7. Rubber, Flexible Connectors:
- a. General Rubber Corp.
  - b. Mercer Rubber Co.
  - c. Metraflex Co.
  - d. Proco Products, Inc.
  - e. Red Valve Co., Inc.
  - f. Uniflex, Inc.
8. Mechanical Sleeve Seals:
- a. Calpico, Inc.
  - b. Metraflex Co.
  - c. Thunderline/Link-Seal.

## 2.2 PIPE AND PIPE FITTINGS

- A. Refer to individual Division 15 piping Sections for pipe and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

## 2.3 JOINING MATERIALS

- A. Refer to individual Division 15 piping Sections for special joining materials not listed below.

- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, unless thickness or specific material is indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
  2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32.
1. Alloy Sn95 or Alloy Sn94: Approximately 95 percent tin and 5 percent silver, with 0.10 percent lead content.
  2. Alloy E: Approximately 95 percent tin and 5 percent copper, with 0.10 percent maximum lead content.
  3. Alloy HA: Tin-antimony-silver-copper zinc, with 0.10 percent maximum lead content.
  4. Alloy HB: Tin-antimony-silver-copper nickel, with 0.10 percent maximum lead content.
  5. Alloy Sb5: 95 percent tin and 5 percent antimony, with 0.20 percent maximum lead content.
- F. Brazing Filler Metals: AWS A5.8.
1. BCuP Series: Copper-phosphorus alloys.
  2. BAg1: Silver alloy.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements: Manufacturer's standard solvent cements for the following:
1. ABS Piping: ASTM D 2235.
  2. CPVC Piping: ASTM F 493.
  3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
  4. PVC to ABS Piping Transition: ASTM D 3138.
- I. Plastic Pipe Seals: ASTM F 477, elastomeric gasket.
- J. Flanged, Ductile-Iron Pipe Gasket, Bolts, and Nuts: AWWA C110, rubber gasket, carbon-steel bolts and nuts.

- K. Couplings: Iron-body sleeve assembly, fabricated to match OD of plain-end, pressure pipes.
  - 1. Sleeve: ASTM A 126, Class B, gray iron.
  - 2. Followers: ASTM A 47 malleable iron or ASTM A 536 ductile iron.
  - 3. Gaskets: Rubber.
  - 4. Bolts and Nuts: AWWA C111.
  - 5. Finish: Enamel paint.

## 2.4 DIELECTRIC FITTINGS

- A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.
- B. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.
- C. Insulating Material: Suitable for system fluid, pressure, and temperature.
- D. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- F. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
  - 1. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure as required to suit system pressures.
- G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- H. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

## 2.5 FLEXIBLE CONNECTORS

- A. General: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections. Include 125-psig minimum working-pressure rating, unless higher working pressure is indicated, and ends according to the following:
  - 1. 2-Inch NPS and Smaller: Threaded.
  - 2. 2-1/2-Inch NPS and Larger: Flanged.
  - 3. Option for 2-1/2-Inch NPS and Larger: Grooved for use with keyed couplings.

- B. Bronze-Hose, Flexible Connectors: Corrugated, bronze, inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to hose.
- C. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.
- D. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.
- E. Rubber, Flexible Connectors: CR or EPDM elastomer rubber construction, with multiple plies of NP fabric, molded and cured in hydraulic presses. Include 125-psig minimum working-pressure rating at 220 deg F. Units may be straight or elbow type, unless otherwise indicated.

## 2.6 MECHANICAL SLEEVE SEALS

- A. Description: Modular design, with interlocking rubber links shaped to continuously fill annular space between pipe and sleeve. Include connecting bolts and pressure plates.

## 2.7 PIPING SPECIALTIES

- A. Sleeves: The following materials are for wall, floor, slab, and roof penetrations:
  1. Steel Sheet Metal: 0.0239-inch minimum thickness, galvanized, round tube closed with welded longitudinal joint.
  2. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends.
  3. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
  4. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
    - a. Underdeck Clamp: Clamping ring with set screws.
  5. PVC: Manufactured, permanent, with nailing flange for attaching to wooden forms.
  6. PVC Pipe: ASTM D 1785, Schedule 40.
  7. PE: Manufactured, reusable, tapered, cup shaped, smooth outer surface, with nailing flange for attaching to wooden forms.
- B. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type if required to conceal protruding fittings and sleeves.
  1. ID: Closely fit around pipe, tube, and insulation of insulated piping.
  2. OD: Completely cover opening.
  3. Cast Brass: One piece, with set screw.

- a. Finish: Rough brass.
  - b. Finish: Polished chrome-plate.
4. Cast Brass: Split casting, with concealed hinge and set screw.
- a. Finish: Rough brass.
  - b. Finish: Polished chrome-plate.
5. Stamped Steel: One piece, with set screw and chrome-plated finish.
6. Stamped Steel: One piece, with spring clips and chrome-plated finish.
7. Stamped Steel: Split plate, with concealed hinge, set screw, and chrome-plated finish.
8. Stamped Steel: Split plate, with concealed hinge, spring clips, and chrome-plated finish.
9. Stamped Steel: Split plate, with exposed-rivet hinge, set screw, and chrome-plated finish.
10. Stamped Steel: Split plate, with exposed-rivet hinge, spring clips, and chrome-plated finish.
11. Cast-Iron Floor Plate: One-piece casting.

## 2.8 IDENTIFYING DEVICES AND LABELS

- A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 15 Sections. If more than one type is specified for application, selection is Installer's option, but provide one selection for each product category.
- B. Equipment Nameplates: Metal nameplate with operational data engraved or stamped; permanently fastened to equipment.
- 1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data.
  - 2. Location: Accessible and visible location.
- C. Stencils: Standard stencils, prepared for required applications with letter sizes complying with recommendations of ASME A13.1 for piping and similar applications, but not less than 1-1/4-inch- high letters for ductwork and not less than 3/4-inch- high letters for access door signs and similar operational instructions.
- 1. Material: Fiberboard.
  - 2. Material: Brass.
  - 3. Stencil Paint: Standard exterior-type stenciling enamel; black, unless otherwise indicated; either brushing grade or pressurized spray-can form and grade.
  - 4. Identification Paint: Standard identification enamel of colors indicated or, if not otherwise indicated for piping systems, comply with ASME A13.1 for colors.
- D. Snap-on Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid, snap on, color-coded, complying with ASME A13.1.

- E. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, permanent adhesive, color-coded, pressure-sensitive vinyl, complying with ASME A13.1.
- F. Plastic Duct Markers: Manufacturer's standard color-coded, laminated plastic. Comply with the following color code:
1. Green: Cold air.
  2. Yellow: Hot air.
  3. Yellow/Green or Green: Supply air.
  4. Blue: Exhaust, outside, return, and mixed air.
  5. For hazardous exhausts, use colors and designs recommended by ASME A13.1.
  6. Nomenclature: Include the following:
    - a. Direction of airflow.
    - b. Duct service.
    - c. Duct origin.
    - d. Duct destination.
    - e. Design cubic feet per meter.
- G. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated.
1. Fabricate in sizes required for message.
  2. Engraved with engraver's standard letter style, of sizes and with wording to match equipment identification.
  3. Punch for mechanical fastening.
  4. Thickness: 1/16 inch, unless otherwise indicated.
  5. Thickness: 1/8 inch, unless otherwise indicated.
  6. Thickness: 1/16 inch, for units up to 20 sq. in. or 8 inches long; 1/8 inch for larger units.
  7. Fasteners: Self-tapping stainless-steel screws or contact-type permanent adhesive.
- H. Plastic Equipment Markers: Color-coded, laminated plastic. Comply with the following color code:
1. Green: Cooling equipment and components.
  2. Yellow: Heating equipment and components.
  3. Yellow/Green: Combination cooling and heating equipment and components.
  4. Brown: Energy reclamation equipment and components.
  5. Blue: Equipment and components that do not meet any criteria above.
  6. For hazardous equipment, use colors and designs recommended by ASME A13.1.
  7. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
    - a. Name and plan number.
    - b. Equipment service.
    - c. Design capacity.



- d. Other design parameters such as pressure drop, entering and leaving conditions, and rpm.
- 8. Size: Approximate 2-1/2 by 4 inches for control devices, dampers, and valves; and 4-1/2 by 6 inches for equipment.
- I. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification, with corresponding designations indicated. Use numbers, lettering, and wording indicated for proper identification and operation/maintenance of mechanical systems and equipment.
  - 1. Multiple Systems: If multiple systems of same generic name are indicated, provide identification that indicates individual system number and service such as "Boiler No. 3," "Air Supply No. 1H," or "Standpipe F12."

## 2.9 GROUT

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

## PART 3 - EXECUTION

### 3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. General: Install piping as described below, unless piping Sections specify otherwise. Individual Division 15 piping Sections specify unique piping installation requirements.
- B. General Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved on Coordination Drawings.
- C. Install piping at indicated slope.
- D. Install components with pressure rating equal to or greater than system operating pressure.
- E. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.
- F. Install piping free of sags and bends.

- G. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.
- H. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.
- I. Install piping to allow application of insulation plus 1-inch clearance around insulation.
- J. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
- K. Install fittings for changes in direction and branch connections.
- L. Install couplings according to manufacturer's written instructions.
- M. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:
  - 1. Chrome-Plated Piping: Cast brass, one piece, with set screw, and polished chrome-plated finish. Use split-casting escutcheons if required, for existing piping.
  - 2. Uninsulated Piping Wall Escutcheons: Cast brass or stamped steel, with set screw.
  - 3. Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.
  - 4. Insulated Piping: Cast brass or stamped steel; with concealed hinge, spring clips, and chrome-plated finish.
  - 5. Piping in Utility Areas: Cast brass or stamped steel, with set-screw or spring clips.
- N. Sleeves are not required for core drilled holes.
- O. Permanent sleeves are not required for holes formed by PE removable sleeves.
- P. Install sleeves for pipes passing through concrete and masonry walls, and concrete floor and roof slabs.
- Q. 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 above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  - 2. Build sleeves into new walls and slabs as work progresses.
  - 3. Install sleeves large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
    - a. PVC Pipe Sleeves: For pipes smaller than 6-inch NPS.

- b. Steel Pipe Sleeves: For pipes smaller than 6-inch NPS.
  - c. Steel, Sheet-Metal Sleeves: For pipes 6-inch NPS and larger, penetrating gypsum-board partitions.
  - d. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
    - 1) Seal space outside of sleeve fittings with nonshrink, nonmetallic grout.
4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants. Refer to Division 7 Section "Joint Sealants" for materials.
  5. Use Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant, unless otherwise indicated.
- R. Aboveground, Exterior-Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
  2. Install cast-iron "wall pipes" for sleeves 6 inches in diameter and larger.
  3. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.
- S. Underground, Exterior-Wall, Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.
- T. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping materials. Refer to Division 7 Section "Firestopping" for materials.
- U. Verify final equipment locations for roughing-in.
- V. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- W. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping specification Sections:
1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
  2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

3. Soldered Joints: Construct joints according to AWS's "Soldering Manual," Chapter "The Soldering of Pipe and Tube"; or CDA's "Copper Tube Handbook."
4. Soldered Joints: Construct joints according to AWS's "Soldering Manual," Chapter "The Soldering of Pipe and Tube."
5. Soldered Joints: Construct joints according to CDA's "Copper Tube Handbook."
6. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
7. 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:
  - a. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
  - b. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
  - c. Align threads at point of assembly.
  - d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
  - e. 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.
8. Welded Joints: Construct joints according to AWS D10.12, "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe," using qualified processes and welding operators according to "Quality Assurance" Article.
9. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.
10. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join pipe and fittings according to the following:
  - a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  - b. ABS Piping: ASTM D 2235 and ASTM D 2661.
  - c. CPVC Piping: ASTM D 2846 and ASTM F 493.
  - d. PVC Pressure Piping: ASTM D 2672.
  - e. PVC Nonpressure Piping: ASTM D 2855.
  - f. PVC to ABS Nonpressure Transition Fittings: Procedure and solvent cement according to ASTM D 3138.
11. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657 procedures and manufacturer's written instructions.
  - a. Plain-End Pipe and Fittings: Use butt fusion.
  - b. Plain-End Pipe and Socket Fittings: Use socket fusion.

- X. Piping Connections: Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping 2-inch NPS and smaller, adjacent to each valve and at final connection to each piece of equipment with 2-inch NPS or smaller threaded pipe connection.
  2. Install flanges, in piping 2-1/2-inch NPS and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.
  3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
  4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

### 3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.
- B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- D. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- E. Install equipment giving right of way to piping installed at required slope.
- F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

### 3.3 LABELING AND IDENTIFYING

- A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.
  1. Stenciled Markers: According to ASME A13.1.
  2. Plastic markers, with application systems. Install on insulation segment if required for hot, uninsulated piping.
  3. Locate pipe markers as follows if piping is exposed in finished spaces, machine rooms, and accessible maintenance spaces, such as shafts, tunnels, plenums, and exterior nonconcealed locations:
    - a. Near each valve and control device.
    - b. Near each branch, excluding short takeoffs for fixtures and terminal units. Mark each pipe at branch, if flow pattern is not obvious.

- c. Near locations if pipes pass through walls, floors, ceilings, or enter nonaccessible enclosures.
  - d. At access doors, manholes, and similar access points that permit view of concealed piping.
  - e. Near major equipment items and other points of origination and termination.
  - f. Spaced at maximum of 50-foot intervals along each run. Reduce intervals to 25 feet in congested areas of piping and equipment.
  - g. On piping above removable acoustical ceilings, except omit intermediately spaced markers.
- B. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of mechanical equipment.
- 1. Lettering Size: Minimum 1/4-inch- high lettering for name of unit if viewing distance is less than 24 inches, 1/2-inch- high lettering for distances up to 72 inches, and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
  - 2. Text of Signs: Provide name of identified unit. Include text to distinguish between multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
- C. Duct Systems: Identify air supply, return, exhaust, intake, and relief ducts with duct markers; or provide stenciled signs and arrows, showing duct system service and direction of flow.
- 1. Location: In each space, if ducts are exposed or concealed by removable ceiling system, locate signs near points where ducts enter into space and at maximum intervals of 50 feet.
- D. Adjusting: Relocate identifying devices as necessary for unobstructed view in finished construction.

### 3.4 PAINTING AND FINISHING

- A. Refer to Division 9 Section "Painting" for paint materials, surface preparation, and application of paint.
- B. Apply paint to exposed piping according to the following, unless otherwise indicated:
- 1. Interior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
  - 2. Interior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
  - 3. Interior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
  - 4. Exterior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.
  - 5. Exterior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.

6. Exterior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.

C. Do not paint piping specialties with factory-applied finish.

D. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

### 3.5 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."

### 3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS D1.1, "Structural Welding Code--Steel."

### 3.7 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

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

### 3.8 DEMOLITION

A. Disconnect, demolish, and remove Work specified in Division 15 Sections.

B. If pipe, ductwork, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.

C. Accessible Work: Remove indicated exposed pipe and ductwork in its entirety.

D. Work Abandoned in Place: Cut and remove underground pipe a minimum of 2 inches beyond face of adjacent construction. Cap and patch surface to match existing finish.

E. Removal: Remove indicated equipment from Project site.

- F. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

### 3.9 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair cut surfaces to match adjacent surfaces.

### 3.10 GROUTING

- A. Install nonmetallic, nonshrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's written instructions.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placing of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases to provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout according to manufacturer's written instructions.

END OF SECTION 15050



## SECTION 15067 - HANGERS AND SUPPORTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following hangers and supports for HVAC system piping and equipment:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Equipment supports.

- B. Related Sections include the following:

1. Division 5 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 13 Section "Fire-Suppression Piping" for pipe hangers for fire-protection piping.
3. Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
4. Division 15 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
5. Division 15 Section(s) "Metal Ducts" for duct hangers and supports.

#### 1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

## 1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Design seismic-restraint hangers and supports for piping and equipment.

## 1.5 SUBMITTALS

- A. Product Data: For the following:
  - 1. Steel pipe hangers and supports.
  - 2. Fiberglass pipe hangers.
  - 3. Thermal-hanger shield inserts.
  - 4. Powder-actuated fastener systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
  - 1. Trapeze pipe hangers. Include Product Data for components.
  - 2. Metal framing systems. Include Product Data for components.
  - 3. Fiberglass strut systems. Include Product Data for components.
  - 4. Pipe stands. Include Product Data for components.
  - 5. Equipment supports.
- C. Welding certificates.

## 1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code—Steel"
- B. Welding: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1, "Structural Welding Code--Steel."

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

## 2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Available Manufacturers:
  1. AAA Technology & Specialties Co., Inc.
  2. Bergen-Power Pipe Supports.
  3. B-Line Systems, Inc.; a division of Cooper Industries.
  4. Carpenter & Paterson, Inc.
  5. Empire Industries, Inc.
  6. ERICO/Michigan Hanger Co.
  7. Globe Pipe Hanger Products, Inc.
  8. Grinnell Corp.
  9. GS Metals Corp.
  10. National Pipe Hanger Corporation.
  11. PHD Manufacturing, Inc.
  12. PHS Industries, Inc.
  13. Piping Technology & Products, Inc.
  14. Tolco Inc.
- C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

## 2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

## 2.4 FIBERGLASS PIPE HANGERS

- A. Clevis-Type, Fiberglass Pipe Hangers: Similar to MSS Type 1, steel pipe hanger except hanger is made of fiberglass and continuous-thread rod and nuts are made of polyurethane or stainless steel.

1. Available Manufacturers:
  - a. B-Line Systems, Inc.; a division of Cooper Industries.
  - b. Champion Fiberglass, Inc.
  - c. Cope, T. J., Inc.; Tyco International, Ltd.
  - d. Seasafe, Inc.
  - e. Unistrut Corp.; Tyco International, Ltd.
  - f. Wesanco, Inc.

B. Strap-Type, Fiberglass Pipe Hangers: Made of fiberglass loop with stainless-steel continuous-thread rod, nuts, and support hook.

1. Available Manufacturers:
  - a. Plasti-Fab, Inc.

## 2.5 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Available Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
3. GS Metals Corp.
4. Power-Strut Div.; Tyco International, Ltd.
5. Thomas & Betts Corporation.
6. Tolco Inc.
7. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

## 2.6 FIBERGLASS STRUT SYSTEMS

A. Description: Shop- or field-fabricated pipe-support assembly, similar to MFMA-3, made of fiberglass channels and other components.

B. Available Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Champion Fiberglass, Inc.
3. Cope, T. J., Inc.; Tyco International Ltd.
4. Seasafe, Inc.

## 2.7 THERMAL-HANGER SHIELD INSERTS

- A. Description: **100-psig- (690-kPa-)** minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Available Manufacturers:
  - 1. Carpenter & Paterson, Inc.
  - 2. ERICO/Michigan Hanger Co.
  - 3. PHS Industries, Inc.
  - 4. Pipe Shields, Inc.
  - 5. Rilco Manufacturing Company, Inc.
  - 6. Value Engineered Products, Inc.
- C. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend **2 inches (50 mm)** beyond sheet metal shield for piping operating below ambient air temperature.

## 2.8 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
  - 1. Available Manufacturers:
    - a. Hilti, Inc.
    - b. ITW Ramset/Red Head.
    - c. Masterset Fastening Systems, Inc.
    - d. MKT Fastening, LLC.
    - e. Powers Fasteners.
- B. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
  - 1. Available Manufacturers:
    - a. B-Line Systems, Inc.; a division of Cooper Industries.
    - b. Empire Industries, Inc.
    - c. Hilti, Inc.

- d. ITW Ramset/Red Head.
- e. MKT Fastening, LLC.
- f. Powers Fasteners.

## 2.9 PIPE STAND FABRICATION

- A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
  - 1. Available Manufacturers:
    - a. ERICO/Michigan Hanger Co.
    - b. MIRO Industries.
- C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
  - 1. Available Manufacturers:
    - a. MIRO Industries.
- D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
  - 1. Available Manufacturers:
    - a. ERICO/Michigan Hanger Co.
    - b. MIRO Industries.
    - c. Portable Pipe Hangers.
  - 2. Base: Stainless steel.
  - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
  - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
  - 1. Available Manufacturers:
    - a. Portable Pipe Hangers.
  - 2. Bases: One or more plastic.
  - 3. Vertical Members: Two or more protective-coated-steel channels.
  - 4. Horizontal Member: Protective-coated-steel channel.
  - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

## 2.10 EQUIPMENT SUPPORTS

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

## 2.11 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
  - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
  - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

## PART 3 - EXECUTION

### 3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).
  - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F (49 to 232 deg C) pipes, NPS 4 to NPS 16 (DN 100 to DN 400), requiring up to 4 inches (100 mm) of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, **NPS 3/4 to NPS 24 (DN 20 to DN 600)**, requiring clamp flexibility and up to **4 inches (100 mm)** of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, **NPS 1/2 to NPS 24 (DN 15 to DN 600)**, if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, **NPS 1/2 to NPS 4 (DN 15 to DN 100)**, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, **NPS 3/4 to NPS 8 (DN 20 to DN 200)**.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, **NPS 1/2 to NPS 8 (DN 15 to DN 200)**.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, **NPS 1/2 to NPS 8 (DN 15 to DN 200)**.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, **NPS 1/2 to NPS 2 (DN 15 to DN 50)**.
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, **NPS 3/8 to NPS 8 (DN 10 to DN 200)**.
11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, **NPS 3/8 to NPS 3 (DN 10 to DN 80)**.
12. U-Bolts (MSS Type 24): For support of heavy pipes, **NPS 1/2 to NPS 30 (DN 15 to DN 750)**.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes, **NPS 4 to NPS 36 (DN 100 to DN 900)**, with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, **NPS 4 to NPS 36 (DN 100 to DN 900)**, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, **NPS 2-1/2 to NPS 36 (DN 65 to DN 900)**, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, **NPS 1 to NPS 30 (DN 25 to DN 750)**, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, **NPS 2-1/2 to NPS 20 (DN 65 to DN 500)**, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes, **NPS 2 to NPS 42 (DN 50 to DN 1050)**, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, **NPS 2 to NPS 24 (DN 50 to DN 600)**, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, **NPS 2 to NPS 30 (DN 50 to DN 750)**, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.



- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, **NPS 3/4 to NPS 20 (DN 20 to DN 500)**.
  2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, **NPS 3/4 to NPS 20 (DN 20 to DN 500)**, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to **6 inches (150 mm)** for heavy loads.
  2. Steel Clevises (MSS Type 14): For **120 to 450 deg F (49 to 232 deg C)** piping installations.
  3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
  4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  5. Steel Weldless Eye Nuts (MSS Type 17): For **120 to 450 deg F (49 to 232 deg C)** piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  6. C-Clamps (MSS Type 23): For structural shapes.
  7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
  8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
  9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
  10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
  11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
  12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): **750 lb (340 kg)**.
    - b. Medium (MSS Type 32): **1500 lb (680 kg)**.
    - c. Heavy (MSS Type 33): **3000 lb (1360 kg)**.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
  15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
  2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed **1-1/4 inches (32 mm)**.
  3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
  4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
  5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
  6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
  7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
  8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    - a. Horizontal (MSS Type 54): Mounted horizontally.
    - b. Vertical (MSS Type 55): Mounted vertically.
    - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

- N. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

### 3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
  - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
  - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Fiberglass Pipe Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.
- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled fiberglass struts.
- F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- G. Fastener System Installation:
  - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
  - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- H. Pipe Stand Installation:
  - 1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
  - 2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 7 Section "Roof Accessories" for curbs.

- I. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- K. Install hangers and supports to allow controlled thermal 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.
- L. Install lateral bracing with pipe hangers and supports to prevent swaying.
- M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, **NPS 2-1/2 (DN 65)]** and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- N. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- P. 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 B31.1 for power piping and ASME B31.9 for building services piping.
  - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
    - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe **NPS 4 (DN 100)** and larger if pipe is installed on rollers.
  - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
    - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe **NPS 4 (DN 100)** and larger if pipe is installed on rollers.
  - 4. Shield Dimensions for Pipe: Not less than the following:

- a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
  - b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
  - c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
  - d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
  - e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
5. Pipes NPS 8 (DN 200) and Larger: Include wood inserts.
  6. Insert Material: Length at least as long as protective shield.
  7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

### 3.3 EQUIPMENT SUPPORTS

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

### 3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 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.

### 3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

### 3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 15067

## **SECTION 15077 – MECHANICAL IDENTIFICATION**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

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

#### **1.2 SUMMARY**

- A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Duct labels.
4. Stencils.
5. Valve tags.

#### **1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

#### **1.4 COORDINATION**

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

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT LABELS

#### A. Metal Labels for Equipment:

1. Material and Thickness: Stainless steel, 0.025-inch (0.64-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

#### B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

#### C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

#### D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.



## 2.2 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
  - 2. Lettering Size: At least 1-1/2 inches (38 mm) high.

## 2.3 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: White.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
  - 2. Lettering Size: At least 1-1/2 inches (38 mm) high.

## 2.4 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of **1-1/4 inches (32 mm)** for ducts; and minimum letter height of **3/4 inch (19 mm)** for access panel and door labels, equipment labels, and similar operational instructions.
1. Stencil Material: Fiberboard or metal.
  2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
  3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

## 2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with **1/4-inch (6.4-mm)** letters for piping system abbreviation and **1/2-inch (13-mm)** numbers.
1. Tag Material: Stainless steel, **0.025-inch (0.64-mm)** minimum thickness, and having predrilled or stamped holes for attachment hardware.
  2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. Valve Schedules: For each piping system, on **8-1/2-by-11-inch (A4)** bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.

## PART 3 - EXECUTION

### 3.1 PREPARATION

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

### 3.2 EQUIPMENT LABEL INSTALLATION

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

### 3.3 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
1. Near each valve and control device.
  2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
  4. At access doors, manholes, and similar access points that permit view of concealed piping.
  5. Near major equipment items and other points of origination and termination.
  6. Spaced at maximum intervals of **50 feet (15 m)** along each run. Reduce intervals to **25 feet (7.6 m)** in areas of congested piping and equipment.
  7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

### 3.4 DUCT LABEL INSTALLATION

- A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
- B. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction, may be provided instead of plastic-laminated duct labels, at Installer's option, if lettering larger than **1 inch (25 mm)** high is needed for proper identification because of distance from normal location of required identification.
- C. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of **50 feet (15 m)** in each space where ducts are exposed or concealed by removable ceiling system.

### 3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

END OF SECTION 15077

## SECTION 15080 - MECHANICAL INSULATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes mechanical insulation for duct, equipment, and pipe, including the following:

- 1. Insulation Materials:
  - a. Phenolic Foam.
  - b. Cellular glass.
  - c. Flexible elastomeric.
  - d. Mineral fiber.
- 2. Fire-rated insulation systems.
- 3. Insulating cements.
- 4. Adhesives.
- 5. Mastics.
- 6. Lagging adhesives.
- 7. Sealants.
- 8. Factory-applied jackets.
- 9. Field-applied fabric-reinforcing mesh.
- 10. Field-applied cloths.
- 11. Field-applied jackets.
- 12. Tapes.
- 13. Securements.
- 14. Corner angles.

- B. Related Sections include the following:

- 1. Division 2 Section "Hydronic Distribution" for loose-fill pipe insulation in underground piping outside the building.

#### 1.3 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.

#### 1.4 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. Application at linkages of control devices.
  - 7. Field application for each equipment type.
- C. Installer Certificates: Signed by Contractor certifying that installers comply with requirements.
- D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- E. Field quality-control inspection reports.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, 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.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

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

#### 1.7 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 15 Section "Hangers and Supports."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

#### 1.8 SCHEDULING

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

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
  2. Products: Subject to compliance with requirements, provide one of the products specified.
  3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

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

## 2.2 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 C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
  1. Available Products:
    - a. ACS.
    - b. Pittsburgh Corning Corporation; Foamglas Super K.
  2. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
  3. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
  4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- G. 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.
  1. Available Products:
    - a. Aeroflex USA Inc.; Aerocel.
    - b. Armacell LLC; AP Armaflex.
    - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
  1. Available Products:

- a. CertainTeed Corp.; Duct Wrap.
  - b. Johns Manville; Microlite.
  - c. Knauf Insulation; Duct Wrap.
  - d. Owens Corning; All-Service Duct Wrap.
- I. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
- 1. Available Products:
    - a. CertainTeed Corp.; Commercial Board.
    - b. Johns Manville; 800 Series Spin-Glas.
    - c. Knauf Insulation; Insulation Board.
    - d. Owens Corning; Fiberglas 700 Series.
- J. Mineral-Fiber, Preformed Pipe Insulation:
- 1. Available Products:
    - a. Johns Manville; Micro-Lok.
    - b. Knauf Insulation; 1000(Pipe Insulation.
    - c. Owens Corning; Fiberglas Pipe Insulation.
  - 2. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

## 2.3 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is UL tested and certified to provide a 1 or 2-hour fire rating, as required.
- 1. Products:
    - a. CertainTeed Corp.; FlameChek.
    - b. Johns Manville; Firetemp Wrap.
    - c. Thermal Ceramics; FireMaster Duct Wrap.
    - d. 3M; Fire Barrier Wrap Products.

## 2.4 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.



- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

## 2.5 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. Cellular-Glass Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F (minus 59 to plus 149 deg C).
- C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- E. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- F. PVC Jacket Adhesive: Compatible with PVC jacket.

- 1. Products:

## 2.6 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- B. 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 F 1249, 0.05 perm (0.03 metric perm) at 35-mil (0.9-mm) dry film thickness.
- 3. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).
- 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
- 5. Color: White.

## 2.7 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
2. Service Temperature Range: Minus 50 to plus 180 deg F (Minus 46 to plus 82 deg C).
3. Color: White.

## 2.8 SEALANTS

### A. Joint Sealants:

1. Joint Sealants for Cellular-Glass, Products:
  - a. Childers Products, Division of ITW; CP-76.
  - b. Pittsburgh Corning Corporation; Pittseal 444.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
5. Color: White or gray.

### B. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: Aluminum.

### C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: White.

## 2.9 FACTORY-APPLIED JACKETS

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

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

4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

#### 2.10 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. (68 g/sq. m) with a thread count of 10 strands by 10 strands/sq. inch (4 strands by 4 strands/sq. mm) for covering pipe and pipe fittings.
- B. Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 6 oz./sq. yd. (203 g/sq. m) with a thread count of 5 strands by 5 strands/sq. inch (2 strands by 2 strands/sq. mm) for covering equipment.

#### 2.11 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).

#### 2.12 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 D 1784, Class 16354-C; thickness 20 mil; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
  1. Adhesive: As recommended by jacket material manufacturer.
  2. Color: White.
  3. 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.
  4. Factory-fabricated tank heads and tank side panels.
- D. Metal Jacket:
  1. 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.
    - b. Thickness: 0.020" Smooth.

- c. Moisture Barrier for Indoor Applications: 1-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.

## 2.13 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136 and UL listed.
  - 1. Width: 3 inches.
  - 2. Thickness: 11.5 mils.
  - 3. Adhesion: 90 ounces force/inch in width.
  - 4. Elongation: 2 percent.
  - 5. Tensile Strength: 40 lbf/inch in width.
  - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136 and UL listed.
  - 1. Width: 3 inches.
  - 2. Thickness: 6.5 mils.
  - 3. Adhesion: 90 ounces force/inch in width.
  - 4. Elongation: 2 percent.
  - 5. Tensile Strength: 40 lbf/inch in width.
  - 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
  - 1. Width: 2 inches.
  - 2. Thickness: 6 mils.
  - 3. Adhesion: 64 ounces force/inch in width.
  - 4. Elongation: 500 percent.
  - 5. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive and UL listed.

1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

## 2.14 SECUREMENTS

### A. Bands:

1. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing or closed seal.
2. 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.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
  - a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

### C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

### D. Wire: 0.080-inch nickel-copper alloy.

## 2.15 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

## PART 3 - EXECUTION

### 3.1 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.

### 3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.3 COMMON INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  1. Install insulation continuously through hangers and around anchor attachments.
  2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to

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

### 3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
  - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at 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.
  - 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.
  - 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.
  - 2. Pipe: Install insulation continuously through floor penetrations.



3. Seal penetrations through fire-rated assemblies according to Division 7 Section "Through-Penetration Firestop Systems."

### 3.5 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 50 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 capacitor-discharge-weld pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

### 3.6 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 50 percent coverage of tank and vessel surfaces.
  2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
  3. Protect exposed corners with secured corner angles.
  4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
    - a. Do not weld anchor pins to ASME-labeled pressure vessels.
    - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
    - d. Do not overcompress insulation during installation.
    - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    - f. Impale insulation over anchor pins and attach speed washers.
    - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
  6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
  7. Stagger joints between insulation layers at least 3 inches.
  8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
  9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
  10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- 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 0.040 inch thick.
  3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

### 3.7 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this Article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
  2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
  3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
  5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
  6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
  7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
  8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
  9. 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 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.

### 3.8 CELLULAR-GLASS INSULATION INSTALLATION

#### A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

#### 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 cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, 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. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

### 3.9 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.

### 3.10 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 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, 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 50 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 capacitor-discharge-weld pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - d. Do not 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 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    - b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches (75 mm).
  5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
  6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
  7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- 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 50 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 capacitor-discharge-weld pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
  - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
  - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
  - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
  - d. Do not 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 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
  - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
  - b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches (75 mm).
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.



### 3.11 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 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
  - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- 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 o.c. and at end joints.

### 3.12 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous UL-listed fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 7 Section "Through-Penetration Firestop Systems."

### 3.13 FINISHES

- A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 9 painting Sections. Paint only those items in exposed, public areas.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
  - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

### 3.14 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent inspecting agency to perform field inspections and prepare inspection reports.
- B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements. Remove defective Work.
- C. Install new insulation and jackets to replace insulation and jackets removed for inspection. Repeat inspection procedures after new materials are installed.

### 3.15 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
  1. Indoor, concealed supply and outdoor air.
  2. Indoor, exposed supply and outdoor air.
  3. Indoor, concealed return located in nonconditioned space.
  4. Indoor, exposed return located in nonconditioned space.
  5. Indoor, concealed oven and warewash exhaust.
  6. Indoor, exposed oven and warewash exhaust.
  7. Indoor, concealed exhaust air.
  8. Indoor, exposed exhaust air.
  9. Outdoor, concealed supply and return.
  10. Outdoor, exposed supply and return.
- B. Items Not Insulated:
  1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
  2. Factory-insulated flexible ducts.
  3. Factory-insulated plenums and casings.
  4. Flexible connectors.
  5. Vibration-control devices.
  6. Factory-insulated access panels and doors.

### 3.16 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Concealed, round and flat-oval, supply-air duct insulation shall be the following:
  - 1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
- B. Concealed, round and flat-oval, return-air duct insulation shall be the following:
  - 1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
- C. Concealed, round and flat-oval, outdoor-air duct insulation shall be the following:
  - 1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
- D. Concealed, round and flat-oval, exhaust-air duct insulation shall be the following:
  - 1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
- E. Concealed, rectangular, supply-air duct insulation shall be the following:
  - 1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
- F. Concealed, rectangular, return-air duct insulation shall be the following:
  - 1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
- G. Concealed, rectangular, outdoor-air duct insulation shall be the following:
  - 1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
- H. Concealed, rectangular, exhaust-air duct insulation shall be the following:
  - 1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
- I. Concealed, return-air plenum insulation shall be the following:
  - 1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
  - 2. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
- J. Exposed, round and flat-oval, supply-air duct insulation shall be the following:
  - 1. Double wall insulated duct.
- K. Exposed, round and flat-oval, return-air duct insulation shall be the following:
  - 1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
  - 2. Insulation not required in conditioned spaces.
- L. Exposed, round and flat-oval, outdoor-air duct insulation shall be the following:
  - 1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
- M. Exposed, round and flat-oval, exhaust-air duct insulation shall be the following:
  - 1. Mineral-Fiber Blanket: 2 inches thick and nominal density.
  - 2. Insulation not required in conditioned spaces.
- N. Exposed, rectangular, supply-air duct insulation shall be the following:
  - 1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
  - 2. For rectangular ducts in public spaces, use double-wall insulated duct.
- O. Exposed, rectangular, return-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and nominal density.
2. Insulation not required in conditioned spaces.

P. Exposed, rectangular, outdoor-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

Q. Exposed, rectangular, exhaust-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
2. Insulation not required in conditioned spaces.

R. Exposed, return-air plenum insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
2. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

### 3.17 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. Round, flat-oval, and rectangular supply-air duct insulation shall be the following:

1. Flexible Elastomeric: 3 layers, each 1" thick.

C. Round, flat-oval, and rectangular return-air duct insulation shall be the following:

1. Flexible Elastomeric: 3 layers, each 1" thick.

### 3.18 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. Chillers: Insulate cold surfaces on chillers, including, but not limited to, evaporator bundles, suction piping, compressor inlets, tube sheets, water boxes, and nozzles with the following:

1. Flexible Elastomeric: 1 inch thick.

D. Heat-exchanger (water-to-water for cooling service) insulation shall be the following:

1. Flexible Elastomeric: 1 inch thick.

E. Chilled-water pump insulation shall be the following:

1. Cellular Glass: 3 inches thick.
2. Phenolic Foam: 2 inches thick.

F. Condenser-water pump insulation shall be the following:

1. Not applicable.

- G. Domestic water pump insulation shall be the following:
  - 1. Not applicable.
- H. Heating-hot-water pump insulation shall be the following:
  - 1. Cellular Glass: 3 inches thick.
- I. Chilled-water expansion/compression tank insulation shall be the following:
  - 1. Flexible Elastomeric: 1 inch thick.
- J. Chilled-water air-separator insulation shall be the following:
  - 1. Flexible Elastomeric: 1 inch thick.
- K. Domestic hot-water storage tank insulation shall be the following:
  - 1. Mineral-Fiber Board: 4 inches thick and 2-lb/cu. ft. nominal density.
- L. Thermal storage tank (brine, water, ice) insulation shall be the following:
  - 1. Cellular Glass: 4 inches thick.

### 3.19 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. Fire-suppression piping.
  - 2. Drainage piping located in crawl spaces.
  - 3. Below-grade piping.
  - 4. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

### 3.20 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
  - 1. Insulation shall be the following:
    - a. Mineral-Fiber Pipe Insulation, Type I: 1/2 inch thick.
- B. Domestic Hot and Recirculated Hot Water:
  - 1. Insulation shall be the following:
    - a. Mineral-Fiber Pipe Insulation, Type I: 1 inch thick.
- C. Domestic Chilled Water (Potable):
  - 1. All Pipe Sizes: Insulation shall be the following:

- a. Mineral-Fiber Pipe Insulation, Type I: 1 inch thick.
- D. Stormwater and Overflow:
- 1. All Pipe Sizes: Insulation shall be the following:
    - a. Mineral-Fiber Pipe Insulation, Type I: 1 inch thick.
  - 2. Insulation required only on horizontal runs.
- E. Roof Drain and Overflow Drain Bodies:
- 1. All Pipe Sizes: Insulation shall be the following:
    - a. Mineral-Fiber Pipe Insulation, Type I: 1 inch thick.
- F. Condensate and Equipment Drain Water below 60 Deg F:
- 1. All Pipe Sizes: Insulation shall be the following:
    - a. Flexible Elastomeric: 3/4 inch thick.
- G. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:
- 1. All Pipe Sizes: Insulation shall be the following:
    - a. Mineral-Fiber Pipe Insulation, Type I: 1 inch thick.
- H. Chilled Water and Brine, above 40 Deg F:
- 1. NPS 4 DN 100 and Smaller: Insulation shall be the following:
    - a. Cellular Glass: 1-1/2 inches thick.
    - b. Phenolic Foam: 1 inch thick.
  - 2. NPS 6 (DN 150) to NPS 12 (DN300): Insulation shall be the following:
    - a. Cellular Glass: 2 inches thick.
    - b. Phenolic Foam: 1 ½ inches thick.
  - 3. NPS 14 (DN350) and Larger: Insulation shall be the following:
    - a. Cellular Glass: 2 - ½ inches thick.
    - b. Phenolic Foam: 2 inches thick.
- I. Condenser-Water Supply and Return:
- 1. No insulation.
- J. Heating-Hot-Water Supply and Return, 200 Deg F and below:
- 1. Insulation shall be the following:

- a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.

K. Refrigerant Suction and Hot-Gas Piping:

- 1. All Pipe Sizes: Insulation shall be the following:
  - a. Flexible Elastomeric: 3/4 inch thick.

3.21 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping:

- 1. All Pipe Sizes: Insulation shall be the following:
  - a. Mineral-Fiber Pipe Insulation, Type I: 1 inch thick.

B. Domestic Hot and Recirculated Hot Water:

- 1. All Pipe Sizes: Insulation shall be the following:
  - a. Mineral-Fiber Pipe Insulation, Type I: 1 inches thick.

C. Chilled Water and Brine:

- 1. All Pipe Sizes: Insulation shall be the following:
  - a. Cellular Glass: Refer to interior schedule for thickness.
  - b. Phenolic Foam: Refer to interior schedule for thickness.

D. Condenser-Water Supply and Return:

- 1. All Pipe Sizes: Insulation not required.

E. Heating-Hot-Water Supply and Return, 200 Deg F and below:

- 1. All Pipe Sizes: Insulation shall be the following:
  - a. Mineral-Fiber Pipe Insulation, Type I: 1 ½ inches thick.

F. Refrigerant Suction and Hot-Gas Piping:

- 1. All Pipe Sizes: Insulation shall be the following:
  - a. Flexible Elastomeric: 1 inch thick.

3.22 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Loose-fill insulation, for belowground piping, is specified in Division 2 piping distribution Sections.

B. Chilled Water, All Sizes: Use pre-insulated pipe system.

- C. Condenser-Water Supply and Return, All Sizes: Insulation not required. Provide anti corrosion coating as specified in Hydronic Piping Specification.
- D. Heating-Hot-Water Supply and Return, All Sizes, 200 Deg F and below: Use pre-insulated pipe system.

### 3.23 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts and Plenums, Concealed:
  - 1. None.
- D. Ducts and Plenums, Exposed:
  - 1. None.
- E. Equipment, Concealed:
  - 1. None.
- F. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
  - 1. None.
- G. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:
  - 1. None.
- H. Piping, Concealed:
  - 1. ASJ – factory.
- I. Piping, Exposed:
  - 1. PVC: 20 mils thick.

### 3.24 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. Ducts and Plenums, Concealed:



- 1. Painted Aluminum, Smooth: 0.020 inch thick.
  - D. Ducts and Plenums, Exposed:
    - 1. Painted Aluminum, Smooth: 0.020 inch thick.
  - E. Equipment, Concealed:
    - 1. PVC: 20 mils thick.
  - F. Equipment, Exposed:
    - 1. Aluminum, Smooth: 0.020 inch thick.
  - G. Piping, Concealed:
    - 1. PVC: 20 mils thick.
  - H. Piping, Exposed:
    - 1. Aluminum, Smooth: 0.020 inch thick.
- 3.25 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET
- A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 15080

## SECTION 15110 - VALVES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following general-duty valves:
  - 1. Bronze angle valves.
  - 2. Cast-iron angle valves.
  - 3. Copper-alloy ball valves.
  - 4. Ferrous-alloy ball valves.
  - 5. Ferrous-alloy butterfly valves.
  - 6. Bronze check valves.
  - 7. Gray-iron swing check valves.
  - 8. Ferrous-alloy wafer check valves.
  - 9. Spring-loaded, lift-disc check valves.
  - 10. Bronze gate valves.
  - 11. Cast-iron gate valves.
  - 12. Bronze globe valves.
  - 13. Cast-iron globe valves.
  - 14. Chainwheel actuators.
- B. Related Sections include the following:
  - 1. Division 2 piping Sections for general-duty and specialty valves for site construction piping.
  - 2. Division 15 Section "Mechanical Identification" for valve tags and charts.
  - 3. Division 15 piping Sections for specialty valves applicable to those Sections only.

#### 1.3 DEFINITIONS

- A. The following are standard abbreviations for valves:
  - 1. CWP: Cold working pressure.
  - 2. EPDM: Ethylene-propylene-diene terpolymer rubber.
  - 3. NBR: Acrylonitrile-butadiene rubber.
  - 4. PTFE: Polytetrafluoroethylene plastic.
  - 5. SWP: Steam working pressure.
  - 6. TFE: Tetrafluoroethylene plastic.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

#### 1.5 QUALITY ASSURANCE

- A. ASME Compliance: ASME B31.1 for power piping valves and ASME B31.9 for building services piping valves.
  - 1. Exceptions: Domestic hot- and cold-water, sanitary waste, and storm drainage piping valves unless referenced.
- B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.
- C. NSF Compliance: NSF 61 for valve materials for potable-water service.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads, flange faces, grooves, and weld ends.
  - 3. Set angle, gate, and globe valves closed to prevent rattling.
  - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
  - 5. Set butterfly valves closed or slightly open.
  - 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
  - 1. Maintain valve end protection.
  - 2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

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

### 2.2 VALVES, GENERAL

- A. Refer to Part 3 "Valve Applications" Article for applications of valves.
- B. Bronze Valves: NPS 2 (DN 50) and smaller with threaded ends, unless otherwise indicated.
- C. Ferrous Valves: NPS 2-1/2 (DN 65) and larger with flanged ends, unless otherwise indicated.
- D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
- F. Valve Actuators:
  - 1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
  - 2. Gear Drive: For quarter-turn valves NPS 8 (DN 200) and larger.
  - 3. Handwheel: For valves other than quarter-turn types.
  - 4. Lever Handle: For quarter-turn valves NPS 6 (DN 150) and smaller, except plug valves.
- G. Extended Valve Stems: On insulated valves.
- H. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.
- I. Valve Grooved Ends: AWWA C606.
  - 1. Solder Joint: With sockets according to ASME B16.18.
    - a. Caution: Use solder with melting point below 840 deg F (454 deg C) for angle, check, gate, and globe valves; below 421 deg F (216 deg C) for ball valves.

2. Threaded: With threads according to ASME B1.20.1.

J. Valve Bypass and Drain Connections: MSS SP-45.

## 2.3 BRONZE ANGLE VALVES

A. Manufacturers:

1. Type 2, Bronze Angle Valves with Nonmetallic Disc:
  - a. Crane Co.
  - b. Grinnell Corporation.
  - c. Hammond Valve.
  - d. NIBCO INC.

B. Bronze Angle Valves, General: MSS SP-80, with ferrous-alloy handwheel.

C. Type 2, Class 150, Bronze Angle Valves: Bronze body with nonmetallic PTFE or TFE disc.

## 2.4 CAST-IRON ANGLE VALVES

A. Manufacturers:

1. Type II, Cast-Iron Angle Valves with Metal Seats:
  - a. Crane Co.
  - b. NIBCO INC.

B. Cast-Iron Angle Valves, General: MSS SP-85, Type II.

C. Class 125, Cast-Iron Angle Valves: Bronze mounted with gray-iron body and bronze seats.

## 2.5 COPPER-ALLOY BALL VALVES

A. Manufacturers:

1. Two-Piece, Copper-Alloy Ball Valves:
  - a. Conbraco Industries, Inc.; Apollo Div.
  - b. Crane Co.
  - c. Grinnell Corporation.
  - d. Hammond Valve.
  - e. Jamesbury, Inc.
  - f. Kitz Corporation of America.
  - g. Legend Valve & Fitting, Inc.
  - h. Milwaukee Valve Company.
  - i. NIBCO INC.

- j. Red-White Valve Corp.
- k. Watts Industries, Inc.; Water Products Div.

2. Safety-Exhaust, Copper-Alloy Ball Valves:

- a. Conbraco Industries, Inc.; Apollo Div.
- b. Grinnell Corporation.
- c. Hammond Valve.
- d. Jamesbury, Inc.
- e. Milwaukee Valve Company.
- f. NIBCO INC.

B. Copper-Alloy Ball Valves, General: MSS SP-110.

C. Two-Piece, Copper-Alloy Ball Valves: Brass or bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.

D. Safety-Exhaust, Copper-Alloy Ball Valves: Two-piece bronze body with exhaust vent opening, chrome-plated ball with vent, blowout-proof stem, locking handle, and working pressure rating of 600-psig CWP.

## 2.6 FERROUS-ALLOY BALL VALVES

A. Manufacturers:

- 1. Conbraco Industries, Inc.; Apollo Div.
- 2. Crane Co.
- 3. Hammond Valve.
- 4. Jamesbury, Inc.
- 5. Kitz Corporation of America.
- 6. Milwaukee Valve Company.
- 7. NIBCO INC.

B. Ferrous-Alloy Ball Valves, General: MSS SP-72, with flanged ends.

C. Ferrous-Alloy Ball Valves: Class 150, full port.

## 2.7 FERROUS-ALLOY BUTTERFLY VALVES

A. Manufacturers:

- 1. Single-Flange, Ferrous-Alloy Butterfly Valves:
  - a. Bray International, Inc.
  - b. Crane Co.
  - c. Grinnell Corporation.
  - d. Hammond Valve.
  - e. Kitz Corporation of America.
  - f. Legend Valve & Fitting, Inc.

- g. Metraflex Co.
  - h. Milwaukee Valve Company.
  - i. Mueller.
  - j. NIBCO INC.
  - k. Red-White Valve Corp.
  - l. Tyco International.
  - m. Watts Industries.
2. Grooved-End, Ductile-Iron Butterfly Valves:
- a. Grinnell Corporation.
  - b. Hammond Valve.
  - c. Milwaukee Valve Company.
  - d. Mueller.
  - e. NIBCO INC.
  - f. Victaulic Co. of America.
- B. Ferrous-Alloy Butterfly Valves, General: MSS SP-67, Type I, for tight shutoff, with disc and lining suitable for potable water, unless otherwise indicated.
- C. Single-Flange, 150-psig (1035-kPa) CWP Rating, Ferrous-Alloy Butterfly Valves: Wafer-lug type with one- or two-piece stem.
- D. Grooved-End, 175-psig (1207-kPa) CWP Rating, Ferrous-Alloy Butterfly Valves: Ductile-iron or steel body with grooved or shouldered ends.

## 2.8 BRONZE CHECK VALVES

- A. Manufacturers:
- 1. Type 2, Bronze, Horizontal Lift Check Valves with Nonmetallic Disc:
    - a. Crane Co.
  - 2. Type 2, Bronze, Vertical Lift Check Valves with Nonmetallic Disc:
    - a. Grinnell Corporation.
    - b. Kitz Corporation of America.
    - c. Milwaukee Valve Company.
  - 3. Type 4, Bronze, Swing Check Valves with Nonmetallic Disc:
    - a. Crane Co.
    - b. Grinnell Corporation.
    - c. Hammond Valve.
    - d. Milwaukee Valve Company.
    - e. NIBCO INC.
    - f. Red-White Valve Corp.
    - g. Watts Industries.
- B. Bronze Check Valves, General: MSS SP-80.

- C. Type 2, Class 150, Bronze, Horizontal Lift Check Valves: Bronze body with nonmetallic disc and bronze seat.
- D. Type 2, Class 150, Bronze, Vertical Lift Check Valves: Bronze body with nonmetallic disc and bronze seat.
- E. Type 4, Class 150, Bronze, Swing Check Valves: Bronze body with nonmetallic disc and bronze seat.

## 2.9 GRAY-IRON SWING CHECK VALVES

### A. Manufacturers:

#### 1. Type II, Gray-Iron Swing Check Valves with Composition to Metal Seats:

- a. Crane Co.
- b. Mueller Co.
- c. Watts Industries.

#### 2. Grooved-End, Ductile-Iron Swing Check Valves:

- a. Grinnell Corporation.
- b. Mueller Co.
- c. Victaulic Co. of America.

### B. Gray-Iron Swing Check Valves, General: MSS SP-71.

### C. Type II, Class 125, gray-iron, swing check valves with composition to metal seats.

### D. 175-psig (1207-kPa) CWP Rating, Grooved-End, Swing Check Valves: Ductile-iron body with grooved or shouldered ends.

## 2.10 FERROUS-ALLOY WAFER CHECK VALVES

### A. Manufacturers:

#### 1. Dual-Plate, Ferrous-Alloy, Wafer Check Valves:

- a. Crane Co.
- b. Grinnell Corporation.
- c. Metraflex Co.
- d. Mueller.
- e. NIBCO INC.
- f. Red-White Valve Corp.
- g. Watts Industries.

### B. Ferrous-Alloy Wafer Check Valves, General: API 594, spring loaded.



- C. Dual-Plate, Class 125 or 150, Ferrous-Alloy, Wafer-Lug Check Valves: Single-flange body.

## 2.11 SPRING-LOADED, LIFT-DISC CHECK VALVES

### A. Manufacturers:

- 1. Type II, Compact-Wafer, Lift-Disc Check Valves:
  - a. Grinnell Corporation.
  - b. Hammond Valve.
  - c. Metraflex Co.
  - d. Milwaukee Valve Company.
  - e. Mueller.
  - f. NIBCO INC.
- 2. Type IV, Threaded Lift-Disc Check Valves:
  - a. Grinnell Corporation.
  - b. Legend Valve & Fitting, Inc.
  - c. Metraflex Co.
  - d. Milwaukee Valve Company.
  - e. Mueller.
  - f. NIBCO INC.
  - g. Watts Industries.

- B. Lift-Disc Check Valves, General: FCI 74-1, with spring-loaded bronze or alloy disc and bronze or alloy seat.
- C. Type II, Class 125, Compact-Wafer, Lift-Disc Check Valves: Compact-wafer style with cast-iron shell with diameter made to fit within bolt circle.
- D. Type IV, Class 150, Threaded Lift-Disc Check Valves: Threaded style with bronze shell and threaded ends.

## 2.12 BRONZE GATE VALVES

### A. Manufacturers:

- 1. Type 2, Bronze, Rising-Stem, Solid-Wedge Gate Valves:
  - a. Crane Co.
  - b. Grinnell Corporation.
  - c. Hammond Valve.
  - d. Kitz Corporation of America.
  - e. Milwaukee Valve Company.
  - f. NIBCO INC.
  - g. Red-White Valve Corp.

- B. Bronze Gate Valves, General: MSS SP-80, with ferrous-alloy handwheel.

- C. Type 2, Class 150, Bronze Gate Valves: Bronze body with rising stem and bronze solid wedge.

## 2.13 CAST-IRON GATE VALVES

### A. Manufacturers:

- 1. Type I, Cast-Iron, Nonrising-Stem Gate Valves:
  - a. Crane Co.
  - b. Grinnell Corporation.
  - c. Hammond Valve.
  - d. Kitz Corporation of America.
  - e. Legend Valve & Fitting, Inc.
  - f. Milwaukee Valve Company.
  - g. NIBCO INC.
  - h. Red-White Valve Corp.
  - i. Watts Industries.

### B. Cast-Iron Gate Valves, General: MSS SP-70, Type I.

- C. Class 125, NRS, Bronze-Mounted, Cast-Iron Gate Valves: Cast-iron body with bronze trim, nonrising stem, and solid-wedge disc.

## 2.14 BRONZE GLOBE VALVES

### A. Manufacturers:

- 1. Type 1, Bronze Globe Valves with Metal Disc:
  - a. Crane Co.
  - b. Grinnell Corporation.
  - c. Hammond Valve.
  - d. Kitz Corporation of America.
  - e. Legend Valve & Fitting, Inc.
  - f. Milwaukee Valve Company.
  - g. NIBCO INC.
  - h. Red-White Valve Corp.
- 2. Type 2, Bronze Globe Valves with Nonmetallic Disc:
  - a. Crane Co.
  - b. Grinnell Corporation.
  - c. Hammond Valve.
  - d. Kitz Corporation of America.
  - e. Milwaukee Valve Company.
  - f. NIBCO INC.
  - g. Red-White Valve Corp.

### B. Bronze Globe Valves, General: MSS SP-80, with ferrous-alloy handwheel.

- C. Type 1, Class 125, Bronze Globe Valves: Bronze body with bronze disc.
- D. Type 2, Class 150, Bronze Globe Valves: Bronze body with nonmetallic PTFE or TFE disc.

## 2.15 CAST-IRON GLOBE VALVES

### A. Manufacturers:

- 1. Type I, Cast-Iron Globe Valves with Metal Seats:
  - a. Crane Co.
  - b. Grinnell Corporation.
  - c. Hammond Valve.
  - d. Kitz Corporation of America.
  - e. Milwaukee Valve Company.
  - f. NIBCO INC.
  - g. Red-White Valve Corp.

### B. Cast-Iron Globe Valves, General: MSS SP-85.

### C. Type I, Class 125, Cast-Iron Globe Valves: Gray-iron body with bronze seats.

## 2.16 CHAINWHEEL ACTUATORS

### A. Manufacturers:

- 1. Babbitt Steam Specialty Co.
- 2. Roto Hammer Industries, Inc.

### B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

- 1. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. Include zinc coating on exterior applications.
- 2. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
- 3. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

#### A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.

- 1. Proceed with installation only after unsatisfactory conditions have been corrected.

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

### 3.2 VALVE APPLICATIONS

- A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
  - 1. Shutoff Service: Ball, butterfly, gate, or plug valves.
  - 2. Throttling Service: Angle, ball, butterfly, or globe valves.
  - 3. Pump Discharge: Spring-loaded, lift-disc check valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- C. Chilled-Water Piping: Use the following types of valves:
  - 1. Angle Valves, NPS 2 (DN 50) and Smaller: Type 2, Class 150, bronze.
  - 2. Angle Valves, NPS 2-1/2 (DN 65) and Larger: Type II, Class 125, cast iron.
  - 3. Ball Valves, NPS 2 (DN 50) and Smaller: Two-piece, 600-psig (4140-kPa) CWP rating, copper alloy.
  - 4. Ball Valves, NPS 2-1/2 (DN 65) and Larger: Class 150, ferrous alloy.
  - 5. Butterfly Valves, NPS 2-1/2 (DN 65) and Larger: Single-flange, 150-psig (1035-kPa) CWP rating, ferrous alloy, with Buta-N liner.
  - 6. Grooved-End, Ductile-Iron Butterfly Valves, NPS 2-1/2 (DN 65) and Larger: 300-psig (2070-kPa) CWP rating.
  - 7. Lift Check Valves, NPS 2 (DN 50) and Smaller: Type 2, Class 150, horizontal or vertical, bronze.
  - 8. Swing Check Valves, NPS 2 (DN 50) and Smaller: Type 4, Class 150, bronze.
  - 9. Swing Check Valves, NPS 2-1/2 (DN 65) and Larger: Type II, Class 125, gray iron.
  - 10. Grooved-End, Ductile-Iron, Swing Check Valves, NPS 2-1/2 (DN 65) and Larger: 175-psig (1207-kPa) CWP rating.
  - 11. Wafer Check Valves, NPS 2-1/2 (DN 65) and Larger: Dual-plate, wafer, Class 125 or 150 ferrous alloy.

12. Spring-Loaded, Lift-Disc Check Valves, NPS 2 (DN 50) and Smaller: Type IV, Class 150.
13. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 (DN 65) and Larger: Type II, Class 125, cast iron.
14. Gate Valves, NPS 2 (DN 50) and Smaller: Type 2, Class 150, bronze.
15. Gate Valves, NPS 2-1/2 (DN 65) and Larger: Type I, Class 125, NRS, bronze-mounted cast iron.
16. Globe Valves, NPS 2 (DN 50) and Smaller: Type 2, Class 150, bronze.
17. Globe Valves, NPS 2-1/2 (DN 65) and Larger: Type I, Class 125, bronze-mounted cast iron.

D. Condenser Water Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Two-piece, 600-psig CWP rating, copper alloy.
2. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.
3. Butterfly Valves, NPS 2-1/2 and Larger: Single-flange, 150-psig CWP rating, ferrous alloy, with Buta-N liner.
4. Grooved-End, Ductile-Iron Butterfly Valves, NPS 2-1/2 and Larger: 300-psig CWP rating.
5. Lift Check Valves, NPS 2 and Smaller: Type 2, Class 150, horizontal or vertical, bronze.
6. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 150, bronze.
7. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.
8. Grooved-End, Ductile-Iron, Swing Check Valves, NPS 2-1/2 and Larger: 175-psig CWP rating.
9. Wafer Check Valves, NPS 2-1/2 and Larger: Dual-plate, wafer, Class 125 or 150, ferrous alloy.
10. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class 150.
11. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, cast iron.
12. Gate Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
13. Gate Valves, NPS 2-1/2 and Larger: Type I, Class 125, NRS, bronze-mounted cast iron.
14. Globe Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
15. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 125, bronze-mounted cast iron.

E. Domestic Water Piping: Use the following types of valves:

1. Angle Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
2. Angle Valves, NPS 2-1/2 and Larger: Type II, Class 125, cast iron.
3. Ball Valves, NPS 2 and Smaller: Two-piece, 600-psig CWP rating, copper alloy.
4. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.
5. Butterfly Valves, NPS 2-1/2 and Larger: Single-flange, 150-psig CWP rating, ferrous alloy, with EPDM liner.
6. Grooved-End, Ductile-Iron Butterfly Valves, NPS 2-1/2 and Larger: 300-psig CWP rating.
7. Lift Check Valves, NPS 2 and Smaller: Type 2, Class 150, horizontal or vertical, bronze.

8. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 125, bronze.
9. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.
10. Grooved-End, Ductile-Iron, Swing Check Valves, NPS 2-1/2 and Larger: 175-psig CWP rating.
11. Wafer Check Valves, NPS 2-1/2 and Larger: Dual-plate, wafer, Class 125 or 150, ferrous alloy.
12. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class 150.
13. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, cast iron.
14. Gate Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
15. Gate Valves, NPS 2-1/2 and Larger: Type I, Class 125, NRS, bronze-mounted cast iron.
16. Globe Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
17. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 125, bronze-mounted cast iron.

F. Heating Water Piping: Use the following types of valves:

1. Angle Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
2. Angle Valves, NPS 2-1/2 and Larger: Type II, Class 125, cast iron.
3. Ball Valves, NPS 2 and Smaller: Two-piece, 600-psig CWP rating, copper alloy.
4. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.
5. Butterfly Valves, NPS 2-1/2 and Larger: Single-flange, 150-psig CWP rating, ferrous alloy, with EPDM liner.
6. Grooved-End, Ductile-Iron Butterfly Valves, NPS 2-1/2 and Larger: 300-psig CWP rating.
7. Lift Check Valves, NPS 2 and Smaller: Type 2, Class 150, horizontal vertical, bronze.
8. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 150, bronze.
9. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.
10. Grooved-End, Ductile-Iron, Swing Check Valves, NPS 2-1/2 and Larger: 175-psig CWP rating.
11. Wafer Check Valves, NPS 2-1/2 and Larger: Dual-plate, wafer, Class 125 or 150, ferrous alloy.
12. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class 150.
13. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, cast iron.
14. Gate Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
15. Gate Valves, NPS 2-1/2 and Larger: Type I, Class 125, NRS, bronze-mounted cast iron.
16. Globe Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
17. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 125, bronze-mounted cast iron.

G. Sanitary Waste and Storm Drainage Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Two-piece, 600-psig CWP rating, copper alloy.
2. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.

3. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 150, bronze.
4. Swing Check Valves, NPS 2-1/2 and Larger: Type I or II, Class 125, gray iron.
5. Grooved-End, Ductile-Iron, Swing Check Valves, NPS 2-1/2 and Larger: 175-psig minimum CWP rating.
6. Gate Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
7. Gate Valves, NPS 2-1/2 and Larger: Type I, Class 125, NRS, bronze-mounted cast iron.
8. Globe Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
9. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 125, cast iron.

H. Select valves, except wafer and flangeless types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for heating hot water.
2. For Copper Tubing, NPS 2-1/2 (DN65) and larger: Flanged ends.
3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
4. For Steel Piping, NPS 2-1/2 (DN65) and larger: Flanged ends.
5. For Grooved-End, Copper Tubing and Steel Piping: Valve ends may be grooved. Do not use for steam or steam condensate piping.

### 3.3 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above center of pipe.
- E. Install valves in position to allow full stem movement.
- F. Install chainwheel operators on valves and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor elevation.
- G. Install check valves for proper direction of flow and as follows:
  1. Swing Check Valves: In horizontal position with hinge pin level.
  2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
  3. Lift Check Valves: With stem upright and plumb.

### 3.4 JOINT CONSTRUCTION

- A. Refer to Division 15 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.

### 3.5 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 15110



## SECTION 15181 - HYDRONIC PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes piping, special-duty valves, and hydronic specialties for hot-water heating, chilled-water cooling, and condenser water systems; makeup water for these systems; blowdown drain lines; and condensate drain piping.
- B. Related Sections include the following:
  - 1. Division 7 Section "Through-Penetration Firestop Systems" for materials and methods for sealing pipe penetrations through fire and smoke barriers.
  - 2. Division 7 Section "Joint Sealants" for materials and methods for sealing pipe penetrations through exterior walls.
  - 3. Division 15 Section "Basic Mechanical Materials and Methods" for general piping materials and installation requirements.
  - 4. Division 15 Section "Hangers and Supports" for pipe supports, product descriptions, and installation requirements. Hanger and support spacing is specified in this Section.
  - 5. Division 15 Section "Valves" for general-duty gate, globe, ball, butterfly, and check valves.
  - 6. Division 15 Section "Meters and Gages" for thermometers, flow meters, and pressure gages.
  - 7. Division 15 Section "Mechanical Identification" for labeling and identifying hydronic piping.
  - 8. Division 15 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing for diverting fittings, calibrated balancing valves, and automatic flow-control valves.
- B. Shop Drawings: Pipe routing and detail fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops. Drawings to be submitted at ¼"=1'0" scale.
- C. Welding Certificates: Copies of certificates for welding procedures and personnel.

- D. 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.
- E. Maintenance Data: For hydronic specialties and special-duty valves to include in maintenance manuals specified in Division 1.
- F. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

#### 1.4 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

#### 1.5 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. Roof specialties are specified in Division 7 Sections.
- 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 Division 7 Section "Through-Penetration Firestop Systems" for fire and smoke wall and floor assemblies.

#### 1.6 EXTRA MATERIALS

- A. Water Treatment Chemicals: Furnish sufficient chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Grooved Mechanical-Joint Fittings and Couplings:
    - a. Grinnell Corporation.
    - b. Victaulic Company of America.
  2. Calibrated Balancing Valves:
    - a. Armstrong Pumps, Inc.
    - b. Flow Design, Inc.
    - c. Griswold Controls.
    - d. ITT Bell & Gossett; ITT Fluid Technology Corp.
  3. Pressure-Reducing Valves:
    - a. Amtrol, Inc.
    - b. Armstrong Pumps, Inc.
    - c. ITT Bell & Gossett; ITT Fluid Technology Corp.
    - d. Spence Engineering Company, Inc.
    - e. Watts Industries, Inc.; Watts Regulators.
  4. Safety Valves:
    - a. Amtrol, Inc.
    - b. Armstrong Pumps, Inc.
    - c. ITT McDonnell & Miller Div.; ITT Fluid Technology Corp.
    - d. Spence Engineering Company, Inc.
  5. Automatic Flow-Control Valves:
    - a. Flow Design, Inc.
    - b. Griswold Controls.
  6. Expansion Tanks:
    - a. Amtrol, Inc.
    - b. Armstrong Pumps, Inc.
    - c. ITT Bell & Gossett; ITT Fluid Technology Corp.
    - d. John Wood Co.
  7. Air Separators and Air Purgers:
    - a. Amtrol, Inc.
    - b. Armstrong Pumps, Inc.
    - c. ITT Bell & Gossett; ITT Fluid Technology Corp.
    - d. Taco, Inc.

## 2.2 PIPING MATERIALS

- A. General: Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

## 2.3 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: **ASTM B 88, Type L** (ASTM B 88M, Type B).
- B. Annealed-Temper Copper Tubing: **ASTM B 88, Type K** (ASTM B 88M, Type A).
- C. DWV Copper Tubing: ASTM B 306, Type DWV.
- D. Wrought-Copper Fittings: ASME B16.22.
- E. Wrought-Copper Unions: ASME B16.22.
- F. Solder Filler Metals: ASTM B 32, 95-5 tin antimony.
- G. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (silver).

## 2.4 STEEL PIPE AND FITTINGS

- A. Steel Pipe, **NPS 2-1/2 through NPS 12** (DN 65 through DN 300): ASTM A 53, Type E (electric-resistance welded), Grade B, Schedule 40, black steel, plain ends.
- B. Steel Pipe, **NPS 14 through NPS 18** (DN 350 through DN 450): ASTM A 53, Type E (electric-resistance welded) or Type S (seamless), Grade B, Schedule 30, black steel, plain ends.
- C. Steel Pipe, **NPS 20** (DN 500) and larger: ASTM A 53, Type E (electric-resistance welded) or Type S (seamless), Grade B, Schedule 20, black steel, plain ends.
  - 1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53, Schedule 40, black steel; electric-resistance welded for **NPS 2-1/2** (DN 65) and larger.
- D. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250.
- E. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
- F. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.
- G. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced.
- H. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- I. 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.
- J. Grooved Mechanical-Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; **ASTM A 47 (ASTM A 47M)**, Grade 32510 malleable iron; ASTM A 53, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders designed to accept grooved end couplings.
- K. Grooved Mechanical-Joint Couplings: Ductile- or malleable-iron housing 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.
- L. Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; **150-psig (1035-kPa)** minimum working pressure and **250 deg F (121 deg C)** maximum operating temperature. Connectors shall have flanged or threaded-end connections to match equipment connected and shall be capable of **3/4-inch (20-mm)** misalignment.
- M. Spherical, Rubber, Flexible Connectors: Fiber-reinforced rubber body with steel flanges drilled to align with Classes 150 and 300 steel flanges; operating temperatures up to **250 deg F (121 deg C)** and pressures up to **150 psig (1035 kPa)**.
- N. Packed, Slip, Expansion Joints: **150-psig (1035-kPa)** 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.
- O. 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.
- P. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.
- 2.5 PRE-INSULATED PIPING SYSTEM - STEEL
- A. Chilled Water: Below grade, use pre-insulated piping system. All pre-insulated pipe, fittings, insulating materials, and technical support shall be provided by the Pre-insulated Piping System manufacturer. **The system shall be FERRO-THERM as manufactured by Thermacor Process, L.P.**
1. **Carrier pipe** shall be steel ASTM A-53, Grade B., ERW (Type E) or seamless (Type S), standard weight for sizes 2" and larger, and shall be ASTM A-106/ A-53, seamless, standard weight for sizes 1-1/2" and smaller (Std. Wt. is the same as Sch. 40 through 10"). All carbon steel pipe shall have ends cut square and beveled for butt-welding. Straight sections of factory insulated pipe shall have 6" of exposed pipe at each end for field joint fabrication.
  2. **Jacketing material** shall be extruded, black, high density polyethylene (HDPE), having a minimum wall thickness not less than 125 mils for pipe sizes less than or equal to 12", 150 mils for jacket sizes larger than 12"

to 20", and 175 mils for jacket sizes greater than 20". No tape jacket allowed. The inner surface of the HDPE jacket shall be oxidized by means of corona treatment, flame treatment, or other approved methods. This will ensure a secure bond between the jacket and foam insulation preventing any ingress of water at the jacket/ foam interface. Insulation:

3. **Insulation** shall be polyurethane foam either spray applied or high pressure injected with one shot into the annular space between carrier pipe and jacket. Insulation shall be rigid, 90% minimum closed cell polyurethane with a minimum 2.0 lbs. per cubic foot density, compressive strength of 30 psi, and coefficient of thermal conductivity (K- Factor) of not higher than 0.15 @ 75°F per ASTM C-518. Maximum operating temperature shall not exceed 250°F.
4. **Fittings** are Thermacor's SC (standard components) factory pre-fabricated and pre-insulated fittings with polyurethane foam to the thickness specified and jacketed with a one-piece seamless molded HDPE fitting cover, a butt fusion welded, or an extrusion welded and mitered HDPE jacket. Carrier pipe fittings shall be butt-welded, except sizes smaller than 2" shall be socket-welded. Fittings include expansion loops, elbows, tees, reducers, and anchors. Elbows, loops, offsets, or any other direction changes shall conform to the standards set by ANSI B31.1, Code for Power Piping.
5. **Straight run joints** shall be field-insulated per the manufacturer's instructions, using polyurethane foam poured in an HDPE sleeve and sealed with a heat shrink sleeve. All joint closures and insulation shall occur at straight sections of pipe. All insulation and jacketing materials shall be furnished by THERMACOR.

## 2.6 VALVES

- A. Gate, globe, check, ball, and butterfly valves are specified in Division 15 Section "Valves."
- B. Refer to Part 3 "Valve Applications" Article for applications of each valve.
- C. Calibrated Balancing Valves, **NPS 2 (DN 50)** and Smaller: Bronze body, ball type, **125-psig (860-kPa)** working pressure, **250 deg F (121 deg C)** 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.
- D. Calibrated Balancing Valves, **NPS 2-1/2 (DN 65)** and Larger: Cast-iron or steel body, ball type, **125-psig (860-kPa)** working pressure, **250 deg F (121 deg C)** 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.

- 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.
- 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 (1206 kPa) at 200 deg F (93 deg C) with stainless-steel piston and spring.
  - 2. Brass or ferrous-metal body, designed for 300 psig (2068 kPa) at 250 deg F (121 deg C) with corrosion-resistant, tamperproof, self-cleaning, piston-spring assembly easily removable for inspection or replacement.
  - 3. Combination assemblies, including bronze ball valve and brass alloy control valve, with stainless-steel piston and spring, fitted with pressure and temperature test valves, and designed for 300 psig (2067 kPa) at 250 deg F (121 deg C).

## 2.7 HYDRONIC SPECIALTIES

- A. Manual Air Vent: Bronze body and nonferrous internal parts; 150-psig (1035-kPa) working pressure; 225 deg F (107 deg C) operating temperature; manually operated with screwdriver or thumbscrew; with NPS 1/8 (DN 6) discharge connection and NPS 1/2 (DN 15) inlet connection.
- B. Automatic Air Vent: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig (1035-kPa) working pressure; 240 deg F (116 deg C) operating temperature; with NPS 1/4 (DN 8) discharge connection and NPS 1/2 (DN 15) inlet connection.
- C. Expansion Tanks: Welded carbon steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature. Separate air charge from system water to maintain design expansion capacity by a flexible diaphragm securely sealed into tank. Include drain fitting and taps for pressure gage and air-charging fitting. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Factory fabricate and test tank with taps and supports installed and labeled according to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

- D. Tangential-Type Air Separators: Welded black steel; ASME constructed and labeled for 125-psig (860-kPa) minimum working pressure and 375 deg F (191 deg C) maximum operating temperature; perforated stainless-steel air collector tube designed to direct released air into expansion tank; tangential inlet and outlet connections; threaded connections for NPS 2 (DN 50) and smaller; flanged connections for NPS 2-1/2 (DN 65) and larger; threaded blowdown connection. Provide units in sizes for full-system flow capacity.
- E. Air Purgers: Cast-iron body with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal. Maximum working pressure of 150 psig (1035 kPa) and temperature of 250 deg F (121 deg C).
- F. Bypass Chemical Feeder: Welded steel construction; 125-psig (860-kPa) working pressure; 5-gal. (19-L) capacity; with fill funnel and inlet, outlet, and drain valves.
  - 1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.
- G. Diverting Fittings: 125-psig (860-kPa) working pressure; 250 deg F (121 deg C) maximum operating temperature; cast-iron body with threaded ends, or wrought copper with soldered ends. Indicate flow direction on fitting.
- H. Y-Pattern Strainers: 125-psig (860-kPa) working pressure; cast-iron body (ASTM A 126, Class B), flanged ends for NPS 2-1/2 (DN 65) and larger, threaded connections for NPS 2 (DN 50) and smaller, bolted cover, perforated stainless-steel basket, and bottom drain connection.
- I. Basket Strainers: 125-psig (860-kPa) working pressure; high-tensile cast-iron body (ASTM A 126, Class B), flanged-end connections, bolted cover, perforated stainless-steel basket, and bottom drain connection.
- J. T-Pattern Strainers: 750-psig (5170-kPa) working pressure; ductile-iron or malleable-iron body, grooved-end connections, stainless-steel basket with 57 percent free area; removable access coupling and end cap for strainer maintenance.
- K. Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig (1035-kPa) minimum working pressure and 250 deg F (121 deg C) maximum operating temperature. Connectors shall have flanged- or threaded-end connections to match equipment connected and shall be capable of 3/4-inch (20-mm) misalignment.
- L. Spherical, Rubber, Flexible Connectors: Fiber-reinforced rubber body with steel flanges drilled to align with Classes 150 and 300 steel flanges; operating temperatures up to 250 deg F (121 deg C) and pressures up to 150 psig (1035 kPa).
- M. Packed, Slip, Expansion Joints: 150-psig (1035-kPa) 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.



## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS

- A. Hot and Chilled Water, **NPS 2 (DN 50)** and Smaller: Aboveground, use **Type L (Type B)** drawn-temper copper tubing with soldered joints. Belowground or within slabs, use **Type K (Type A)** annealed-temper copper tubing with soldered joints. Use the fewest possible joints belowground and within floor slabs. Alternately, steel pipe with threaded joint couplings may be used.
- B. Hot and Chilled Water, **NPS 2-1/2 (DN 65)** and Larger: Steel pipe with welded and flanged joints or grooved mechanical-joint couplings.
- C. Condenser Water: Steel pipe with welded and flanged joints or grooved mechanical-joint couplings. Direct buried condenser water pipe shall be encased with 3/8" coaltar coating and crosslaminated PE film of 0.004 inch minimum thickness.
- D. Condensate Drain Lines: **Type M (Type C)** drawn-temper copper tubing with soldered joints.
- E. Hot and chilled water: Below grade, use pre-insulated pipe system. Install with 36" minimum cover and per manufacturer's recommendations.

### 3.2 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 each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves at each branch connection to return mains, at return connections 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.

### 3.3 PIPING INSTALLATIONS

- A. Refer to Division 15 Section "Mechanical Materials and Methods" for basic piping installation requirements.
- B. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- C. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) ball valve, and short NPS 3/4 (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- D. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- E. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- F. 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.
- G. Install strainers on supply side of each control valve, pressure-reducing valve, solenoid valve, pump, and elsewhere as indicated. Install NPS 3/4 (DN 20) nipple and ball valve in blowdown connection of strainers NPS 2 (DN 50) and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2 (DN 50). Extend blowdown piping to nearest floor drain.
- H. Anchor piping for proper direction of expansion and contraction.

### 3.4 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 15 Section "Hangers and Supports." Comply with requirements below for maximum spacing of supports.
- B. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet (6 m) long.
  - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet (6 m) or longer.
  - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
  - 4. Spring hangers to support vertical runs.
  - 5. 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 3/4 (DN 20): Maximum span, 7 feet (2.1 m); minimum rod size, 1/4 inch (6.4 mm).

2. **NPS 1 (DN 25):** Maximum span, **7 feet (2.1 m)**; minimum rod size, **1/4 inch (6.4 mm)**.
3. **NPS 1-1/2 (DN 40):** Maximum span, **9 feet (2.7 m)**; minimum rod size, **3/8 inch (10 mm)**.
4. **NPS 2 (DN 50):** Maximum span, **10 feet (3 m)**; minimum rod size, **3/8 inch (10 mm)**.
5. **NPS 2-1/2 (DN 65):** Maximum span, **11 feet (3.4 m)**; minimum rod size, **3/8 inch (10 mm)**.
6. **NPS 3 (DN 80):** Maximum span, **12 feet (3.7 m)**; minimum rod size, **3/8 inch (10 mm)**.
7. **NPS 4 (DN 100):** Maximum span, **14 feet (4.3 m)**; minimum rod size, **1/2 inch (13 mm)**.
8. **NPS 6 (DN 150):** Maximum span, **17 feet (5.2 m)**; minimum rod size, **1/2 inch (13 mm)**.
9. **NPS 8 (DN 200):** Maximum span, **19 feet (5.8 m)**; minimum rod size, **5/8 inch (16 mm)**.
10. **NPS 10 (DN 250):** Maximum span, **20 feet (6.1 m)**; minimum rod size, **3/4 inch (19 mm)**.
11. **NPS 12 (DN 300):** Maximum span, **23 feet (7 m)**; minimum rod size, **7/8 inch (22 mm)**.
12. **NPS 14 (DN 350):** Maximum span, **25 feet (7.6 m)**; minimum rod size, **1 inch (25 mm)**.
13. **NPS 16 (DN 400):** Maximum span, **27 feet (8.2 m)**; minimum rod size, **1 inch (25 mm)**.
14. **NPS 18 (DN 450):** Maximum span, **28 feet (8.5 m)**; minimum rod size, **1-1/4 inches (32 mm)**.
15. **NPS 20 (DN 500):** Maximum span, **30 feet (9.1 m)**; minimum rod size, **1-1/4 inches (32 mm)**.

D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. **NPS 3/4 (DN 20):** Maximum span, **5 feet (1.5 m)**; minimum rod size, **1/4 inch (6.4 mm)**.
2. **NPS 1 (DN 25):** Maximum span, **6 feet (1.8 m)**; minimum rod size, **1/4 inch (6.4 mm)**.
3. **NPS 1-1/2 (DN 40):** Maximum span, **8 feet (2.4 m)**; minimum rod size, **3/8 inch (10 mm)**.
4. **NPS 2 (DN 50):** Maximum span, **8 feet (2.4 m)**; minimum rod size, **3/8 inch (10 mm)**.
5. **NPS 2-1/2 (DN 65):** Maximum span, **9 feet (2.7 m)**; minimum rod size, **3/8 inch (10 mm)**.
6. **NPS 3 (DN 80):** Maximum span, **10 feet (3 m)**; minimum rod size, **3/8 inch (10 mm)**.

E. Support vertical runs at roof, at each floor, and at **10-foot (3-m)** intervals between floors.

### 3.5 PIPE JOINT CONSTRUCTION

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" 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.

### 3.6 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents in mechanical equipment rooms only at high points of system piping, at heat-transfer coils, and elsewhere as required for system air venting.
- C. Install dip-tube fittings in boiler outlet. Install piping to expansion tank with a 2 percent upward slope toward tank. Connect boiler-outlet piping.
- D. Install air separator in pump suction lines.
- E. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than **48 inches (1200 mm)** above floor.
- F. Install expansion tanks on floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system design requirements.

### 3.7 TERMINAL EQUIPMENT CONNECTIONS

- A. Size for supply and return piping connections shall be same as for equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If multiple, parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure and temperature gages at coil inlet connections.

### 3.8 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, and to sustain the following water characteristics:
  - 1. Copper: 200-500 ppm
  - 2. pH: 7.0-8.5
- B. Fill system and perform initial chemical treatment.

### 3.9 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.

### 3.10 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.

### 3.11 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 15181

## SECTION 15189 – HVAC WATER TREATMENT

### General

- I. Section Includes
  - A. Furnish and install water treatment for HVAC piping systems; including:
    1. Cleaning of piping systems.
    2. Chemical feeder equipment.
    3. Treatment for closed loop system(s).
    4. Provide monthly service for 1 year after the date of substantial completion
- II. Related Sections
  - A. Section 15628- Scroll Water Chillers.
- III. Submittals
  - A. Include product data for all chemical treatment materials, chemicals and equipment.
  - B. Include manufacturer's installation instruction.
  - C. Provide operation and maintenance manual.
- IV. Maintenance Service
  - A. Provide service and maintenance of treatment systems for one year from Date of Substantial Completion.
  - B. Provide monthly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.
  - C. Provide laboratory and technical assistance services for warranty period.
  - D. Include one four hour training course for operating personnel, instructing them on installation, care, maintenance, testing and operation of water treatment systems. Arrange course at start-up of systems.
  - E. Provide on-site inspections of equipment during scheduled or emergency shutdown.
  - F. Evaluate success of water treatment program and make recommendations in writing based upon these inspections.
  - G. Provide sufficient chemicals for treatment and testing during warranty period.

### Part 2 - Products

I. Manufactures

1. AquaLogic Water Consulting, LLC (no substitutions accepted)
2. Availabe Manufacturers subject to compliance with requirements.

II. Materials

A. System Cleaner

1. Liquid alkaline compound with emulsifying agents and detergents to remove grease, mill scale, and petroleum products. Chemical shall be AquaLogic's Logiclean prepping compound.
2. Algaecide; shall be AquaLogic's Aquacar 45 glutaraldehyde 45%.

B. Closed System Treatment

1. Sequestering agent to reduce deposits and adjust pH.
2. Corrosion inhibitor; liquid boron-nitrite, sodium nitrite and borax, tolytriazole, low molecular weight polymers. Chemical shall be AquaLogic's CL-3000 inhibiting compound.

III. Equipment

- A. Bypass filter feeder: Five gallon cartridge type filter housing with legs, as shown on the drawings, quick opening cap for working pressure of 200 psig. Construction materials which are impervious to the products being used. Product manufactured by Vector Industries model number FA-1000 AL. Filter shall be 50 micron and be changed monthly during the initial 12 months of system operation.
- B. Corrosion coupon rack: Two station ¾" corrosion coupon rack with quick disconnect holders, built to ASME specifications, polyethylene panel mounted with clear PVC piping over coupon, 0-10 GPM Blue & White flow indicator. Product manufactured by Advantage Controls, Inc. model number ARC-20-BG for chilled water and ARC-25-H for hot water.
- C. Water meter: displacement type cold water meter with sealed, tamper-proof magnetic drive. Installed on make line to each system.
- D. Provide test kits to monitor inhibitor levels and reagents during warranty period.

Part 3 – Execution

A. Preparation



1. Provide systems which are operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
2. Place all control valves in open position for cleaning.

#### B. Cleaning Sequence

1. Add cleaner to closed systems at concentration as recommended by AquaLogic. Circulate for 48 hours and flush as quickly as possible until water is clean and approved by water treatment representative.
2. Remove, clean, and replace strainer screens.
3. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

#### Part 4- Closed System Treatment

1. Provide one bypass filter feeder on each system. Install isolating and drain valves and necessary piping. Install around ball valve downstream of circulating pumps unless indicated otherwise.
2. Introduce closed system treatment through filter feeder when required or indicated by test.
3. Provide  $\frac{3}{4}$ " corrosion coupon rack around circulating pumps with space for two test coupons. Coupons will be analyzed every 90 days.
4. Provide water meter on system make-up.
5. Introduce algaecide into system through filter feeder.
6. Submit reports indicating analysis of system water after cleaning and after treatment.

END OF SECTION

## **SECTION 15269 – VARIABLE FREQUENCY CONTROLLERS**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Variable Frequency Drives (VFDs)

#### **1.2 REFERENCES**

- A. UL 508
- B. NEC
- C. Canadian Underwriters Laboratory (C-UL)

#### **1.3 SUBMITTALS**

- A. Submit manufacturer's performance data including dimensional drawings, power circuit diagrams, installation and maintenance manuals, warranty description, VFD's FLA rating, certification agency file numbers and catalog information.
- B. The specification lists the minimum VFD performance requirements for this project. Each supplier shall list any exceptions to the specification. If no departures from the specification are identified, the supplier shall be bound by the specification.

#### **1.4 WARRANTY**

- A. The VFD shall be warranted by the manufacturer for a period of 60 months from date of shipment. The warranty shall include parts, labor, travel costs and living expenses incurred by the manufacturer to provide factory authorized on-site service. The warranty shall be provided by the VFD manufacturer.

### **PART 2 - PRODUCTS**

#### **2.1 MANUFACTURERS**

- A. Graham VLT 6000 Series
- B. ABB Power Distribution
- C. MagneTek Drives
- D. Toshiba International
- E. Yaskawa

#### **2.2 GENERAL**

- A. Furnish complete variable frequency drives (VFDs) as specified herein for the fans and pumps designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. VFD shall be housed in a metal NEMA 1 enclosure for indoor applications unless installed within same room as water pumps. NEMA 12 enclosure shall be utilized for indoor applications within rooms with water pumps. NEMA 3R enclosure shall be used in all outdoor applications. The VFD's UL listing shall allow mounting in plenum or other air handling compartments.
- B. The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control and to eliminate the need for

motor derating.

- C. With the motor's rated voltage applied to the VFD input, the VFD shall allow the motor to produce full rated power at rated amps, RMS fundamental volts, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3<sup>rd</sup> harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.
- D. The VFD shall include an input full-wave bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.
- E. The VFD and options shall be tested to ANSI/UL Standard 508. The complete VFD, including all specified options, shall be assembled by the manufacturer, which shall be UL-508 certified for the building and assembly of option panels. Assembly of the option panels by a third-party panel shop is not acceptable. The appropriate UL stickers shall be applied to both the VFD and option panel, in the case where these are not contained in one panel. When these VFDs are to be located in Canada, CSA or C-UL certifications shall apply. Both VFD and option panel shall be manufactured in ISO 9001 certified facilities.
- F. The VFD shall be CE marked, and conform to product standard EN 61800-3.
- G. The VFD shall have a dual 5% DC link reactor on the positive and negative rails of the DC bus to minimize power line harmonics and protect the drive from power line transients. The reactor shall be non-saturating (linear) to provide full harmonic filtering throughout the entire load range. VFDs with saturating (non-linear) DC link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.
- H. The VFD's full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting.
- I. The VFD shall be able to provide full torque at any selected frequency from 29 Hz to base speed to allow driving direct drive fans without derating.
- J. An automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continually monitor the motor's speed and load and adjust the applied voltage to maximize energy savings and provide up to an additional 3% to 10% energy savings.
- K. Input and output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD. Switching rate may be up to 1 time per minute on the input and unlimited on the output.
- L. An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to run the test.
- M. Galvanic and/or optical isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete I/O shall include additional isolation modules.
- N. VFD shall minimize the audible motor noise through the used of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD efficiencies while

reducing motor noise.

- O. All VFDs shall contain integral EMI filters to attenuate radio frequency interference conducted to the AC power line.

P. PROTECTIVE FEATURES

- 1) A minimum of Class 20 I<sup>2</sup>t electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor applications shall be provided.
- 2) Protection against input transients, loss of AC line phase, output short circuit, output ground fault, overvoltage, undervoltage, VFD overtemperature and motor overtemperature. The VFD shall display all faults in plain English. Codes are not acceptable.
- 3) Protect VFD from sustained power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output with an input voltage as low as 164 V AC for 208/230 volt units, 313 V AC for 460 volt units, and 394 volts for 600 volt units.
- 4) The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.
- 5) VFD package shall include semi-conductor rated input fuses to protect power components.
- 6) To prevent breakdown of the motor winding insulation, the VFD shall be designed to comply with IEC Part 34-17. Otherwise the VFD manufacturer must ensure that inverter rated motors are supplied.
- 7) VFD shall include a "signal loss detection" circuit to sense the loss of an analog input signal such as 4 to 20 mA or 2 to 10 V DC, and shall be programmable to react as desired in such an instance.
- 8) VFD shall function normally when the keypad is removed while the VFD is running and continue to follow remote commands. No warnings or alarms shall be issued as a result of removing the keypad.
- 9) VFD shall catch a rotating motor operating forward or reverse up to full speed.
- 10) VFD shall be rated for 100,000 amp interrupting capacity (AIC).
- 11) VFD shall include current sensors on all three output phases to detect and report phase loss to the motor. The VFD will identify which of the output phases is low or lost.
- 12) VFD shall continue to operate without faulting until input voltage reaches 300 V AC on 208/230 volt units, 539 V AC on 460 volt units, and 690 volts on 600 volt units.

Q. INTERFACE FEATURES

- 1) Hand/Start, Off/Stop and Auto/Start selector switches shall be provided to start and stop the VFD and determine the speed reference.
- 2) The VFD shall be able to be programmed to provide a 24 V DC output signal to indicate that the VFD is in Auto/Remote mode.

- 3) The VFD shall provide digital manual speed control. Potentiometers are not acceptable.
- 4) Lockable, alphanumeric backlit display keypad can be remotely mounted up to 10 feet away using standard 9-pin cable.
- 5) The keypads for all sizes of VFDs shall be identical and interchangeable.
- 6) To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD's keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters.
- 7) Display shall be programmable to display in 9 languages including English, Spanish and French.
- 8) The display shall have four lines, with 20 characters on three lines and eight large characters on one line.
- 9) A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.
- 10) A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD eliminating the need for macros.
- 11) The VFD shall include a standard EIA-485 communications port and capabilities to be connected to a Johnson Controls N2 Metasys, Siemens FLN or Modbus RTU system at no additional cost to the owner. The use of gateways is not acceptable. The connection shall be software selectable by the user.
- 12) As a minimum, the following points shall be controlled and/or accessible:
  - a. VFD Start/Stop
  - b. Speed reference
  - c. Fault diagnostics
  - d. Meter points
    - (1) Motor power in HP
    - (2) Motor power in kW
    - (3) Motor kW-hr
    - (4) Motor current
    - (5) Motor voltage
    - (6) Hours run
    - (7) Feedback signal #1

- (8) Feedback signal #2
- (9) DC link voltage
- (10) Thermal load on motor
- (11) Thermal load on VFD
- (12) Heatsink temperature
- 13) Four additional Form C 230 volt programmable relays shall be available for factory or field installation within the VFD.
- 14) LonWorks communication shall be available for factory or field installation within the VFD.
- 15) BACnet communication shall be available for factory or field installation.
- 16) Two set-point control interface (PID control) shall be standard in the unit. VFD shall be able to look at two feedback signals, compare with two set-points and make various process control decisions.
- 17) Floating point control interface shall be provided to increase/decrease speed in response to contact closures.
- 18) Four simultaneous displays shall be available. They shall include frequency or speed, run time, output amps and output power. VFDs unable to show these four displays simultaneously shall provide panel meters.
- 19) Sleep mode shall be provided to automatically stop the VFD when its speed drops below set "sleep" level for a specified time. The VFD shall automatically restart when the speed command exceeds the set "wake" level.
- 20) The sleep mode shall be functional in both follower mode and PID mode.
- 21) Run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of sending an output signal as a start command to actuate external equipment before allowing the VFD to start.
- 22) The following displays shall be accessible from the control panel in actual units: Reference Signal Value in actual units, Output Frequency in Hz or percent, Output Amps, Motor HP, Motor kW, kWhr, Output Voltage, DC Bus Voltage, VFD Temperature in degrees, and Motor Speed in engineering units per application (in GPM, CFM, etc.). VFD will read out the selected engineering unit either in a linear, square or cubed relationship to output frequency as appropriate to the unit chosen.
- 23) The display shall be programmed to read in inches of water column (in-wg) for an air handler application, pressure per square inch (psi) for a pump application, and temperature (°F) for a cooling tower application.
- 24) VFD shall be able to be programmed to sense the loss of load and signal a no load/broken belt warning or fault.
- 25) If the temperature of the VFD's heat sink rises to 80°C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. If the temperature of the heat sink

continues to rise the VFD shall automatically reduce its output frequency to the motor. As the VFD's heat sink temperature returns to normal, the VFD shall automatically increase the output frequency to the motor and return the carrier frequency to its normal switching speed.

- 26) The VFD shall have temperature controlled cooling fans for quiet operation and minimized losses. At low loads or low ambients the fans may be off even when the drive is running.
- 27) The VFD shall store in memory the last 10 faults and related operational data.
- 28) Eight programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
- 29) Two programmable relay outputs, one Form C 240 V AC, one Form A 30 V AC, shall be provided for remote indication of VFD status.
- 30) Three programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include two voltage (0 to 10 V DC, 2 to 10 V DC) and one current (0 to 20 mA, 4 to 20 mA) input.
- 31) Two programmable 0 to 20 mA analog outputs shall be provided for indication of VFD status. These outputs shall be programmable for output speed, frequency, current and power. They shall also be programmable to provide a selected 24 V DC status indication.
- 32) Standard programmable firefighter's override mode allows a digital input to control the drive and override all other local or remote commands and ignoring most normal drive safety circuits. If equipped with bypass, the VFD may be programmed to switch to bypass immediately or only if the drive fails. The VFD's keypad shall display FIREMODE whenever in firefighter's override mode, even when running in bypass.
- 33) A real-time clock shall be available, mounted in the drive, displaying through the keypad. The clock shall not require a battery, eliminating the need for battery replacement. Twenty programmable time periods, with individually selectable ON and OFF functions shall be available. All drive faults shall be time stamped to aid troubleshooting.

## R. ADJUSTMENTS

- 1) The VFD shall have an adjustable carrier frequency in steps of not less than 0.1 kHz to allow tuning the VFD to the motor.
- 2) Sixteen preset speeds shall be provided.
- 3) Four acceleration and four deceleration ramps shall be provided. Accel and decel time shall be adjustable over the range from 0 to 3,600 seconds to base speed. The shape of these curves shall be automatically contoured to ensure no-trip acceleration and deceleration.
- 4) Four current limit settings shall be provided.
- 5) If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: undervoltage, overvoltage, current limit and inverter overload.
- 6) The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.
- 7) An automatic "on delay" may be selected from 0 to 120 seconds.

## S. BYPASS

- 1) Provide an optional, manual 2-contactor bypass consisting of a door interlocked main fused disconnect padlockable in the off position, a built-in motor starter and a three position DRIVE/OFF/BYPASS switch controlling two contactors. In the DRIVE position, the motor is operated at an adjustable speed from the VFD. In the OFF position, the motor and VFD are disconnected. In the BYPASS position, the motor is operated at full speed from the AC power line and power is disconnected from the VFD so that service can be performed. In case of an external safety fault, a customer supplied normally closed dry contact shall be able to stop the motor whether in DRIVE or BYPASS mode.

## T. SERVICE CONDITIONS

- 1) Ambient temperature, -10 to 40°C (14 to 104°F).
- 2) 0 to 95% relative humidity, non-condensing.
- 3) Elevation to 3,300 feet without derating.
- 4) AC line voltage variation, -10 to +10% of nominal with full output.
- 5) No side clearance shall be required for cooling of any units. All power and control wiring shall be done from the bottom.

## U. QUALITY ASSURANCE

- 1) To ensure quality and minimize infantile failures at the jobsite, the complete VFD shall be tested by the manufacturer. The VFD shall operate a dynamometer at full load and speed and shall be cycled during the test.
- 2) All optional features shall be functionally tested at the factory for proper operation.

## PART 3 - EXECUTION

### 3.1 START-UP SERVICE

- A. The manufacturer shall provide start-up commissioning of the variable frequency drive and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. The commissioning personnel shall be the same personnel that will provide the factory service and warranty repairs at the customer's site. Sales personnel and other agents who are not factory certified technicians for VFD field repair shall not be acceptable as commissioning agents. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system. Start-up shall include customer operator training at the time of the equipment commissioning.

### 3.2 EXAMINATION

- A. Contractor to verify that job site conditions for installation meet factory recommended and code-required conditions for VFD installation prior to start-up, including clearance spacing, temperature, contamination, dust, and moisture of the environment. Separate conduit installation of the motor wiring, power wiring, and control wiring, and installation per the manufacturer's recommendations shall be verified.



- B. The VFD is to be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD shall not be operated while the unit is covered.

END OF SECTION 15269

## 15725 – MODULAR AIR HANDLING UNITS

### PART 1: GENERAL

#### 1.01 SECTION INCLUDES

- A. Outdoor Air Handling Units.

#### 1.02 REFERENCES

- A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. AMCA 99 - Standards Handbook.
- C. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.
- D. AMCA 300 - Test Code for Sound Rating Air Moving Devices.
- E. AMCA 500 - Test Methods for Louver, Dampers, and Shutters.
- F. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
- G. AHRI 430 - Central-Station Air-Handling Units.
- H. AHRI 435 - Application of Central-Station Air-Handling Units.
- I. ASTM B117 - Standard Practice for Operating Salt Spray Apparatus.
- J. NEMA MG1 - Motors and Generators.
- K. NFPA 70 - National Electrical Code.
- L. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- M. UL 723 - Test for Surface Burning Characteristics of Building Materials.
- N. UL 900 - Test Performance of Air Filter Units.
- O. UL 1995 - Standard for Heating and Cooling Equipment.
- P. UL 94 - Test for Flammability of Plastic Materials for Parts in Devices and Appliances.
- Q. IBC 2000, 2003 - International Building Code.
- R. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
- S. NFPA 5000 - Building Construction and Safety Code.
- T. ASHRAE 90.1 Energy Code.
- U. AHRI Standard 1060 - Rating Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment.
- V. GSA 2003 Facilities Standard - 5.9 HVAC Systems and Components.

#### 1.03 SUBMITTALS

- A. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements. Computer generated fan curves for each air handling unit shall be submitted with specific design operating point noted. A computer generated psychrometric chart shall be submitted for each cooling coil with design points and final operating point clearly noted. Sound data for discharge, radiated and return positions shall be submitted by octave band for each unit. Calculations for required baserail heights to satisfy condensate trapping requirements of cooling coil shall be included.
- B. Product Data:
  - 1. Provide literature that indicates dimensions, weights, capacities, ratings, fan performance, finishes of materials, electrical characteristics, and connection requirements.

2. Provide data of filter media, filter performance data, filter assembly, and filter frames.
3. Provide manufacturer's installation instructions.

#### 1.04 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Air Handler products specified in this section must show a minimum five years documented experience and complete catalog data on total product.

#### 1.05 SAFETY AGENCY LISTED & CERTIFICATION

- A. Air Handling units shall be cETLus safety listed to conform with UL Standard 1995 and CAN/CSA Standard C22.2 No. 236. Units shall be accepted for use in New York City by the Department of Building, MEA 342-99-E.
- B. Air handler furnished with double width, double inlet (DWDI) fans and/or plenum fans where applicable, shall be certified in accordance with the central station air handling units certification program, which is based on AHRI Standard 430.
- C. Air handling unit water heating & cooling coils shall be certified in accordance with the forced circulation air cooling and air heating coils certification program, which is based on AHRI Standard 410.

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site.
- B. Accept products on site on factory-furnished shipping skids. Inspect for damage.
- C. Store in clean dry place and protect from construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

#### 1.07 WARRANTY

- A. Provide a manufacturers standard 1-year warranty for repair or replacement of defective parts. Warranty to begin 6 months from shipment or at startup, whichever occurs first.

### PART 2: PRODUCTS

#### 2.01 ACCEPTABLE MANUFACTURERS

- A. The following manufacturers are approved for use. No substitutions will be permitted.
  1. Daikin Applied 'Skyline' Air Handler shall be the basis of design.
  2. Carrier
  3. Trane

#### 2.02 GENERAL DESCRIPTION

- A. Configuration: Fabricate as detailed on prints.
- B. Performance: Conform to AHRI 410 and 430 Standards. See schedules on prints. (NOTE: Above does not apply to fan array)
- C. Acoustics: Sound power levels (dB) for the unit shall not exceed the specified levels shown on the unit schedule. The manufacturer shall provide the necessary sound treatment to meet these levels if required.

#### 2.03 UNIT CONSTRUCTION

- A. Fabricate unit with heavy gauge channel posts and panels secured with mechanical fasteners. All panels, access doors, and ship sections shall be sealed with permanently applied bulb-type gasket. Shipped loose gasketing is not allowed.
- B. Panels and access doors shall be constructed as a 2-inch nominal thick; thermal broke double wall assembly, injected with foam insulation with an R-value of not less than R-13.
  - 1. The outer panel shall be constructed of G60 painted galvanized steel.
  - 2. The inner liner shall be constructed of solid stainless steel.
  - 3. The floor plate shall be constructed as specified for the inner liner.
  - 4. Unit will be furnished with solid inner liners.
- C. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, maximum 5 inches of positive or 6 inches of negative static pressure. Deflection shall be measured at the panel midpoint.
- D. The casing leakage rate shall not exceed .5 cfm per square foot of cabinet area at 5 inches of positive static pressure or 6 inches of negative static pressure (.0025 m<sup>3</sup>/s per square meter of cabinet area at 1.24 kPa static pressure).
- E. Module to module field assembly shall be accomplished with an overlapping, full perimeter internal splice joint that is sealed with bulb type gasketing on both mating modules to minimize on-site labor and meet indoor air quality standards.
- F. Access doors shall be flush mounted to cabinetry, with minimum of two six inch long stainless steel piano-type hinges, latch and full size handle assembly. Access doors shall swing outward for unit sections under negative pressure. Access doors on positive pressure sections, shall have a secondary latch to relieve pressure and prevent injury upon access.
- G. Provide cross broke roofcap system to divert water from the top surface of the air handler. The rain shed roofcap shall have 2"standing seams covered with splice cap channels to seal top seam. Splice cap shall break down over sides of standing seam to protect the ends of the seam.
  - 1. Rooftop air handler cooling coil piping shall extend through the unit casing for field connection. The installing contractor shall insure that connecting piping is protected from weather.
- H. The unit shall have a 6-inch curb ready base for structural rigidity and condensate trapping. The curb-ready base shall be designed with sloped drip pans located under all unit sections except duct openings and shall be supported by frame member.
- I. Roof curb kit of 16-inch height shall provide support for the air handler on the building roof and provide a weather protected area for terminating and securing the roof membrane. The roof curb kit shall be manufactured by the air handler unit manufacturer.
- J. Construct drain pans from stainless steel with cross break and double sloping pitch to drain connection. Provide drain pans under cooling coil section. Drain connection centerline shall be a minimum of 3" above the base rail to aid in proper condensate trapping. Drain connections that protrude from the base rail are not acceptable. There must be a full 2" thickness of insulation under drain pan. Drain pans shall extend 12" past the leaving face of the cooling coil.

## 2.04 FAN ASSEMBLIES

- A. Acceptable fan assembly shall be a single width, single inlet, class II, belt-drive type plenum fan dynamically balanced as an assembly, as shown in schedule. Maximum fan RPM shall be below first critical fan speed. Fan assemblies shall be dynamically balanced by the manufacturer on all three planes and at all bearing supports. Copper lubrication lines shall be provided and extend from the bearings and attached with grease fittings to the fan base assembly near access door. If not supplied at the factory, contractor shall mount copper lube lines in the field. Fan and motor shall be mounted internally on a steel base. Provide access to motor, drive, and bearings through hinged access door.
- B. Fan and motor shall be mounted internally on a steel base. Factory mount motor on slide base that can be slid out the side of the unit if removal is required. Provide access to motor, drive, and bearings through hinged access door. Fan and motor assembly shall be mounted on 2" deflection spring vibration type isolators inside cabinetry.

#### 2.05 BEARINGS, SHAFTS, AND DRIVES

- A. Bearings: Basic load rating computed in accordance with AFBMA - ANSI Standards. The bearings shall be designed for service with an L-50 life of 200,000 hours and shall be a heavy duty pillow block, self-aligning, grease-lubricated ball or spherical roller bearing type.
- B. Shafts shall be solid, hot rolled steel, ground and polished, keyed to shaft, and protectively coated with lubricating oil. Hollow shafts are not acceptable.
- C. V-Belt drives shall be cast iron or steel sheaves, dynamically balanced, bored to fit shafts and keyed. Fixed sheaves, matched belts, and drive rated based on motor horsepower. Minimum of 2 belts shall be provided on all fans with 10 HP motors and above. Standard drive service factor minimum shall be 1.1 S.F. for 1/4 HP – 7.5 HP, 1.3 S.F. for 10 HP and larger, calculated based on fan brake horsepower.

#### 2.06 ELECTRICAL

- A. The air handler(s) shall be ETL and ETL-Canada listed by Intertek Testing Services, Inc. Units shall conform to bi-national standard ANSI/UL Standard 1995/CSA Standard C22.2 No. 236.
- B. Fan motors shall be manufacturer provided and installed, Open Drip Proof, premium efficiency (meets or exceeds EPart requirements), 1750 RPM, single speed, 460V / 60HZ / 3P. Complete electrical characteristics for each fan motor shall be as shown in schedule.
- C. Wiring Termination: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclosed terminal lugs in terminal box sized to NFPA 70.
- D. Manufacturer shall provide ASHRAE 90.1 Energy Efficiency equation details for individual equipment to assist Building Engineer for calculating system compliance.
- E. Installing contractor shall provide GFI receptacle within 25 feet of unit to satisfy National Electrical Code requirements.
- F. All electrical connection components shall be field provided and mounted as shown on project schedule.

#### 2.07 COOLING AND HEATING COILS

- A. Certification: Acceptable water cooling, water heating, steam, and refrigerant coils shall be certified in accordance with AHRI Standard 410 and bear the AHRI label. Coils exceeding

the scope of the manufacturer's certification and/or the range of AHRI's standard rating conditions will be considered provided the manufacturer is a current member of the AHRI Forced Circulation Air-Cooling and Air-Heating Coils certification programs and that the coils have been rated in accordance with AHRI Standard 410. Manufacturer must be ISO 9002 certified.

- B. Water cooling coil shall be provided. Provide access to coil(s) for service and cleaning. Enclose coil headers and return bends fully within unit casing. Unit shall be provided with coil connections that extend a minimum of 5" beyond unit casing for ease of installation. Drain and vent connections shall be provided exterior to unit casing. Coil connections must be factory sealed with grommets on interior and exterior panel liners to minimize air leakage and condensation inside panel assembly. If not factory packaged, Contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.
1. Headers shall consist of seamless copper tubing to assure compatibility with primary surface. Headers to have intruded tube holes to provide maximum brazing surface for tube to header joint, strength, and inherent flexibility. Header diameter should vary with fluid flow requirements.
  2. Fins shall have a minimum thickness of 0.0075 inch aluminum plate construction. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.
  3. Coil tubes shall be 5/8 inch OD seamless copper, 0.020 inch nominal tube wall thickness, expanded into fins, brazed at joints. 1/2 inch OD copper tubes will not be allowed.
  4. Coil connections shall be carbon steel, NPT threaded connection. Connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain fittings shall be furnished on the connections, exterior to the air handler. Vent connections provided at the highest point to assure proper venting. Drain connections shall be provided at the lowest point to insure complete drainage and prevent freeze-up.
  5. Coil casing shall be a formed channel frame of stainless steel.

## 2.08 FILTERS

- A. Furnish flat filter in mixing box section with 2-inch pleated MERV 8 filter with microbial resistant Intersept coating. Provide side loading and removal of filters.
- B. Filter media shall be UL 900 listed, Class I or Class II.

## 2.09 ADDITIONAL SECTIONS

- A. Mixing box section shall be provided with end outside air opening and bottom return air opening with or without parallel low leak airfoil damper blades. Dampers shall be hollow core galvanized steel airfoil blades, fully gasketed and have continuous vinyl seals between damper blades in a galvanized steel frame. Dampers shall have stainless steel jamb seals along end of dampers. Connecting linkage and ABS plastic end caps shall be provided

when return and outside air dampers are each sized for full airflow. Return and outside air dampers of different sizes must be driven separately. Damper Leakage: Leakage rate shall be less than two tenths of one percent leakage at 2 inches static pressure differential. Leakage rate tested in accordance with AMCA Standard 500.

- B. Provide factory mounted airflow measuring stations:

### PART 3: EXECUTION

#### 3.01 INSTALLATION

- A. Install in accordance with manufacturer's Installation & Maintenance instructions.

#### 3.02 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

#### 3.03 EXTRA MATERIALS

- A. Provide one extra set of fan belts and filters for each unit as shown on project schedule.

## SECTION 15815 - METAL DUCTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

1. Metal Ductwork.
2. Nonmetal ductwork.
3. Casing and plenums.
4. Kitchen hood ductwork.
5. Dishwasher exhaust ductwork.
6. Hangers and supports.

- B. References:

1. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel; 1997a.
2. ASTM A 366/A 366M - Standard Specification for Commercial Steel (CS) Sheet, Carbon, (0.15 Maximum Percent) Cold Rolled; 1997.
3. ASTM A 569/A 569M - Standard Specification for Steel, Carbon (0.15 Maximum Percent), Hot-Rolled Sheet and Strip Commercial; 1998.
4. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 1998.
5. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems; National Fire Protection Association; 1996.
6. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems; National Fire Protection Association; 1996.
7. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; National Fire Protection Association; 1994.
8. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; latest Edition.
9. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Underwriters Laboratories Inc.; 1996.



### 1.3 PERFORMANCE REQUIREMENTS

- A. Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", latest edition and NFPA 90A.
- B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

### 1.4 SUBMITTALS

- A. Product Data: For each type of the following products:
  - 1. Liners and adhesives.
  - 2. Sealants and gaskets.
  - 3. Duct Construction Standards (DCS) for each pressure class required for this project. DCS shall include transverse and longitudinal joint type, any internal or external reinforcement and sheetmetal thickness and size for each pressure class.
  - 4. Flexible duct manufacturer, type and product details.
  - 5. Flexible connection materials and connection types.
  - 6. Fitting fabrication details.
  - 7. Damper details.
  - 8. Description of hanger types and sizes for duct sizes used in this project. Hangers must comply with the latest edition of SMACNA's "HVAC Duct Construction Standards - Metal and Flexible". Hanger submittal should include hanger spacing to be used.
- B. Coordination Drawings: Provide drawings indicating fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work. Minimum scale of  $\frac{1}{4}'' = 1'0''$ . Coordinate duct location with other trades.
- C. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

### 1.5 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. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum 5 years of documented experience.

## 1.6 ENVIRONMENTAL REQUIREMENTS

- 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

### 2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Construct with a radius of not less than 1-1/2 times width of duct on centerline. Where not possible, provide a centerline radius of 1.0 times the width of duct. Where space constraints will not allow a centerline radius of 1.0 times the width of duct, provide rectangular elbows with double wall (airfoil) factory fabricated turning vanes installed on vane runner rails. Turning vanes shall not be used in bends other than 90 degrees.
  - 1. Branch connections shall be 45 degree entry fittings.
- C. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

### 2.2 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. McGill AirFlow LLC.
  - 2. SPOT
  - 3. SEMCO
- B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.
- C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated. If duct is exposed to the weather, provide a continuous sheetmetal hat channel over all transverse joints and position openings in longitudinal seams facing in the direction of

possible water flow. Provide a flexible, adhesive aluminum jacket designed for this application over entire duct surface per manufacturer's recommendations.

- D. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
  - 1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.
  - 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
  - 3. Coat insulation with antimicrobial coating.
  - 4. Cover insulation with polyester film complying with UL 181, Class 1.
  - 5. Insulation thickness to be 2 inches.
- E. Inner Duct: Minimum 0.028-inch (0.7-mm) solid sheet steel.

### 2.3 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Lindab Inc.
    - b. McGill AirFlow LLC.
    - c. SEMCO Incorporated.
    - d. Sheet Metal Connectors, Inc.
    - e. SPOT
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 1. Transverse Joints in Ducts Larger Than 36 Inches (1524 mm) in Diameter: Flanged.
- D. Longitudinal Seams: Round and flat oval duct must be spiral seam ductwork. Longitudinal seam snap-lock duct will not be allowed.
- E. Tees, Laterals and Bends: Fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and

Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Elbows and bends: Construct with a radius of not less than 1-1/2 times width of duct on centerline. Where not possible, provide a centerline radius of 1.0 times the width of duct. Elbows shall be of gored, pleated or stamped construction. 90 degree bends shall be a minimum of 5-gore. 45 degree bends shall be a minimum of 3 gore. Adjustable elbows will not be allowed.
2. Branch connections shall be conical, 45 deg. entry or lateral fittings.

## 2.4 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Lindab Inc.
  2. McGill AirFlow LLC.
  3. SEMCO Incorporated.
  4. SPOT
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.
- C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
  1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
    - a. Transverse Joints in Ducts Larger Than 36 Inches (1524 mm) in Diameter: Flanged.
  2. Longitudinal Seams: Round and flat oval duct must be spiral seam ductwork. Longitudinal seam snap-lock duct will not be allowed.
  3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- a. Elbows and bends: Construct with a radius of not less than 1-1/2 times width of duct on centerline. Where not possible, provide a centerline radius of 1.0 times the width of duct. Elbows shall be of gored, pleated or stamped construction. 90 degree bends shall be a minimum of 5-gore. 45 degree bends shall be a minimum of 3 gore. Adjustable elbows will not be allowed.
  - b. Branch connections shall be conical, 45 deg. entry or lateral fittings.
- D. Inner Duct: Minimum 0.028-inch (0.7-mm) solid sheet steel.
- E. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
  - 1. Maximum Thermal Conductivity: [0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K)] at 75 deg F (24 deg C) mean temperature.
  - 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
  - 3. Coat insulation with antimicrobial coating.
  - 4. Cover insulation with polyester film complying with UL 181, Class 1.

## 2.5 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G90 (Z275).
  - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- E. Aluminum Sheets: Comply with **ASTM B 209 (ASTM B 209M)** Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- F. Tie Rods: Galvanized steel, 3/8-inch (10-mm) minimum diameter.

## 2.6 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CertainTeed Corporation; Insulation Group.
    - b. Johns Manville.
    - c. Knauf Insulation.
    - d. Owens Corning.
  2. Maximum Thermal Conductivity:
    - a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.
    - b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F (0.033 W/m x K) at 75 deg F (24 deg C) mean temperature.
  3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
  4. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
    - a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Insulation Pins and Washers:
1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
  2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
- C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."
1. 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.
  2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
  3. Butt transverse joints without gaps, and coat joint with adhesive.

4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm (12.7 m/s).
7. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.
8. 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:
  - a. Fan discharges.
  - b. Intervals of lined duct preceding unlined duct.
  - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm (12.7 m/s) or where indicated.
9. 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.
  - a. Sheet Metal Inner Duct Perforations: 3/32-inch (2.4-mm) diameter, with an overall open area of 23 percent.
10. 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.

## 2.7 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Water-Based Joint and Seam Sealant:
  1. Application Method: Brush on.
  2. Solids Content: Minimum 65 percent.
  3. Shore A Hardness: Minimum 20.
  4. Water resistant.
  5. Mold and mildew resistant.
  6. VOC: Maximum 75 g/L (less water).
  7. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
  8. Service: Indoor or outdoor.

- 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- C. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

## 2.8 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1 (Table 4-1M), "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
  - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
  - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
  - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.



- 2.9 Insulated Flexible Ducts
- 2.10 Kitchen Exhaust Ducts
- 2.11 Dishwasher Exhaust Ducts

## PART 3 - EXECUTION

### 3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round and flat-oval ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 15 Section "Duct Accessories" for fire and smoke dampers.

- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

### 3.2 INSTALLATION OF EXPOSED DUCTWORK

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

### 3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

- A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.
- B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 20 feet (6 m) in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings. Locate access panel on top or sides of duct a minimum of 1-1/2 inches (38 mm) from bottom of duct.
- C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

### 3.4 DUCT SEALING

- A. Seal all duct according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
  - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 2. All duct: Seal Class A.

### 3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  - 1. Where practical, install concrete inserts before placing concrete.
  - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
  - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
  - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1 (Table 4-1M), "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet (5 m).
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### 3.6 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 15 Section "Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

### 3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:
  - a. Ducts with a Pressure Class Higher Than 3-Inch wg (750 Pa): Test representative duct sections, selected by Engineer from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

### 3.8 DUCT CLEANING

A. Clean existing duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 15 Section "Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
3. Supply-air ducts, dampers, actuators, and turning vanes.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Provide drainage and cleanup for wash-down procedures.
6. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

### 3.9 DUCT SCHEDULE

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

1. Underground Ducts: Concrete-encased, PVC-coated, galvanized sheet steel.

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

- a. Pressure Class: Positive [1-inch wg (250 Pa)]
- b. SMACNA Leakage Class for Rectangular: 12
- c. SMACNA Leakage Class for Round and Flat Oval: 12

2. Ducts Connected to Constant-Volume Air-Handling Units:

- a. Pressure Class: Positive 1-inch wg (500 Pa), or round up the ESP listed in the equipment schedules and provide, whichever is greater.
- b. SMACNA Leakage Class for Rectangular: 12
- c. SMACNA Leakage Class for Round and Flat Oval: 12

3. Ducts Connected to Variable-Air-Volume Air-Handling Units prior to terminal units:

- a. Pressure Class: Positive 3-inch wg (750 Pa)

- b. SMACNA Leakage Class for Rectangular: 12
  - c. SMACNA Leakage Class for Round and Flat Oval: 12
- C. Return, toilet exhaust and outside air ducts:
- 1. Pressure Class: Positive or negative 1-inch wg (250 Pa).
  - 2. SMACNA Leakage Class for Rectangular: 12
  - 3. SMACNA Leakage Class for Round and Flat Oval: 12
- D. Special Exhaust Ducts:
- 1. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.
    - a. Exposed to View: Type 304, stainless-steel sheet.
    - b. Concealed: Type 304, stainless-steel sheet.
    - c. Welded seams and joints.
    - d. Pressure Class: Positive or negative 4-inch wg (1000 Pa).
    - e. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
    - f. SMACNA Leakage Class: 3.
    - g. Minimum 18 gauge or thickness required per local code, whichever is greater
  - 2. Ducts Connected to Dishwasher Hoods:
    - a. Type 304, stainless-steel sheet.
    - b. Welded seams and flanged joints with watertight EPDM gaskets.
    - c. Pressure Class: Positive or negative 2-inch wg (500 Pa).
    - d. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
    - e. SMACNA Leakage Class: 3.
    - f. Minimum 18 gauge or thickness required per local code, whichever is greater
- E. Duct Exposed to View
- 1. Supply Air Ducts: shall be double wall spiral round construction with 1" thick insulation in conditioned spaces and 2" insulation in unconditioned spaces.
  - 2. Return and Exhaust Air Ducts: shall be un-insulated single wall spiral round construction in conditioned spaces and double wall round construction with 1" insulation in unconditioned spaces.

END OF SECTION 15815

## SECTION 15820 - DUCT ACCESSORIES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following:

1. Backdraft dampers.
2. Volume dampers.
3. Motorized control dampers.
4. Fire dampers.
5. Smoke dampers.
6. Combination fire and smoke dampers.
7. Turning vanes.
8. Duct-mounting access doors.
9. Flexible connectors.
10. Flexible ducts.
11. Duct accessory hardware.
12. Louvers.

- B. Related Sections include the following:

1. Division 13 Section "Fire Alarm" for duct-mounting fire and smoke detectors.

#### 1.3 SUBMITTALS

- A. Product Data: For the following:

1. Backdraft dampers.
2. Volume dampers.
3. Motorized control dampers.
4. Fire dampers.
5. Smoke dampers.
6. Combination fire and smoke dampers.
7. Turning vanes.
8. Duct-mounting access doors.
9. Flexible connectors.
10. Flexible ducts.

- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Special fittings.
  - 2. Manual-volume damper installations.
  - 3. Motorized-control damper installations.
  - 4. Fire-damper, smoke-damper, and combination fire- and smoke-damper installations, including sleeves and duct-mounting access doors.
  - 5. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Reflected ceiling plans, drawn to scale and coordinating penetrations and ceiling-mounting items. Show ceiling-mounting access panels and access doors required for access to duct accessories.

#### 1.4 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

#### 1.5 EXTRA MATERIALS

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

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

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

#### 2.2 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.
- 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. Stainless Steel: ASTM A 480/A 480M.
- D. Aluminum Sheets: **ASTM B 209 (ASTM B 209M)**, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: **ASTM B 221 (ASTM B 221M)**, alloy 6063, temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods: Galvanized steel, **1/4-inch (6-mm)** minimum diameter for lengths **36 inches (900 mm)** or less; **3/8-inch (10-mm)** minimum diameter for lengths longer than **36 inches (900 mm)**.

### 2.3 BACKDRAFT DAMPERS

- A. Manufacturers:
  1. CESCO Products.
  2. Greenheck.
  3. Ruskin Company.
- B. Description: Multiple-blade, parallel action gravity balanced, with blades of maximum **6-inch (150-mm)** width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.
- C. Frame: **20 gauge**, galvanized sheet steel, with welded corners and mounting flange.
- D. Blades: **0.025-inch-** thick, roll-formed aluminum.
- E. Blade Seals: Vinyl.
- F. Blade Axles: Stainless Steel.
- G. Tie Bars and Brackets: Galvanized steel.
- H. Basis of Design: Ruskin S3G.

### 2.4 VOLUME DAMPERS

- A. Manufacturers:
  1. Flexmaster U.S.A., Inc.
  2. METALAIRE, Inc.
  3. Nailor Industries Inc.
  4. Ruskin Company.
- B. General Description: 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. Pressure Classes of **2-Inch wg (750 Pa)** or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.
- C. 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.
1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of **22 gauge** thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
  2. Single Skin Steel Blades: **22 gauge**, galvanized sheet steel.
  3. Blade Axles: Galvanized steel.
  4. Bearings: Molded synthetic.
  5. Tie Bars and Brackets: Aluminum.
  6. Tie Bars and Brackets: Galvanized steel.
  7. Basis of Design: Ruskin MD 15 (rectangular) and MDRS25 (round).
- D. Jackshaft: **1-inch- (25-mm-)** diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.
- E. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of **3/32-inch- (2.4-mm-)** thick zinc-plated steel, and a **3/4-inch (19-mm)** hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

## 2.5 MOTORIZED CONTROL DAMPERS

- A. Manufacturers:
1. CESCO Products.
  2. Greenheck.
  3. METALAIR, Inc.
  4. Nailor Industries Inc.
  5. Ruskin Company.
- B. General Description: AMCA-rated, parallel (return air applications) or opposed (outside air applications) blade design; minimum of **16 gauge** thick, galvanized-steel frames with holes for duct mounting; minimum of **16 gauge** thick, galvanized-steel damper blades with maximum blade width of **8 inches (203 mm)**.

1. Secure blades to **1/2-inch- (13-mm-)** diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From **minus 40 to plus 200 deg F (minus 40 to plus 93 deg C)**.
3. Provide closed-cell neoprene edging rated for leakage at less than **10 cfm per sq. ft.** of damper area, at differential pressure of **1-inch wg**; when tested according to AMCA 500D.

C. Basis of Design: Ruskin CD35.

## 2.6 FIRE DAMPERS

A. Manufacturers:

1. CESCO Products.
2. Greenheck.
3. METALAIRE, Inc.
4. Nailor Industries Inc.
5. Ruskin Company.

B. Fire dampers shall be labeled according to UL 555.

C. Fire Rating: 1-1/2 hours (3 hours as needed).

D. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, **20 gauge** galvanized steel; with mitered and interlocking corners.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: **20 gauge** frame complies with sleeve requirements.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: 24 gauge, galvanized sheet steel. In place of interlocking blades, use full-length, **0.034-inch- (0.85-mm-)** thick, galvanized-steel blade connectors.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

I. Fusible Links: Replaceable, **165 deg F** rated.

J. Basis of Design: 1-1/2 hour – Ruskin 1BD2-B (rectangular) and FDR25 (round), 3 hour – Ruskin 1BD2-B3 (rectangular)

## 2.7 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:

1. CESCO Products.
2. Greenheck.

3. Nailor Industries Inc.
  4. Ruskin Company.
- B. General Description: Labeled according to UL 555S. Combination fire and smoke dampers shall be labeled according to UL 555 for 1-1/2-hour rating.
  - C. Fusible Links: Replaceable, 165 deg F rated.
  - D. Frame and Blades 16 gauge, galvanized sheet steel.
  - E. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application.
  - F. Damper Motors: Modulating and two-position action.
    1. Comply with requirements in Division 15 Section "Motors."
    2. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
    3. 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 (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).
    4. 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 (minus 40 deg C).
    5. Nonspring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m), size motor for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 300 in. x lbf (34 N x m).
    6. Electrical Connection: 115 V, single phase, 60 Hz.
  - G. Basis of Design: Ruskin FSD376.

## 2.8 TURNING VANES

- A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.
- B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- (38-mm-) wide, double-vane, curved blades of galvanized sheet steel set 3/4 inch (19 mm) o.c.; support with bars perpendicular to blades set 2 inches (50 mm) o.c.; and set into vane runners suitable for duct mounting.
- C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

## 2.9 DUCT-MOUNTING ACCESS DOORS

- A. General Description: Fabricate doors airtight and suitable for duct pressure class.

- B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch (25-by-25-mm) butt or piano hinge and cam latches.
1. Manufacturers:
    - a. CESCO Products.
    - b. Flexmaster U.S.A., Inc.
    - c. Greenheck.
    - d. Nailor Industries Inc.
  2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
  3. Provide number of hinges and locks as follows:
    - a. Less Than 12 Inches (300 mm) Square: Secure with two sash locks.
    - b. Up to 18 Inches (450 mm) Square: Two hinges and two sash locks.
    - c. Up to 24 by 48 Inches (600 by 1200 mm): Three hinges and two compression latches.
    - d. Sizes 24 by 48 Inches (600 by 1200 mm) and Larger: One additional hinge.
- C. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.
- D. Insulation: 1-inch- (25-mm-) thick, fibrous-glass or polystyrene-foam board.

## 2.10 FLEXIBLE CONNECTORS

- A. Manufacturers:
1. Ductmate Industries, Inc.
  2. Duro Dyne Corp.
  3. Ventfabrics, Inc.
  4. Ward Industries, Inc.
- B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
- C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Select metal compatible with ducts.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
  2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
  3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

- E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
  1. Minimum Weight: 24 oz./sq. yd. (810 g/sq. m).
  2. Tensile Strength: 530 lbf/inch (93 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.
  3. Service Temperature: Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C).

2.11 INSULATED ACOUSTICAL MEDIUM PRESSURE FLEXIBLE DUCT

- A. Where flexible duct is shown on drawings, provide Flexmaster Type 8M UL 181 Class I Air Duct or equal.
- B. The duct shall be constructed of a CPE fabric supported by helical wound galvanized steel. The fabric shall be mechanically locked to the steel helix without the use of adhesives or chemicals.
- C. The internal working pressure rating shall be at least 6" w.g. positive and 4" w.g. negative with a bursting pressure of at least 2 ½ time the working pressure
- D. The duct shall be rated for a velocity of at least 4000 feet per minute.
- E. The duct must be suitable for continuous operation at a temperature range of -20° F to +250° F.
- F. Acoustical performance, when tested by an independent laboratory in accordance with the Air Diffusion Council's Flexible Air Duct Test Code FD 72-R1, Section 3.0, Sound Properties, shall be as follows:
  1. The insertion loss (dB) of a 10 foot length of straight duct when tested in accordance with ASTM E477, at a velocity of 2500 feet per minute, shall be at least:

Octave Band	2	3	4	5	6	7
Hz.	125	250	500	1000	2000	4000
6" diameter	7	31	40	38	40	27
8" diameter	13	29	36	35	38	22
12" diameter	21	28	29	33	26	12

2. The radiated noise reduction (dB) of a 10 foot length of straight duct when tested in accordance with ASTM E477, at a velocity of 2500 feet per minute, shall be at least:

Octave Band	2	3	4	5	6	7
-------------	---	---	---	---	---	---

Hz.	12 5	25 0	50 0	100 0	200 0	400 0
6" diameter	5	8	7	8	11	15
8" diameter	10	7	7	8	10	13
12" diameter	9	6	6	5	9	13

3. The self generated sound power levels (LW) dB re 10<sup>-12</sup> Watt of a 10 foot length of straight duct for an empty sheet metal duct when tested in accordance with ASTM E477, at a velocity of 1000 feet per minute, shall not exceed:

Octave Band	2	3	4	5	6	7
Hz.	12 5	250	50 0	100 0	200 0	400 0
6" diameter	42	31	23	18	17	21
8" diameter	41	34	27	19	18	21
12" diameter	54	45	38	31	27	23

- G. Factory insulate the flexible duct with fiberglass insulation. Provide insulation as required by ASHRAE 90.1.
- H. Cover the insulation with a fire retardant metalized vapor barrier jacket reinforced with crosshatched scrim having a permeance of not greater than 0.05 perms when tested in accordance with ASTM #96, Procedure A.

## 2.12 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

## 2.13 LOUVERS

- A. Manufacturers:
1. Ruskin

2. Greenheck
- B. Description: Stationary-type louver with blades designed to prevent the penetration of wind driven rain.
1. Extended sill to drain water to building exterior.
  2. Extruded aluminum alloy as follows:
    - a. 5" deep frame with 0.081" wall thickness.
    - b. Blades shall be double drainable and sight proof.
    - c. Provide with aluminum screen.

## PART 3 - EXECUTION

### 3.1 APPLICATION AND INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- D. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.
- E. Provide test holes at fan inlets and outlets and elsewhere as indicated.
- F. Install fire and smoke dampers, with fusible links, according to manufacturer's UL-approved written instructions.
- G. Install duct silencers independent of ducts with flexible duct connectors, lagged with loaded vinyl sheet on inlets and outlets where indicated.
- H. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:
1. On both sides of duct coils.
  2. Downstream from volume dampers and equipment.
  3. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.
  4. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot (15-m) spacing.
  5. On sides of ducts where adequate clearance is available.



- I. Install the following sizes for duct-mounting, rectangular access doors:
  - 1. One-Hand or Inspection Access: 8 by 5 inches (200 by 125 mm).
  - 2. Two-Hand Access: 12 by 6 inches (300 by 150 mm).
  - 3. Head and Hand Access: 18 by 10 inches (460 by 250 mm).
  - 4. Head and Shoulders Access: 21 by 14 inches (530 by 355 mm).
  - 5. Body Access: 25 by 14 inches (635 by 355 mm).
  - 6. Body Plus Ladder Access: 25 by 17 inches (635 by 430 mm).
  
- J. Install the following sizes for duct-mounting, round access doors:
  - 1. One-Hand or Inspection Access: 8 inches (200 mm) in diameter.
  - 2. Two-Hand Access: 10 inches (250 mm) in diameter.
  - 3. Head and Hand Access: 12 inches (300 mm) in diameter.
  - 4. Head and Shoulders Access: 18 inches (460 mm) in diameter.
  - 5. Body Access: 24 inches (600 mm) in diameter.
  
- K. Label access doors according to Division 15 Section "Mechanical Identification."
  
- L. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.
  
- M. For fans developing static pressures of 5-inch wg (1250 Pa) and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
  
- N. Connect terminal units to supply ducts directly or with maximum 12-inch (300-mm) lengths of flexible duct. Do not use flexible ducts to change directions.
  
- O. Connect diffusers or light troffer boots to low pressure ducts with maximum 60-inch (1500-mm) lengths of flexible duct clamped or strapped in place.
  
- P. Connect flexible ducts to metal ducts with draw bands.
  
- Q. Install duct test holes where indicated and required for testing and balancing purposes.

### 3.2 ADJUSTING

- A. Adjust duct accessories for proper settings.
- B. Adjust fire and smoke dampers for proper action.
- C. Final positioning of manual-volume dampers is specified in Division 15 Section "Testing, Adjusting, and Balancing."

END OF SECTION 15820

## **SECTION 15950 - TESTING, ADJUSTING, AND BALANCING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

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

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Balancing Air Systems:
    - a. Constant-volume air systems.
    - b. Variable-air-volume systems.
  - 2. Balancing Hydronic Piping Systems:
    - a. Primary-secondary hydronic systems.

#### **1.3 DEFINITIONS**

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

#### **1.4 SUBMITTALS**

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 45 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

- C. Strategies and Procedures Plan: Within 90 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. Certified TAB reports.
- E. Sample report forms.
- F. Instrument calibration reports, to include the following:
  - 1. Instrument type and make.
  - 2. Serial number.
  - 3. Application.
  - 4. Dates of use.
  - 5. Dates of calibration.

#### 1.5 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.
- B. TAB Conference: Meet with Architect & Owner's representative on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.
  - 1. Agenda Items:
    - a. The Contract Documents examination report.
    - b. The TAB plan.
    - c. Coordination and cooperation of trades and subcontractors.
    - d. Coordination of documentation and communication flow.
- C. Certify TAB field data reports and perform the following:
  - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
  - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard TAB contractor's forms approved by Engineer.
- E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

#### 1.6 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.

## 1.7 COORDINATION

- A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

## PART 2 - PRODUCTS (Not Applicable)

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 15 Section "Metal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
  - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
  - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's

"HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

### 3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare 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.

### 3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
  - 1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
  - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
  - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 15 Section "Duct Accessories."
  - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 15 Section "HVAC Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

### 3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

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

- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Division 15 Section "Metal Ducts."

### 3.5 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 total airflow.
    - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
  - 2. Measure fan static pressures as follows to determine actual static pressure:
    - a. Measure outlet static pressure as far downstream from the fan as practical 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 the 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.
  - 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
    - a. Report the cleanliness status of filters and the time static pressures are measured.
  - 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
  - 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
  - 6. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 15 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
  - 7. 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 mode to determine the maximum required brake horsepower.

- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
  - 1. Measure airflow of submain and branch ducts.
    - 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. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
  - 3. 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 air 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 air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch 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.

### 3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
  - 1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
  - 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
  - 3. Measure total system airflow. Adjust to within indicated airflow.
  - 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the



- air outlets downstream from terminal units the same as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
    - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
  6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
    - a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
  7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
  8. Record final fan-performance data.

### 3.7 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 the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. 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 liquid level in expansion tank.
  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.

### 3.8 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.

### 3.9 PROCEDURES FOR HEAT EXCHANGERS

- A. Measure water flow through all circuits.
- B. Adjust water flow to within specified tolerances.
- C. Measure inlet and outlet water temperatures.
- D. Measure inlet steam pressure.
- E. Check settings and operation of safety and relief valves. Record settings.

### 3.10 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
  - 1. Manufacturer's name, model number, and serial number.
  - 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 of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

### 3.11 PROCEDURES FOR CHILLERS

- A. Balance water flow through each evaporator to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, 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. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.

3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
6. Capacity: Calculate in tons of cooling.
7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

### 3.12 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

### 3.13 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:
  1. Entering- and leaving-water temperature.
  2. Water flow rate.
  3. Water pressure drop.
  4. Dry-bulb temperature of entering and leaving air.
  5. Wet-bulb temperature of entering and leaving air for cooling coils.
  6. Airflow.
  7. Air pressure drop.
- B. Measure, adjust, and record the following data for each electric heating coil:
  1. Nameplate data.
  2. Airflow.
  3. Entering- and leaving-air temperature at full load.
  4. Voltage and amperage input of each phase at full load and at each incremental stage.
  5. Calculated kilowatt at full load.
  6. Fuse or circuit-breaker rating for overload protection.
- C. Measure, adjust, and record the following data for each steam coil:
  1. Dry-bulb temperature of entering and leaving air.
  2. Airflow.
  3. Air pressure drop.
  4. Inlet steam pressure.
- D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

### 3.14 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
  2. Air Outlets and Inlets: Plus or minus 10 percent.
  3. Cooling-Water Flow Rate: Plus or minus 10 percent.

### 3.15 REPORTING

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

### 3.16 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
  2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Pump curves.
  2. Fan curves.
  3. Manufacturers' test data.
  4. Field test reports prepared by system and equipment installers.
  5. Other information relative to equipment performance; do not include Shop Drawings and product data.

- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
  2. Name and address of the TAB contractor.
  3. Project name.
  4. Project location.
  5. Architect's name and address.
  6. Engineer's name and address.
  7. Contractor's name and address.
  8. Report date.
  9. Signature of TAB supervisor who certifies the report.
  10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
  11. Summary of contents including the following:
    - a. Indicated versus final performance.
    - b. Notable characteristics of systems.
    - c. Description of system operation sequence if it varies from the Contract Documents.
  12. Nomenclature sheets for each item of equipment.
  13. Data for terminal units, including manufacturer's name, type, size, and fittings.
  14. Notes to explain why certain final data in the body of reports vary from indicated values.
  15. Test conditions for fans and pump performance forms including the following:
    - a. Settings for outdoor-, return-, and exhaust-air dampers.
    - b. Conditions of filters.
    - c. Cooling coil, wet- and dry-bulb conditions.
    - d. Face and bypass damper settings at coils.
    - e. Fan drive settings including settings and percentage of maximum pitch diameter.
    - f. Inlet vane settings for variable-air-volume systems.
    - g. Settings for supply-air, static-pressure controller.
    - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
  2. Water and steam flow rates.
  3. Duct, outlet, and inlet sizes.
  4. Pipe and valve sizes and locations.
  5. Terminal units.
  6. Balancing stations.
  7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:
  - a. Unit identification.
  - b. Location.
  - c. Make and type.
  - d. Model number and unit size.
  - e. Manufacturer's serial number.
  - f. Unit arrangement and class.
  - g. Discharge arrangement.
  - h. Sheave make, size in inches (mm), and bore.
  - i. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
  - j. Number, make, and size of belts.
  - k. Number, type, and size of filters.
  
2. Motor Data:
  - a. Motor make, and frame type and size.
  - b. Horsepower and rpm.
  - c. Volts, phase, and hertz.
  - d. Full-load amperage and service factor.
  - e. Sheave make, size in inches (mm), and bore.
  - f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
  
3. Test Data (Indicated and Actual Values):
  - a. Total air flow rate in cfm (L/s).
  - b. Total system static pressure in inches wg (Pa).
  - c. Fan rpm.
  - d. Discharge static pressure in inches wg (Pa).
  - e. Filter static-pressure differential in inches wg (Pa).
  - f. Preheat-coil static-pressure differential in inches wg (Pa).
  - g. Cooling-coil static-pressure differential in inches wg (Pa).
  - h. Heating-coil static-pressure differential in inches wg (Pa).
  - i. Outdoor airflow in cfm (L/s).
  - j. Return airflow in cfm (L/s).
  - k. Outdoor-air damper position.
  - l. Return-air damper position.
  - m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:
  - a. System identification.
  - b. Location.
  - c. Coil type.
  - d. Number of rows.

- e. Fin spacing in  **fins per inch (mm)** o.c.
  - f. Make and model number.
  - g. Face area in  **sq. ft. (sq. m)**.
  - h. Tube size in  **NPS (DN)**.
  - i. Tube and fin materials.
  - j. Circuiting arrangement.
2. Test Data (Indicated and Actual Values):
- a. Air flow rate in  **cfm (L/s)**.
  - b. Average face velocity in  **fpm (m/s)**.
  - c. Air pressure drop in  **inches wg (Pa)**.
  - d. Outdoor-air, wet- and dry-bulb temperatures in  **deg F (deg C)**.
  - e. Return-air, wet- and dry-bulb temperatures in  **deg F (deg C)**.
  - f. Entering-air, wet- and dry-bulb temperatures in  **deg F (deg C)**.
  - g. Leaving-air, wet- and dry-bulb temperatures in  **deg F (deg C)**.
  - h. Water flow rate in  **gpm (L/s)**.
  - i. Water pressure differential in  **feet of head or psig (kPa)**.
  - j. Entering-water temperature in  **deg F (deg C)**.
  - k. Leaving-water temperature in  **deg F (deg C)**.
  - l. Refrigerant expansion valve and refrigerant types.
  - m. Refrigerant suction pressure in  **psig (kPa)**.
  - n. Refrigerant suction temperature in  **deg F (deg C)**.
  - o. Inlet steam pressure in  **psig (kPa)**.
- G. Fan Test Reports: For supply, return, and exhaust fans, include the following:
- 1. Fan Data:
    - a. System identification.
    - b. Location.
    - c. Make and type.
    - d. Model number and size.
    - e. Manufacturer's serial number.
    - f. Arrangement and class.
    - g. Sheave make, size in  **inches (mm)**, and bore.
    - h. Center-to-center dimensions of sheave, and amount of adjustments in  **inches (mm)**.
  - 2. Motor Data:
    - a. Motor make, and frame type and size.
    - b. Horsepower and rpm.
    - c. Volts, phase, and hertz.
    - d. Full-load amperage and service factor.
    - e. Sheave make, size in  **inches (mm)**, and bore.
    - f. Center-to-center dimensions of sheave, and amount of adjustments in  **inches (mm)**.
    - g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):
  - a. Total airflow rate in **cfm** (L/s).
  - b. Total system static pressure in **inches wg** (Pa).
  - c. Fan rpm.
  - d. Discharge static pressure in **inches wg** (Pa).
  - e. Suction static pressure in **inches wg** (Pa).
  
- H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
  1. Report Data:
    - a. System and air-handling-unit number.
    - b. Location and zone.
    - c. Traverse air temperature in **deg F** (deg C).
    - d. Duct static pressure in **inches wg** (Pa).
    - e. Duct size in **inches** (mm).
    - f. Duct area in **sq. ft.** (sq. m).
    - g. Indicated air flow rate in **cfm** (L/s).
    - h. Indicated velocity in **fpm** (m/s).
    - i. Actual air flow rate in **cfm** (L/s).
    - j. Actual average velocity in **fpm** (m/s).
    - k. Barometric pressure in **psig** (Pa).
  
- I. Air-Terminal-Device Reports:
  1. Unit Data:
    - a. System and air-handling unit identification.
    - b. Location and zone.
    - c. Apparatus used for test.
    - d. Area served.
    - e. Make.
    - f. Number from system diagram.
    - g. Type and model number.
    - h. Size.
    - i. Effective area in **sq. ft.** (sq. m).
  
  2. Test Data (Indicated and Actual Values):
    - a. Air flow rate in **cfm** (L/s).
    - b. Air velocity in **fpm** (m/s).
    - c. Preliminary air flow rate as needed in **cfm** (L/s).
    - d. Preliminary velocity as needed in **fpm** (m/s).
    - e. Final air flow rate in **cfm** (L/s).
    - f. Final velocity in **fpm** (m/s).
    - g. Space temperature in **deg F** (deg C).



J. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

- a. Unit identification.
- b. Location.
- c. Service.
- d. Make and size.
- e. Model number and serial number.
- f. Water flow rate in **gpm (L/s)**.
- g. Water pressure differential in **feet of head or psig (kPa)**.
- h. Required net positive suction head in **feet of head or psig (kPa)**.
- i. Pump rpm.
- j. Impeller diameter in **inches (mm)**.
- k. Motor make and frame size.
- l. Motor horsepower and rpm.
- m. Voltage at each connection.
- n. Amperage for each phase.
- o. Full-load amperage and service factor.
- p. Seal type.

2. Test Data (Indicated and Actual Values):

- a. Static head in **feet of head or psig (kPa)**.
- b. Pump shutoff pressure in **feet of head or psig (kPa)**.
- c. Actual impeller size in **inches (mm)**.
- d. Full-open flow rate in **gpm (L/s)**.
- e. Full-open pressure in **feet of head or psig (kPa)**.
- f. Final discharge pressure in **feet of head or psig (kPa)**.
- g. Final suction pressure in **feet of head or psig (kPa)**.
- h. Final total pressure in **feet of head or psig (kPa)**.
- i. Final water flow rate in **gpm (L/s)**.
- j. Voltage at each connection.
- k. Amperage for each phase.

K. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

### 3.17 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
  - a. Measure airflow of at least 10 percent of air outlets.
  - b. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
  - c. Verify that balancing devices are marked with final balance position.
  - d. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Construction Manager.
3. Construction Manager shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

### 3.18 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

### 3.20 DUCT LEAKAGE TESTING

- A. Contractor shall prepare ductwork for leakage testing by test and balance firm. Contractor shall remake any joints and/or duct runs which do not comply with maximum allowable leakage rates for retest by test and balance firm. Mechanical Contractor shall be responsible for any compensation due to the test and balance firm for additional testing required as a result of initial system failure.
- B. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:
  1. Test ductwork assemblies in excess of 1-1/2 inch static pressure class installed by Mechanical Contractor.
  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. 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 (500 Pa) (both positive and negative pressures), and Leakage Class 6 for pressure classes from 2- to 10-inch wg (500 to 2500 Pa).

END OF SECTION 15950

## SECTION 15990 – FACILITY MANAGEMENT SYSTEM FOR HVAC

### PART 1 – GENERAL

#### 1.1 GENERAL SCOPE OF WORK

- A. The existing BCS from Trane shall be a BACnet-compliant web-based system that is stand alone in all aspects and shall consist of a high-speed, peer-to-peer network of direct digital controls (DDC), the network server, NR's, application controllers, and all input/output devices. All BCS controllers and workstations shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135–2010, BACnet or latest revision. Management level Ethernet network speeds shall be 1Gbps minimum and DDC level network speeds shall be ARCNET (156 Kbps) or MSTP (76.8 Kbps) minimum.
- B. Operators shall be able to view and configure systems through the standard web browser and all graphical/data representations shall appear identical whether the user is on site or viewing via the Internet at a remote location. Standard operator functions such as control point manipulation, configuration and viewing of trends, schedules and alarms shall be performed through the standard web-browser. Each mechanical system and building floor plan shall be depicted on the operator workstation by point-and-click graphics.
- C. The system shall directly control HVAC equipment as specified in the sequences of operation. Furnish energy conservation features such as optimal start and stop, night setback and demand level adjustment of set points as specified in the sequences or on the input/output (I/O) summary.

#### 1.3 CONTRACTOR QUALIFICATIONS

- A. The BCS Contractor shall:
  - 1. Have a local staff of trained personnel capable of giving instructions and providing routine and emergency maintenance on the BCS, all components and software/firmware and all other elements of the BCS.
  - 2. Have a proven record of experience in the supply and installation of equivalent BACnet systems over a minimum period of five years. Provide documentation of at least three equal or greater size and complexity, if so requested by the owner's representative.
  - 3. Be a factory certified representative by the BACnet BCS manufacturer for design, installation, and maintenance of the proposed systems.
  - 4. Have comprehensive local service, training and support facilities for the total BCS as provided. Maintain local, supplies of essential expendable parts.
  - 5. The system shall be manufactured and installed by Automated Logic.

#### 1.4 RELATED DOCUMENTS & REFERENCES

- A. Drawings and general provisions of the contract documents, apply to this section including:

1. General and Supplementary Conditions and Division 1 Specification Sections.
  2. Division 23 for mechanical equipment, ductwork, piping, systems
  3. Division 26 for electrical, lighting, and fire alarm equipment.
- B. The latest edition of the following standards and codes in effect as approved by the authority having jurisdiction and amended as of supplier's proposal date, and any applicable subsections thereof, shall govern design and selection of equipment and material supplied:
1. ANSI MC85.1 - Terminology for Automatic Control.
  2. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
  3. ANSI/ASHRAE Standard 135-2010, BACnet (building automation and controls network).
  4. BTL Mark by the BACnet Testing Laboratories.
  5. International Building Code (IBC) & International Energy Conservation Code (IECC) as approved by the local authority having jurisdiction including local amendments.
  6. UL 916 Underwriters Laboratories Standard for Energy Management Equipment.
  7. National Electrical Code (NEC).
  8. FCC Part 15, Subpart J, Class A.

## 1.5 SUBMITTALS

- A. Shop Drawings:
1. The following information shall be included on the cover page for each shop drawing and equipment documentation submittal:
    - a. Project name with date. Refer to the applicable specifications by name and number.
    - b. Provide submittal number and re-submittal number and date as applicable.
    - c. Provided name and address of consulting engineer, mechanical contractor, general contractor
  2. Shop drawings shall be CAD generated, plot size of 8-1/2" x 11" or 11" x 17". Drawings shall include diagrams, mounting instructions, installation procedures, equipment details and software descriptions for all aspects of the system to be installed.
  3. Provide schematic of systems indicating instrumentation locations, all interconnecting cables between supplied cabinets on a mechanical floor plan.
  4. Software specifications and descriptions including operating sequences.

5. Provide a project bill of material that indicates specific manufacturer, part number, part description and quantity of each device for all system components.
  6. Provide a list of the wire labels to be installed on each end of the control wiring: at the device and the control panel terminal. Labels shall be machine generated, typed and legible with a maximum of 17 characters. The label description "AHU-1 SAT" shall indicate the supply air temperature of AHU-1.
  7. Equipment Schematic: Provide an electronic equipment schematic for each piece of mechanical equipment. The schematic shall display all mechanical equipment characteristics including fans, dampers, valves, sensors and other applicable control devices. The schematic shall show wiring terminations to each control device as shown in the submittal and as-built documentation. Control devices shall be labeled by a symbol that can easily be identified in a bill of material that is shown on this graphic. The system bill of material shall show the device symbol, description, manufacturer and part number.
  8. Sequences of Operation: The sequences of operation shall be viewable for each system and be in a text format as shown in the as built documentation. The sequence of operations shall be selectable at the applicable location on the web interface.
- B. Control component submittals:
1. Component technical data sheets with mounting and installation details.
  2. The documentation shall include comprehensive and complete details of the BACnet Interoperability Building Blocks (BIBB) and automation level documentation including address, associated controller type, etc. as required and for the interface to the BCS.
  3. Details of networks/communications equipment, cabling and protocols proposed. Provide schedule of cabling including details of proposed cable types.
  4. Module Drawing: Provide an electronic wiring diagram of each control module. Diagram shall display wiring schematic and terminations to end devices. Diagram shall display each input and output terminals and label those that are used for the control application. Diagram shall display module type/name and network address.
  5. Field sensor and instrumentation specification sheets. Provide complete manufacturer's specifications for all items that are supplied. Include vendor name of every item supplied.
  6. Schedule and specification sheets for dampers, valves and actuators.
  7. Design and provide layout of all components of panel mounted control devices, terminal strips and power supplies.
- C. Colorgraphics: Provide sample layout of colorgraphic representations of the systems for review. The submittal shall indicate the quality of the graphic to be provided with the system with a sample of the specific control points to be included. Control points shall as a minimum include points indicated in the

input/output summary, control schematic and primary controlling points defined in the sequences of operation. Provide a sample of a floor plan layout, typical AHU, terminal unit, outside air pretreatment unit, variable frequency drive, exhaust/supply fan, chiller plant and hot water plant. For control points to be provided by equipment BACnet integration provide sample of the control points, up to 25 total.

- D. Commissioning reports. The submittal shall include a sample of the commissioning reports to be utilized during the commissioning section of this specification. Sample reports shall be approved as submitted or be modified by the engineer or owner's representative. The commissioning reports shall be included in the final operation and maintenance manuals. Reports shall be provided in hard-copy paper forms and electronic (.pdf) format.
1. Project Commissioning/System Verification Form for each controller.
    - a. General information for each form shall include: project name; associated equipment with mark number; control panel number and location; controller number and model number; controller device instance number (address); LAN segment number; verifying technician and date.
    - b. Each connected control point and device shall contain the following columns with a separate line for each connected physical point: point description (same as device label); input/output number for each connected control device (IN-XX or AO-XX).
    - c. Check boxes confirming that the commissioning tasks have been completed: device location, proper termination at device; proper termination at control panel; sequence is verified.
    - d. Data entry boxes indicating measured/confirmed values: preliminary control point value on the graphic; observed control point value; calibration or adjustment value to correct offset; final displayed point value on the color-graphic; date of commissioning; engineer or owner's representative verification.
    - e. Control values that are trended as indicated in the project documents shall be indicated on the verification form with the programmed trending interval.
  2. Control Panel Commissioning Form for each control panel.
    - a. General information: panel location and identification number; panel dimensions and NEMA rating; panel properly installed; Class 1 and Class 2 wiring are properly separated; correct voltage to the panel; no shorts or grounds in panel; no induced voltages in panel wiring; point to point termination match submittal; devices are mounted in the correct location; controller software revision number; address of controllers; panel device checkout is complete; panel startup is complete.
  3. Sequence of Operation Commissioning Form per piece of equipment (AHU, VAV, chiller, boiler, etc.).

- a. General information: project name; system identifier; building area served; control panel and controller numbers; controller model number and instance number (address); LAN segment number; name of verifying technician and date.
  - b. Each step of the sequence of operation for each piece of equipment shall be documented and include a “description of test”, “input to trigger test” and “expected outcome”. A pass/fail checkbox shall indicate each of these actions. Provide space for technician approval with associated date.
  
- E. Operating and Maintenance (O&M) manuals: Provide O&M manual with full information to allow the owner to operate, maintain and repair installed products. Include trade names with model numbers, color, dimensions and other physical characteristics.
  - 1. Format: Produce on 8-1/2 x 11-inch pages and 3-ring/D binders with durable plastic covers. Label binder covers with printed title “OPERATION AND MAINTENANCE MANUAL”, title of project, and subject matter and “Number \_ of \_” of binder. Provide substantial dividers tabbed and titled by section/component number.
  - 2. Table of Contents for each volume:
    - a. Part 1: Directory with name, address and telephone number of designer, contractor and subcontractors and suppliers for each Project Manual section.
    - b. Part 2: Operation and maintenance instructions, arranged by Project Manual Section number where practical and where not, by system.
  - 3. Product design criteria, functions, normal operating characteristic and limiting conditions. Installation, alignment, adjustment, checking instructions and troubleshooting guide. Operating instructions for start-up, normal operation, regulation and control, normal shutdown and emergency shutdown. Test data and performance curves.
  - 4. Spare parts list for operating products, prepared by manufacturers including detailed drawings giving location of each maintainable part, lists of spares recommended for user- service inventory and nearest source of in-stock spares.
  
- F. Record Documentation:
  - 1. Details of all alarm, diagnostic, error and other messages. Detail the operator action to be taken for each instance.
  - 2. Detail special programs provided and provide a complete programming instruction manual. Detail operation of all software applications.
  - 3. Detailed list of the database for all installed devices.
  - 4. Record drawings shall be CAD generated and shall include final locations and point ID for each monitored and controlled device.



5. In addition to the required hard-copies, provide a CD with all of the record documentation in PDF format and a CD(s) containing backup copies of all installed software, graphics and data files.
6. Online as-built documentation: provide digital replications of as-builts that shall be accessible from each equipment graphic page controlled or monitored by the BCS.

#### 1.6 RELATED WORK IN OTHER SECTIONS

- A. Refer to Division 0 and Division 1 for allowances and related contractual requirements.
- B. Refer to Section 23 for general mechanical provisions.
  1. Equipment supplier shall provide, install and commission a BACnet interface to each chiller, packaged DX unit, computer unit (CRAC) and other equipment with factory mounted controllers.
- C. Refer to Section 26 for general electrical provisions.
  1. Switchgear manufacturer shall provide and commission BACnet or Modbus interface to BCS.
  2. Fire alarm manufacturer shall provide contacts within 18 inches of Division 23 control panels for monitoring of binary inputs.

#### 1.8 WARRANTY

- A. Warranty work and the equipment provided under this contract shall be for a period of one year from the date of Substantial Completion. Warranty shall cover all components, system software, parts and assemblies supplied by this contractor and shall be guaranteed against defects in materials and workmanship for one (1) year from the date of Substantial Completion. Labor to troubleshoot, repair, reprogram or replace system components that have failed due to defects in materials and workmanship shall be provided by this contractor at no charge to the owner during the warranty period. All corrective software modifications made during warranty service periods shall be updated on all user documentation and on user and manufacturer archived software disks. All warranty work shall be performed by the BCS contractor's local service office.
- B. Warranty shall not include routine maintenance, e.g., equipment cleaning, mechanical parts lubrication, pilot lamp replacement, operational testing, etc. Warranty shall not cover repair or replacement of equipment damaged by under- or over-voltage, misuse, lack of proper maintenance, lightning, water damage from weather or piping failure.
- C. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the BCS contractor. The maximum acceptable response time to provide this service at the site shall be 24 hours, during normal working hours.

## PART 2 – PRODUCTS

## 2.1 NETWORK SERVER

- A. The central network server and WebCTRL software is existing at the District. New systems provided in the project shall be integrated into the existing software to include network routers, controllers, control devices, new colorgraphics as specified herein.

## 2.4 EXPANDABLE APPLICATION CONTROLLERS (EAC)

- A. Expandable application controllers shall be capable of implementing control strategies for the system based on information from any or all connected inputs. The EAC shall utilize factory pre-programmed global strategies that may be modified by field personnel on-site. Global control algorithms and automated control functions should execute via a 32-bit processor
- B. Programming shall be object-oriented using control program blocks that will support a minimum of 500 Analog Values and 500 Binary Values. Analog and binary values shall support standard BACnet priority arrays. Provide means to graphically view inputs and outputs to each program block in real-time as program is executing.
- C. Controller shall have adequate data storage to ensure high performance and data reliability. Battery shall retain static RAM memory and real-time clock functions for a minimum of 1.5 years (cumulative). Battery shall be a field-replaceable (non-rechargeable) lithium type. The onboard, battery-backed real time clock must support schedule operations and trend logs.
- D. Controller shall include both on-board 10BASE-T/100BASE-TX Ethernet BACnet communication over a twisted pair cable (UTP) and shall include BACnet IP communication
- E. The base unit of the EAC shall host up to five expansion modules with various I/O combinations including universal 10-bit inputs, binary triac outputs, and 8-bit switch selectable analog outputs (0-10V or 4-20 mA). Inputs shall support 3K and 10K thermistors, 0-5VDC, 0-10VDC, 4-20mA, dry contacts and pulse inputs directly.
- F. All outputs must have onboard Hand-Off-Auto switches. HOA switch position shall be monitored. Each analog output shall include a potentiometer for manually adjusting the output when the HOA switch is in the Hand position. The position of each and every HOA switch shall be available system wide as a BACnet object.
- G. BACnet Conformance
  - 1. Standard BACnet object types supported shall include as a minimum: Analog Input, Binary Input, Analog Output, Binary Output, Analog Value, Binary Value, Device, File, Group, Event Enrollment, Notification Class, Program and Schedule object types. All necessary tools shall be supplied for working with proprietary information.
  - 2. The Controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP network, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the LAN. Must support interoperability on

wide and local area networks (WANs) and function as a BACnet Broadcast Management Device (BBMD).

- H. Schedules: Each EAC shall support a minimum of 50 BACnet schedule objects.
- I. Logging Capabilities: Each controller shall support a minimum of 100 trend logs. Sample time interval shall be adjustable at the operator's workstation. Controller shall periodically upload trended data to the system server for long term archiving if desired. Archived data stored in database format shall be available for use in third-party spreadsheet or database programs.
- J. Alarm Generation: Alarms may be generated within the system for any object change of value or state either real or calculated. This includes things such as analog object value changes, binary object state changes, and various controller communication failures. Alarm logs shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site via remote communications. Controller must be able to handle up to 200 alarm setups stored as BACnet event enrollment objects – system destination and actions individually configurable.

## 2.5 UNITARY CONTROLLERS - GENERAL

- A. The BCS Contractor shall provide all Unitary Controllers (UC). UC shall be fully programmable or applications specific controllers with operating sequences maintained in EEPROM or flash RAM.
- B. The UC shall be a node on one of the automation LANs and shall control its own communications so that the failure of any one node, shall not inhibit communications on the network between the remaining nodes. UC shall be totally independent of other LAN nodes for their monitoring and control functions.
- C. Provide each UC with a battery back-up or EEPROM for the protection of volatile memory for a minimum of 72 hours. Batteries shall be rated for a ten year life.
- D. All associated applications programs shall reside at the UC. The UC shall not require communication to any other panel for normal operating sequences other than time scheduled base commands.
- E. Control shall be based on algorithms, i.e. proportional plus integral plus derivative (PID), proportional plus integral (PI), or proportional (P) to comply with the sequences of operation.
- F. The UC shall be configured with sufficient input/output capacity to achieve the required control points to meet the sequence of operations.

## 2.10 FIELD INSTRUMENTATION

- A. Temperature: All temperature sensors to be solid state electronic thermistor or RTD, factory-calibrated to within 0.5°F, totally interchangeable with housing appropriate for application. Sensors shall be 10,000 ohm thermistor @ 77 F (type II or III as applicable) with temperature curve rated for the application. Sensor wiring terminations shall be in a galvanized box (not plastic).
  - 1. Outside air temperature sensor: Sensors shall be installed in weather proof enclosure with ventilated PVC sun-shield

2. Duct mounted temperature sensor shall be averaging type for supply air, mixed air and low temperature applications for air handling units. Duct probe temperature sensor shall be acceptable for terminal units.
  3. Space temperature sensor shall have a blank cover with slide bar temperature adjustment and momentary push-button override.
  4. Provide flat plate stainless steel space temperature sensors with no local set point adjustment in corridors and common areas as indicated on the drawings.
  5. Thermowell temperature sensor: Sensors shall be stainless steel probe of length that is equivalent to a minimum of 20% of the pipe diameter. End-to-end accuracy shall be  $\pm 0.25$  deg. F. Connection box shall be moisture/water proof with conduit fitting. Furnish the stainless steel thermowell to the mechanical contractor for installation. A thermal conducting grease shall be installed in the thermowell to provide uniform temperature sensing.
- B. Carbon Dioxide Sensor: The CO<sub>2</sub> sensor shall be capable of monitoring CO<sub>2</sub> concentration with an accuracy of  $\pm 30$  parts per million (PPM). The CO<sub>2</sub> sensor shall produce a linear 0-10 VDC or 4-20 ma signal over the range of 0 to 2000 PPM. The CO<sub>2</sub> sensor shall measure using non-dispersed infrared (NDIR) technology to measure carbon dioxide gas and shall have
1. Wall mounted carbon dioxide sensors shall be Veris CWVS series.
  2. Duct Mounted Carbon Dioxide Sensor: CO<sub>2</sub> sensors for duct mounted applications shall be installed in the return air path. Duct mounted carbon dioxide sensors shall be Veris CDE series.
  3. The BCS contractor shall utilize the required calibration devices to properly commission and calibrate the CO<sub>2</sub> sensors per the manufacturer's recommendations.
- C. Relative humidity sensors: All relative humidity sensors shall be a two wire type, 4-20 mA output proportional to the relative humidity range of 0-100%. The accuracy of the sensors shall be  $\pm 3\%$  over a range of 5-95% r.h. The sensor shall be replaceable. Sensor wiring terminations shall be in a galvanized box (not plastic). Veris HO series or approved equal.
1. Outdoor air relative humidity sensors: provide non-corroding outdoor shield to minimize wind effects and solar heating. Install wall-mount weather proof enclosure with conduit fitting.
  2. Interior air relative humidity sensor: wall mounted humidity sensors shall be installed in a wall mounted enclosure with white or off-white cover to match the wall temperature sensors.
  3. Duct mounted relative humidity sensor: Duct mounted relative humidity sensors shall be provided with a moisture resistant enclosure with conduit fitting. The probe length shall be 8" minimum.
- D. Differential pressure sensors:
1. Duct static pressure sensor: The differential pressure sensors shall have an input range compatible with the medium being measured. The

proportional output signal shall be 0-10 Vdc or 4-20 mA. Accuracy of the sensor shall be  $\pm 5\%$  over an operating range of 0-2.0 inches w.g.

2. Water differential pressure sensors: The water differential pressure sensor shall be provided with a cast aluminum NEMA-1 enclosure with an operating range of 0-30 psig and an accuracy of  $\pm 2\%$  of full scale reading. Sensor shall be installed with a valved piping bypass by the mechanical contractor. See details on the drawings.
- E Freezestat: Provide freezestats for all chilled water air handling systems that receive more than 10% untreated outside air. Freezestats shall provide vapor tension elements, which shall serpentine the inlet face on all coils. Provide additional sensors, wired in series, to provide one linear foot per square foot of coil surface area. Freezestat shall be manually reset at the switch. Interlock to the associated fan so that fan will shut down when HOA switch is in hand or auto position. Provide time delay relays with a 0-10 minute time delay relay duration to minimize nuisance freezestat trips. Time delay relay shall be adjustable at the associated control panel.
  - F. Air differential pressure switch: For fan shutdown provide air differential pressure switches for all fans controlled by a variable frequency drive (VFD) to shut down the associated fan in the event of sensing high differential pressure. Air differential pressure switches shall have an adjustable setpoint with a range of 0-10 inches w.g. with manual reset at the switch. Provide  $\frac{1}{4}$  inch copper tubing with compression fittings to mount to the side of the duct.
  - G. Momentary control relays: Provide momentary control relays as indicated. . Relays shall have coil ratings of 120 VAC, 50 mA or 10-30 VAC/VDC, 40 mA as suitable for the application. Contact ratings shall be 10 amps. Provide complete isolation between the control circuit and the digital output. Relays shall be located in the UC or other local enclosures and have pin-type terminals. Relays shall have LED indication of status.
  - H. Current sensing relay: Current sensing relays shall be rated for the applicable load. The output relay shall have an accessible trip adjustment over its complete operating range. Enclosure shall have an LED to indicate relay status.
  - I. Water flowmeter -- insertion type: Water turbine shall have a stainless steel insertion probe with non-metallic rotors; 2.0 % accuracy of actual reading from 0.4 to 20 ft/s; turndown ratio of 30:1; pulse outputs proportional to flow rate. The flowmeter shall be an Insertion type single turbine on applications with 20 diameters of pipe upstream and 5 diameters of pipe downstream. The flow meter shall be a dual turbine flow meters on applications with 10 diameters of pipe upstream and 5 diameters of pipe downstream. Provide valve to allow for removal and re-insertion without disruption to the water service. Manufacturer shall Onicon or approved equal.

## 2.13 CONTROL VALVES

- A. Furnish all valves controlled by the BCS as detailed in the mechanical drawings, the sequences of operation and the input/output summary. Furnish chiller isolation valves as indicated in the sequences. Control valves shall be factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated. Where necessary to achieve the required performance and pressure drop a

control valve may be down sized up to two nominal sizes below line size. Two-position control valves shall be full-line size.

1. All chilled water, condenser water, and hot water valves shall meet, at minimum, the following ANSI Class 150 ratings. Valves 0.5 inch to 2 inches shall have NPT female screwed ends.
  2. Equal Percentage control characteristic shall be provided for all 3-way water coil control valves.
- B. Characterized Control Ball Valves (CCV) for ½' to 3": for 2 and 3-way applications shall have equal percentage characteristics. Manufacturer shall be Belimo CCV or approved equal.
1. Valve housing shall consist of forged brass rated at no less than 400 psi at 250°F. Three-way valves shall have EPDM o-rings behind ball seals to allow for a minimum close-off pressure of 40 psi with an actuator that provides 35 in-lbs torque for ½ to 2 in. sizes. Three-way valves shall be installed in a "tee" configuration with actuator perpendicular to the shaft. Confirm mixing or diverting application for correct valve selection.
- C. Globe Valves 2-1/2" to 6": for 2 and 3-way applications shall have equal percentage characteristics. Manufacturer shall be Belimo G7 series or approved equal.
1. Valve housing shall consist of cast iron rated at no less than 125 psi at 300°F. Valve shall have stainless steel stem, plug and seat. Three-way valves shall be installed in a "tee" configuration with actuator perpendicular to the shaft. Confirm mixing or diverting application for correct valve selection.
- D. Butterfly valves: For chiller isolation control valves and cooling tower bypass valves butterfly control valves may be provided.
1. Butterfly valves shall be sized for modulating service at 60-70 degree stem rotation. Isolation valves shall be line-size. Design velocity shall be less than 12 feet per second when used with standard EPDM seats. Butterfly valves shall have ductile iron body, 304 stainless steel disc and EPDM seat. The valve body close-off pressure rating shall be 150 psi over a range of -20 F to 250 F. The flange shall be ANSI 125/250. Belimo F6 and F7 series or approved manufacturer.
- E. Control Valve Actuators for CCV and Globe valves:
1. Provide electric actuators for all control valves that are furnished as part of the BCS contract.
  2. Motor driven type with gear assembly made of hardened steel. Actuator shall have an input voltage of 24 VAC. Interior actuator housings shall be NEMA-2 rated. Exterior housings shall require a weather shield or shall be NEMA-4 rated. Provide visual mechanical position indication
  3. Valves shall be sized to meet the shut-off requirements when operating at the maximum system differential pressure and with the installed

system pump operating at shut-off head. Actuators shall control against system maximum working pressures.

4. Normal and failure positions shall be as indicated in the operating sequences. Provide spring return action per the sequences.
5. Manual de-clutch lever to enable manual operation of the valve. It shall be possible for an operator to manually modulate valves located in mechanical rooms in the event of loss of power.
6. Overload Protection: Actuators shall provide protection against actuator burnout by using an internal current limiting circuit or digital motor rotation sensing circuit. Circuit shall insure that actuators cannot burn out due to a stalled damper or mechanical and electrical paralleling. End switches to deactivate the actuator at the end of rotation are acceptable only for butterfly valve actuators.
7. All actuators shall be capable of being electronically programmed in the field by use of external computer software or a dedicated handheld tool for the adjustment of flow. Programming using actuator mounted switches or multi-turn actuators are not acceptable.
8. Electric actuators shall be Belimo compatible with valve furnished.

#### F. Butterfly Valve Industrial Actuators

1. Enclosure shall be NEMA 4 (weatherproof) enclosure and will have an industrial quality coating.
2. Actuator shall have a motor rated for continuous duty. The motor shall be fractional horsepower; permanent split capacitor type designed to operate on a 120 VAC, 1 phase, 60 Hz supply. Two adjustable cam actuated end travel limit switches shall be provided to control direction of travel. A self-resetting thermal switch shall be imbedded in the motor for overload protection.
3. Reduction gearing shall be designed to withstand the actual motor stall torque. Gears shall be hardened alloy steel, permanently lubricated. A self-locking gear assembly or a brake shall be supplied.
4. Actuator shall have a 6 ft wiring harness provided for ease in field wiring (above 1500 in-lbs). Two adjustable SPDT cam-actuated auxiliary switches, rated at 250 VAC shall be provided for indication of open and closed position. Actuator shall have heater and thermostat to minimize condensation within the actuator housing.
5. Actuator shall be equipped with a hand wheel for manual override to permit operation of the valve in the event of electrical power failure or system malfunction. Hand wheel must be permanently attached to the actuator and when in manual operation electrical power to the actuator will be permanently interrupted. The hand wheel shall not rotate while the actuator is electrically driven.
6. The actuator shall be analog, floating, or two position as called out in the control sequence of operation. All analog valves shall be positive positioning, and respond to a 0-10 VDC, 4-20 mA, or adjustable signal as required. Analog actuators shall have a digital control card allowing any

voltage input for control and any DC voltage feedback signal for position indication.

7. Butterfly valve actuators shall be Belimo furnished with specified butterfly valves.

#### 2.14 PANELS AND ENCLOSURES

- A. Provide panels and enclosures for all components of the BCS, which are susceptible to physical or environmental damage.
- B. Interior panels and enclosures shall meet be NEMA 1 rated painted steel panels with locking door.
- C. Exterior panels and enclosures exposed to weather shall meet be NEMA 3R rated painted steel panels with locking door.
- C. Exterior mounted panels and enclosures in a corrosive environment shall be NEMA 4 painted steel panels with locking door.
- D. Panels for UC's shall be mounted on the outside of all unit ventilators and fan coil units with three feet of wall clearance in front of them and no higher than 7 feet to the bottom of the panel.

#### 2.15 LABELING and WARNING NOTICES

- A. Provide labeling for all control panels and enclosures.
- B. Provide labeling of all control wires and input/output points at the controller and at the control device; the label at each end of the wire shall be the same labels shall be machine generated, typed and clearly legible with a maximum of 17 characters. Hand written labels or labels written on the control wire jacket will not be acceptable. Each label shall be unique to its function and shall reference the applicable system. For example "AHU-1 SAT" will indicate the supply air temperature sensor for AHU-1. Improper labeling shall be removed and shall require re-commissioning of the control device and controller to document correct functionality.
- C. Provide high voltage warning notices at all equipment controlled by the BCS and at all associated motor starters when used by equipment controller.

#### 2.16 TUBING AND PIPING

- A. Provide tubing and piping as required for the field instrumentation.
- B. Tubing within equipment rooms, vertical risers, and penetrations to ductwork shall be either copper pipe or shall be plastic tubing within conduit. Tubing for all water-based instrumentation shall be copper pipe. Identify the type of tubing proposed in the shop drawing submittal.
- C. Provide suitable bulk head fittings for duct and panel penetrations.
- D. Tubing in plenum rated areas may be plastic tubing. Polyethylene tubing shall meet, at minimum, the following requirements: flame retardant; crack resistant; 300 psi burst pressure.

#### 2.17 CONDUIT AND FITTINGS

- A. Provide all conduits, raceways and fittings for the BCS monitoring, communication and control cabling. All work shall meet all applicable codes.



- B. Conduit, where required, shall meet, the requirements specified within Division 26 .
- D. BCS monitoring and control cable shall not share conduit with cable carrying voltages in excess of 48 volts.

## 2.17 CABLING

- A. Provide all cables for the BCS. Cable shall meet, at minimum, the following requirements:
  - 1. Minimum 98% conductivity stranded copper.
  - 2. Proper impedance for the application as recommended by the BCS component manufacturer.
  - 3. Monitoring and control cable shall be #18 AWG or larger, dependent on the application. Analog input and output cabling shall be shielded.
  - 4. Management Level Network cable shall be CAT 6, 24 gage unshielded.
  - 5. BCS Controller Network cable shall be #22 AWG shielded.
  - 6. Shield shall be grounded at the EAC, UC, or control panel. Ground at one end only to avoid ground loops.
  - 7. Identification of each end at the termination point. Identification should be indicated on and correspond to the record drawings.
- B. 120 VAC power wiring shall be of #12 AWG solid conductor or larger as required.

## PART 3 – EXECUTION

### 3.1 PRE-CONSTRUCTION

- A. The BCS supplier shall provide a pre-construction coordination meeting with the affected trades to ensure a cooperative efficient process of installation. The invited trades shall include the general contractor, mechanical contractor, electrical contractor, test and balance contractor, owner's representative, consulting engineer and others with a direct interest in the coordination of the affected systems. The BCS contractor shall provide an outline of the meeting agenda highlighting the construction schedule, coordination with mechanical and electrical trades. Provide a sign-in sheet and submit it through the attendees along with a summary of the meeting notes for future reference.

### 3.2 INSPECTION DURING INSTALLATION

- A. Provide a technician to assist the engineer or owner's representative with inspections made during the installation period that are required to review the progress and quality of ongoing work. The engineer/owner's representative shall generate field observation reports on the findings of the inspection. The engineer or owner's representative shall advise the BCS contractor during the inspection of any concerns noted with respect to the installation and shall repeat the concerns in writing as soon as possible after the inspection is completed. The BCS contractor shall take corrective action to meet the requirements of the

specifications. Upon correction the BCS contractor shall submit written documentation through the contractors to the engineer.

### 3.3 INSTALLATION OF COMPONENTS

- A. Provide all interlock and control wiring. All wiring shall be installed in a neat and professional manner in accordance with specification division 26 and all national, state and local electrical codes.
- B. Provide wire and wiring techniques recommended by equipment manufacturer. Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of all control equipment with the owner's representative prior to rough-in. Provide auxiliary pilot duty relays on motor starters as required for control function.
- C. Electrical Contractor shall provide 120 or 277 volt power at a junction box within 48" of the controller. The BCS contractor shall coordinate with the electrical contractor to identify locations of power requirements prior to the installation of the controls.
- D. Conduit for control wiring shall be provided whenever one of the following conditions exists:
  - 1. Conduit is indicated on the drawings or specifically required by the specifications.
  - 2. Cabling runs through accessible areas such as within partitions/walls, above closed in ceilings, under floor; within trenches and underground; on the exterior of the building; exposed on the surface of the building; when encased in concrete or other material that makes the cable accessible or when located such that access to the cable is not readily obtained.
  - 3. Cable within mechanical, telecommunications and electrical equipment rooms and control rooms.
  - 4. Conduit shall be installed with 2" x 4" mounting box inside wall from sensor box to above the wall, for all wall mounted temperature, humidity and CO2 sensors.
- E. Control wiring located above an accessible ceiling space may be plenum rated cable. Plenum rated wire shall be bundled and routed at right angles to the building lines and secured to the building structure every 6 feet.
- F. When communication bus enters or exits a building, a surge suppressor shall be installed. The surge suppressor shall be installed according to the controls manufacturer's instructions.
- G. Provide sleeves for all cable and conduit passing through walls, partitions, structural components, floors and roof.
- H. All sensor wiring shall be labeled to indicate the origination (at the device) and destination of data (at the control panel). The description shall indicate the type and location of the control device such as "AHU-1 SA temp" or "VAV 1-1 space temp".

- I. Wall temp sensors at 48" above the finished floor to comply with ADA requirements and to match the height of the light switches. Mount humidity sensor at equal height to wall temperature sensor.

### 3.3 COMMISSIONING REQUIREMENTS

- A. Commissioning shall be provided by the BCS contractor to demonstrate and confirm that the installed system complies with the specifications and the control sequences of operation herein specified. Upon completion of the commissioning process the BCS contractor shall demonstrate to the engineer or owner's representative the functionality of the control system devices are in compliance with the contract documents.
- B. Technicians provided by the BCS contractor shall be factory trained and qualified in the operation of the provided control system. The BCS contractor shall provide, if requested, the factory training certificates of the individuals providing the commissioning services on this project.
- C. Commissioning tools, applicable to the system provided, shall be utilized by the factory trained technicians for proper verification of system operation and functionality. Temperature verification sensors shall be NIST certified within the last 12 months. Meters such as Fluke 52 series or better shall be utilized. Use of non-certified meters may require the system to be re-commissioned with certified meters at no cost to the owner.
- D. Documentation of the commissioning process shall be provided per the project general conditions in a hard-copy paper or electronic (.pdf) format as requested. Documentation shall include the following forms:
  - 1. Project Commissioning/System Verification Form for each controller provided on the project to verify the proper function of each controller, control device and system component provided.
  - 2. Panel Commissioning Form for each control panel to document the proper installation and function of each control panel provided.
  - 3. Sequence of Operation Commissioning Form for each piece of controlled equipment to confirm compliance of the control system with the specified sequences of operation.
  - 4. Not providing proper documentation for each control devices, panel, or system, upon request by the engineer or owner's representative, may require the BCS contractor to re-commission the applicable systems at no additional cost to the owner.
- E. After completion of the commissioning, the BCS contractor shall be able to demonstrate the sequence of operations for each system to the engineer and the owner's representative.
- F. Equipment checkout sheets are to be produced by this contractor showing checkboxes and compliance with the following procedures for each piece of equipment and turned over to the owner and/or mechanical engineer.

### 3.4 COLORGRAPHICS

- A. The system colorgraphics shall be provided for the BCS system prior to system acceptance and owner training.

- B. The colorgraphics provided shall include the following as a template. Provide forward and backward links on the graphic.
1. Site plan with link to overall building plan including detached buildings. Provide link to proceed to the overall building floor plan.
  2. The overall building plan shall indicate space temperature conditions referenced by the color of the zone. Specific details of the zone temperatures and equipment are not required. Provide a link to the floor plan wings, upper floors and remote buildings.
  3. The floor plan colorgraphics shall indicate the space temperatures by color references. Additional information shall indicate the space temperature, the occupancy of the zone, air handling units, VAV terminals and ductwork with diffusers. A link at each terminal unit or AHU shall automatically connect the system operator to the equipment colorgraphic.
  4. The colorgraphics for the equipment shall as a minimum be equal to the points from the input/output summary or control schematic. Primary control devices as required by the sequences of operation shall also be provided.
  5. Control points from equipment that are integrated into the BCS via a factory BACnet card shall be provided to convey the operating conditions of the attached equipment. Up to 25 key operating points per equipment graphic may be required. Coordination of the specific points shall be provided during the submittal phase.

### 3.5 CONTROL SYSTEM DEMONSTRATION and ACCEPTANCE

- A. Startup testing documentation: Prepare the checklist documenting startup testing of each input and output device, with technician's initials and date certifying each device has been tested and calibrated prior to acceptance testing. This document shall indicate proof that the following functions have been commissioned and shall be included in the as-built documentation: short to ground check, configuration of trends, confirmation that color-graphics are accurately representing actual systems, point to point checkout, all damper and valve actuators respond to input change, control modules are addressed and have functional descriptors, specified interlocks are functional, calibration report of all sensors, discrete outputs respond to time schedule or manual enable command.
- B. Demonstration. Prior to acceptance, demonstrate the following performance tests to demonstrate system operation and compliance with specifications.
1. Engineer, owner's representative and mechanical contractor shall be invited to observe and review system demonstration. Provide attendees at least 10 days notice.
  2. Demonstration shall follow process approved as part of the submittal and shall include complete checklists and forms for each system as part of system demonstration.
  3. Demonstrate actual field operation of each sequence of operation as specified. Demonstrate calibration and response of any input and output points requested by engineer or owner's representative.

4. Demonstrate complete operation of operator interface including review of color-graphics, time schedules, trend logs, alarm notification, functionality of tablet PC operation.
    - a. DDC loop response. Supply graphical trend data output showing each DDC loop's response to a set point change representing an actuator position change of at least 25% of full range. Trend sampling rate shall be selectable from 10 seconds to 3 minutes, depending on loop speed. Each sample's trend data shall show set point, actuator position, and controlled variable values.
    - b. Demand limiting if applicable in the sequence of operations. Supply trend data output showing demand-limiting algorithm action. Trend data shall document action sampled each minute over at least a 30-minute period and shall show building kW, demand-limiting set point, and status of set points and other affected equipment parameters.
    - c. Trend logs for each system. Trend data shall indicate set points, operating points, valve positions, and other data as specified. Logs shall be accessible through system's operator interface and shall be retrievable for use in other software programs.
  5. Alarms and Interlocks. Check each alarm with an appropriate signal at a value that will trip the alarm. Trip interlocks using field contacts to check logic and to ensure that actuators fail in the proper direction. Alarm verification shall include temperatures exceeding alarm threshold (high and low), fan failure safety, duct high static pressure switch, freezestat, smoke detector shutdown.
  6. Tests that fail to demonstrate proper system operation to the engineer shall be repeated after contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.
- C. Acceptance.
1. After tests described in this specification are performed to the satisfaction of both Engineer and owner's representative, the Engineer shall accept the control system as meeting completion requirements. Engineer may exempt tests from completion requirements that cannot be performed due to circumstances beyond BCS contractor's control. Engineer shall provide written statement of each exempted test. Exempted tests shall be performed as part of warranty.
  2. System shall not be accepted until completed demonstration forms and checklists are submitted and approved by the Engineer.

### 3.6 COMMISSIONING ASSISTANCE

A. Provide technical assistance, up to 16 hours, to the project commissioning agent to demonstrate the BCS operating system to allow the agent perform the following functions during the commissioning process:

1. Change setpoints including temperatures, pressures, CO2 levels, humidity
2. Change operating schedules.
3. Change minimum damper and valve positions (per sequences).

### 1.7 DEMONSTRATION AND OWNER TRAINING

A. Furnish basic operator training for multiple persons on data display, alarm and status descriptors, requesting data, execution commands and log requests. Include a minimum of 16 hours: 8 hours instructor time for onsite training and 8 hours of hands on class environment training. Training sessions may be provided in 4-hour increments as approved by the owner's representative.

1. Change/modify temperature setpoints.
2. Change/modify time of day, holiday and override schedules.
3. Display, create, and modify trends of system points.
4. Update room numbers on the color-graphics.

B. Demonstrate complete and operating system to Owner. Provide written documentation listing the attendees of the specified training with sign-in sheet and training time and date.

### 1.8 SEQUENCES OF OPERATION

A. General: Hereinafter are standard control sequences that shall be provided for the equipment as indicated in the equipment specific sequences of operation or input/output summary. This information is complementary to and does not supersede the contract drawings. The BCS contractor shall provide the necessary hardware and software points to comply with the sequences of operations in addition to the points listed on the input/output summary, control schematics and mechanical drawings. Setpoints, schedules, alarm limits shall be coordinated with the engineer and owner's representative during the commissioning of the systems.

1. Start/stop of equipment: All equipment as hereinafter specified in the sequences of operation, shall be provide with a start/stop sequence based upon time-of-day and holiday schedule. Equipment status shall be verified via a current sensing relay across the fan or pump power connection. For fans and pumps provided with variable frequency drives the equipment status shall be monitored via the drive run status auxiliary contact wired in series with the current sensing relay. Operating schedules shall be defined and changeable by the building BCS operator.

2. Control algorithms: Proportional control shall be used for space temperature control of valves and dampers. Proportional+integral (PI) control shall be used for variable air volume control of fan or pump speed, building static pressure control and supply air/water supply temperature control.
3. For fan systems, outside air dampers shall be closed during unoccupied schedules. During the occupied schedule the outside air damper shall open to the scheduled minimum position (adjustable). Damper control shall be subject to economizer and/or demand control ventilation as specified hereinafter.
2. DX cooling control shall be provided with proportional (P) control for space temperature. Supply air or supply water temperatures shall be provided with proportional+integral (PI) control. The sequencing shall be coordinated with the equipment provided. The BCS contractor shall verify the number of stages (compressors and unloaders) and coordinate with the equipment supplier. Sequencing shall be programmed to avoid excessive over/under-shooting of the setpoint. Confirm with equipment supplier the required time delay between stages of loading/unloading. Coordinate control sequence with factory installed time-delay relays on the equipment. Electric heating control shall function similarly.
3. Economizer control: The BCS contractor shall coordinate economizer cooling with the equipment provided. An economizer control algorithm shall be provided as scheduled to provide free-cooling with outside air when the outside air enthalpy is below the enthalpy setpoint. The enthalpy of the outside air shall be calculated with information from the outside air temperature and humidity/dewpoint sensors. The economizer sequence shall compare the return air to the outside air dry-bulb temperature to optimize free-cooling with outside air. A mixed air temperature sensor upstream of the cooling coil shall override and limit the cooling temperature to avoid freezing the coil. The minimum damper position shall be controlled by the CO2 sensor as hereinafter specified.
4. Demand control ventilation: A space or return air carbon dioxide sensor shall be provided as indicated on the drawings or input/output summary. During unoccupied periods the outside air dampers shall be closed. During occupied periods the outside air damper shall open to the scheduled minimum damper position (adjustable). The CO2 sensor shall modulate open, with a proportional algorithm, the outside air dampers from the minimum position, to maintain a CO2 level in the return air or space 400 ppm above the ambient conditions. An outside air CO2 sensor shall determine current ambient conditions with a weatherproof enclosure. An alarm shall annunciate at the operator work station if the CO2 level exceeds 600 ppm above ambient for more than two hours. The economizer control point may open the outside air dampers beyond the CO2 control point to utilize outside air for cooling.
5. Duct static pressure control: A differential pressure sensor shall be installed in the system ductwork to maintain the system static pressure setpoint. The sensor shall be located on the drawings approximately 2/3

the total distance of the longest duct connected to the system. The BCS contractor shall make allowances in the installation to allow relocation of the sensor up to 50 feet, at no additional cost if requested by the engineer during the commissioning of the systems. A high-static differential pressure switch, located five duct diameters in a straight duct run after the fan discharge, shall deenergize the fan and annunciate an alarm at the BCS computer.

6. Lead/lag control: A lead/lag control program shall be provided as scheduled to minimize run-time on a designated piece of equipment. The lead/lag schedule shall include standard templates such that the operator may designate the maximum run-time of the equipment or the day/date/time of switchover to the lag equipment. Changeover will occur after the limit is reached and only during unoccupied schedules.
7. Space temperature: Each space temperature sensor shall be installed with setpoint adjustment up to  $\pm 4$  F and occupancy override capability. The setpoint adjustment and override switch shall not be enabled during system commissioning. The BCS contractor shall provide training to the owner's representative to allow enabling these functions in the future.
8. Trending of control system values (for connected I/O points) shall be provided as indicated in the contract documents with the following minimum trend intervals:
  1. Space temperature, humidity, CO2: 15 minutes.
  2. Air handling unit supply air temperature, valve position, damper position, fan status, VFD speed, duct static pressure: 10 minutes for analog points and change of value (COV) for discrete points.
  3. Chilled water plant including chiller status and alarms, chilled water supply & return temperature for each chiller, building chilled water supply & return temperature and flow, pump status and speed, differential water pressure, cooling tower fan status and speed, condenser water supply & return temperature for each chiller; cooling tower supply & return temperature, bypass valve position, isolation valve position: 10 minutes for analog points and change of value (COV) for discrete points.
  4. Hot water plant shall have trends similar to the chilled water plant.
  5. Exhaust fan status where provided: COV.
9. Occupancy and temperature schedules: Unless hereinafter specified the schedules shall be as follows:
  - a. Occupied: weekdays, 7:00 a.m. to 6:00 p.m.; 74 F cooling, 70 F heating, 60 F dewpoint.
  - b. Unoccupied: all other times, 80 F cooling, 55 F heating, 64 F dewpoint.
  - c. Chilled water supply temperature shall be 44 F.
  - d. All setpoints for space temperature, water temperature, differential air/water pressure shall be adjustable at the BCS.



- e. Occupied ventilation: weekdays, 8:00 a.m. to 5:00 p.m.
- B. Project specific sequences shall be provided by the BCS supplier as indicated on the contract drawings.

## **SECTION 16051 - COMMON WORK RESULTS FOR ELECTRICAL**

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Electrical equipment coordination and installation.
  - 2. Sleeves for raceways and cables.
  - 3. Sleeve seals.
  - 4. Grout.
  - 5. Common electrical installation requirements.

#### 1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

#### 1.4 SUBMITTALS

- A. Product Data: For sleeve seals.

#### 1.5 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. Access doors and panels are specified in Division 8 Section "Access Doors and Frames."
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

## PART 2 - PRODUCTS

### 2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
  - 1. Minimum Metal Thickness:
    - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
    - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

### 2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Metraflex Co.
    - d. Pipeline Seal and Insulator, Inc.
  - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
  - 3. Pressure Plates: Carbon steel. Include two for each sealing element.

4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## 2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

## PART 3 - EXECUTION

### 3.1 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.

### 3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.

- F. Extend sleeves installed in floors **2 inches (50 mm)** above finished floor level.
- G. Size pipe sleeves to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
  - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 7 Section "Joint Sealants."
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for **1-inch (25-mm)** annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for **1-inch (25-mm)** annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

### 3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### 3.4 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Through-Penetration Firestop Systems."

END OF SECTION 16051

## **SECTION 16060 - GROUNDING AND BONDING**

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment.
  - 1. Overhead-lines grounding.
  - 2. Underground distribution grounding.
  - 3. Common ground bonding with lightning protection system.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:
  - 1. Ground rods.
  - 2. Grounding for sensitive electronic equipment.
- C. Qualification Data: For testing agency and testing agency's field supervisor.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:

#### 1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
  - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with UL 467 for grounding and bonding materials and equipment.

## PART 2 - PRODUCTS

### 2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
  - 1. Solid Conductors: ASTM B 3.
  - 2. Stranded Conductors: ASTM B 8.
  - 3. Tinned Conductors: ASTM B 33.
  - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, **1/4 inch (6 mm)** in diameter.
  - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
  - 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; **1-5/8 inches (41 mm)** wide and **1/16 inch (1.6 mm)** thick.
  - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; **1-5/8 inches (41 mm)** wide and **1/16 inch (1.6 mm)** thick.
- C. Bare Grounding Conductor and Conductor Protector for Wood Poles:
  - 1. No. 4 AWG minimum, soft-drawn copper.
  - 2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir or cypress or cedar.
- D. Grounding Bus: Rectangular bars of annealed copper, **1/4 by 2 inches (6 by 50 mm)** in cross section, unless otherwise indicated; with insulators.

### 2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
  - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

## 2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; **3/4 inch by 10 feet (19 mm by 3 m)** in diameter.

## PART 3 - EXECUTION

### 3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.
  - 1. Bury at least **24 inches (600 mm)** below grade.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
  - 1. Install bus on insulated spacers **1 inch (25 mm)**, minimum, from wall **6 inches (150 mm)** above finished floor, unless otherwise indicated.
  - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.
- E. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
  - 2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
  - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
  - 4. Connections to Structural Steel: Welded connectors.

### 3.2 GROUNDING OVERHEAD LINES

- A. Comply with IEEE C2 grounding requirements.
- B. Install 2 parallel ground rods if resistance to ground by a single, ground-rod electrode exceeds 25 ohms.
- C. Drive ground rods until tops are **12 inches (300 mm)** below finished grade in undisturbed earth.



- D. Ground-Rod Connections: Install bolted connectors for underground connections and connections to rods.
- E. Lightning Arrester Grounding Conductors: Separate from other grounding conductors.
- F. Secondary Neutral and Transformer Enclosure: Interconnect and connect to grounding conductor.
- G. Protect grounding conductors running on surface of wood poles with molding extended from grade level up to and through communication service and transformer spaces.

### 3.3 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so **4 inches (100 mm)** will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from **2 inches (50 mm)** above to **6 inches (150 mm)** below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than **6 inches (150 mm)** from the foundation.

### 3.4 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
  - 1. Feeders and branch circuits.
  - 2. Lighting circuits.
  - 3. Receptacle circuits.
  - 4. Single-phase motor and appliance branch circuits.

5. Three-phase motor and appliance branch circuits.
  6. Flexible raceway runs.
  7. Armored and metal-clad cable runs.
  8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
  9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
  10. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- G. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch (6-by-50-by-300-mm) grounding bus.
  2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

### 3.5 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are **2 inches (50 mm)** below finished floor or final grade, unless otherwise indicated.
  - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
  - 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 2 Section "Underground Ducts and Utility Structures," and shall be at least **12 inches (300 mm)** deep, with cover.
  - 1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
  - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
  - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
  - 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- F. Grounding and Bonding for Piping:
  - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
  3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than **60 feet (18 m)** apart.
- I. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of **20 feet (6 m)** of bare copper conductor not smaller than No. 4 AWG.
1. If concrete foundation is less than **20 feet (6 m)** long, coil excess conductor within base of foundation.
  2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

### 3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- B. Perform the following tests and inspections and prepare test reports:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
  2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
    - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    - b. Perform tests by fall-of-potential method according to IEEE 81.
  3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

- C. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
  2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
  3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
  4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).
  5. Substations and Pad-Mounted Equipment: 5 ohms.
  6. Manhole Grounds: 10 ohms.
  7. ohms.
- D. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 16060

## **SECTION 16075 - ELECTRICAL IDENTIFICATION**

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Identification for raceways.
  - 2. Identification of power and control cables.
  - 3. Identification for conductors.
  - 4. Underground-line warning tape.
  - 5. Warning labels and signs.
  - 6. Instruction signs.
  - 7. Equipment identification labels.
  - 8. Miscellaneous identification products.

#### 1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

#### 1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

## 1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

## PART 2 - PRODUCTS

### 2.1 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
  - 1. Black letters on an orange field.
  - 2. Legend: Indicate voltage and system or service type.
- C. Colors for Raceways Carrying Circuits at More Than 600 V:
  - 1. Black letters on an orange field.
  - 2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high letters on 20-inch (500-mm) centers.
- D. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- E. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- G. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers diagonally over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stop stripes at legends.

- H. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.
- I. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
  - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
  - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

## 2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Colors for Raceways Carrying Circuits at 600 V and Less:
  - 1. Black letters on an orange field.
  - 2. Legend: Indicate voltage and system or service type.
- C. Colors for Raceways Carrying Circuits at More Than 600 V:
  - 1. Black letters on an orange field.
  - 2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high letters on 20-inch (500-mm) centers.
- D. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- E. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

## 2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

## 2.4 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.



B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

## 2.5 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

## 2.6 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 7 by 10 inches (180 by 250 mm).

## 2.7 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).

## 2.8 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be **3/8 inch (10 mm)**.
- B. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be **1 inch (25 mm)**.

## 2.9 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
  - 1. Minimum Width: **3/16 inch (5 mm)**.
  - 2. Tensile Strength at **73 deg F (23 deg C)**, According to ASTM D 638: **12,000 psi (82.7 MPa)**.
  - 3. Temperature Range: **Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**.
  - 4. Color: Black except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
  - 1. Minimum Width: **3/16 inch (5 mm)**.
  - 2. Tensile Strength at **73 deg F (23 deg C)**, According to ASTM D 638: **12,000 psi (82.7 MPa)**.
  - 3. Temperature Range: **Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**.
  - 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
  - 1. Minimum Width: **3/16 inch (5 mm)**.
  - 2. Tensile Strength at **73 deg F (23 deg C)**, According to ASTM D 638: **7000 psi (48.2 MPa)**.
  - 3. UL 94 Flame Rating: 94V-0.
  - 4. Temperature Range: **Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C)**.
  - 5. Color: Black.

## 2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in Division 9 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at **50-foot (15-m)** maximum intervals in straight runs, and at **25-foot (7.6-m)** maximum intervals in congested areas.
- G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
  - 1. Outdoors: UV-stabilized nylon.
  - 2. In Spaces Handling Environmental Air: Plenum rated.
- I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at **6 to 8 inches (150 to 200 mm)** below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds **16 inches (400 mm)** overall.
- J. Painted Identification: Comply with requirements in Division 9 painting Sections for surface preparation and paint application.

### 3.2 IDENTIFICATION SCHEDULE

- A. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil **4-inch- (100-mm-)** wide black stripes on **10-inch (250-mm)** centers over orange background that extends full length of raceway or duct and is **12 inches (300 mm)** wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with **3-inch- (75-mm-)** high black letters on **20-inch (500-mm)** centers. Stop stripes at legends. Apply to the following finished surfaces:
  - 1. Floor surface directly above conduits running beneath and within **12 inches (300 mm)** of a floor that is in contact with earth or is framed above unexcavated space.
  - 2. Wall surfaces directly external to raceways concealed within wall.
  - 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

- B. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with self-adhesive vinyl label. Install labels at 10-foot (3-m) maximum intervals.
- C. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
  - 1. Power.
- D. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
  - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
    - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
    - b. Colors for 208/120-V Circuits:
      - 1) Phase A: Black.
      - 2) Phase B: Red.
      - 3) Phase C: Blue.
    - c. Colors for 480/277-V Circuits:
      - 1) Phase A: Brown.
      - 2) Phase B: Orange.
      - 3) Phase C: Yellow.
    - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- E. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic plastic tag holder with adhesive-backed phase tags, and a separate tag with the circuit designation.
- F. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- G. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.
- H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
  - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
  3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- I. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
1. Limit use of underground-line warning tape to direct-buried cables.
  2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- J. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- K. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs.
1. Comply with 29 CFR 1910.145.
  2. Identify system voltage with black letters on an orange background.
  3. Apply to exterior of door, cover, or other access.
  4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
    - a. Power transfer switches.
    - b. Controls with external control power connections.
- L. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- M. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
    - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with **1/2-inch- (13-mm-)** high letters on **1-1/2-inch- (38-mm-)** high label; where two lines of text are required, use labels **2 inches (50 mm)** high.
    - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
    - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

- d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
2. Equipment to Be Labeled:
- a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label.
  - b. Enclosures and electrical cabinets.
  - c. Access doors and panels for concealed electrical items.
  - d. Switchgear.
  - e. Switchboards.
  - f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
  - g. Enclosed switches.
  - h. Enclosed circuit breakers.
  - i. Enclosed controllers.
  - j. Push-button stations.
  - k. Contactors.

END OF SECTION 16075

## **SECTION 16120 - CONDUCTORS AND CABLES**

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Building wires and cables rated 600 V and less.
  - 2. Connectors, splices, and terminations rated 600 V and less.
  - 3. Sleeves and sleeve seals for cables.
- B. Related Sections include the following:
  - 1. Division 16 Section "Voice and Data Communication Cabling" for cabling used for voice and data circuits.
  - 2. Division 16 Section "Undercarpet Cables" for flat cables for undercarpet installations.
  - 3. Division 16 Section "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 2001 to 35,000 V.

#### 1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For testing agency.
- C. Field quality-control test reports.

#### 1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the

InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

## 1.6 COORDINATION

- A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

## PART 2 - PRODUCTS

### 2.1 CONDUCTORS AND CABLES

- 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. Alcan Products Corporation; Alcan Cable Division.
  2. American Insulated Wire Corp.; a Leviton Company.
  3. General Cable Corporation.
  4. Senator Wire & Cable Company.
  5. Southwire Company.
- B. Copper Conductors: Comply with NEMA WC 70.
- C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN SO.
- D. Multiconductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC with ground wire.

### 2.2 CONNECTORS AND SPLICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:



1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

C. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

### 2.3 SLEEVES FOR CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum **0.052- or 0.138-inch (1.3- or 3.5-mm)** thickness as indicated and of length to suit application.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

### 2.4 SLEEVE SEALS

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

## PART 3 - EXECUTION

### 3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

### 3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN-THWN, single conductors in raceway.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- E. Feeders Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway.
- F. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- I. Branch Circuits Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway.
- J. Branch Circuits in Cable Tray: Type THHN-THWN, single conductors in raceway.
- K. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- L. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- M. Class 2 Control Circuits: Type THHN-THWN, in raceway.

### 3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Division 16 Section "Electrical Supports and Seismic Restraints."
- F. Identify and color-code conductors and cables according to Division 16 Section "Electrical Identification."

### 3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least **6 inches (150 mm)** of slack.

### 3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Rectangular Sleeve Minimum Metal Thickness:
  - 1. For sleeve rectangle perimeter less than **50 inches (1270 mm)** and no side greater than **16 inches (400 mm)**, thickness shall be **0.052 inch (1.3 mm)**.

2. For sleeve rectangle perimeter equal to, or greater than, **50 inches (1270 mm)** and 1 or more sides equal to, or greater than, **16 inches (400 mm)**, thickness shall be **0.138 inch (3.5 mm)**.
- E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- F. Cut sleeves to length for mounting flush with both wall surfaces.
- G. Extend sleeves installed in floors **2 inches (50 mm)** above finished floor level.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 7 Section "Joint Sealants."
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 7 Section "Through-Penetration Firestop Systems."
- K. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for **1-inch (25-mm)** annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for **1-inch (25-mm)** annular clear space between cable and sleeve for installing mechanical sleeve seals.

### 3.6 SLEEVE-SEAL INSTALLATION

- A. Install to seal underground exterior-wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### 3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 7 Section "Through-Penetration Firestop Systems."

### 3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Perform tests and inspections and prepare test reports.
- C. Tests and Inspections:
  - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors feeding the following critical equipment and services for compliance with requirements.
  - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- D. Test Reports: Prepare a written report to record the following:
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.
  - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- E. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 16120

## **SECTION 16130 - RACEWAYS AND BOXES**

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
  - 1. Division 2 Section "Underground Ducts and Utility Structures" for exterior ductbanks, manholes, and underground utility construction.

#### 1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. EPDM: Ethylene-propylene-diene terpolymer rubber.
- D. FMC: Flexible metal conduit.
- E. IMC: Intermediate metal conduit.
- F. LFMC: Liquidtight flexible metal conduit.
- G. LFNC: Liquidtight flexible nonmetallic conduit.
- H. NBR: Acrylonitrile-butadiene rubber.
- I. RNC: Rigid nonmetallic conduit.

#### 1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

1. For handholes and boxes for underground wiring, including the following:
  - a. Duct entry provisions, including locations and duct sizes.
  - b. Frame and cover design.
  - c. Grounding details.
  - d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
  - e. Joint details.
  
- C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
  1. Structural members in the paths of conduit groups with common supports.
  2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.
  
  3. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  4. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
  
- D. Qualification Data: For professional engineer and testing agency.
  
- E. Source quality-control test reports.

## 1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
  
- B. Comply with NFPA 70.

## PART 2 - PRODUCTS

### 2.1 METAL CONDUIT AND TUBING

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  1. AFC Cable Systems, Inc.
  2. Alfex Inc.
  3. Allied Tube & Conduit; a Tyco International Ltd. Co.
  4. Anamet Electrical, Inc.; Anaconda Metal Hose.
  5. Electri-Flex Co.
  6. Manhattan/CDT/Cole-Flex.
  7. Maverick Tube Corporation.

- 8. O-Z Gedney; a unit of General Signal.
  - 9. Wheatland Tube Company.
- B. Rigid Steel Conduit: ANSI C80.1.
  - C. Aluminum Rigid Conduit: ANSI C80.5.
  - D. IMC: ANSI C80.6.
  - E. EMT: ANSI C80.3.
  - F. FMC: Zinc-coated steel.
  - G. LFMC: Flexible steel conduit with PVC jacket.
  - H. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
    - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
    - 2. Fittings for EMT: , set-screw type.
    - 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, **0.040 inch (1 mm)**, with overlapping sleeves protecting threaded joints.
  - I. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

## 2.2 NONMETALLIC CONDUIT AND TUBING

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. AFC Cable Systems, Inc.
  - 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
  - 3. Arnco Corporation.
  - 4. CANTEX Inc.
  - 5. CertainTeed Corp.; Pipe & Plastics Group.
  - 6. Condux International, Inc.
  - 7. ElecSYS, Inc.
  - 8. Electri-Flex Co.
  - 9. Lamson & Sessions; Carlon Electrical Products.
  - 10. Manhattan/CDT/Cole-Flex.
  - 11. RACO; a Hubbell Company.
  - 12. Thomas & Betts Corporation.
- B. ENT: NEMA TC 13.
- C. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.



- D. LFNC: UL 1660.
- E. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.
- F. Fittings for LFNC: UL 514B.

### 2.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

- 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. Arnco Corporation.
  - 2. Endot Industries Inc.
  - 3. IPEX Inc.
  - 4. Lamson & Sessions; Carlon Electrical Products.
- B. Description: Comply with UL 2024; flexible type, approved for plenum installation.

### 2.4 METAL WIREWAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cooper B-Line, Inc.
  - 2. Hoffman.
  - 3. Square D; Schneider Electric.
- B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Hinged type.
- E. Finish: Manufacturer's standard enamel finish.

### 2.5 NONMETALLIC WIREWAYS

- 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. Hoffman.
  - 2. Lamson & Sessions; Carlon Electrical Products.

- B. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

## 2.6 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.
  - 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. Thomas & Betts Corporation.
    - b. Walker Systems, Inc.; Wiremold Company (The).
    - c. Wiremold Company (The); Electrical Sales Division.
- B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors.
  - 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. Manufacturing Company; Walker Division.
    - b. Enduro Systems, Inc.; Composite Products Division.
    - c. Hubbell Incorporated; Wiring Device-Kellems Division.
    - d. Lamson & Sessions; Carlon Electrical Products.
    - e. Panduit Corp.
    - f. Walker Systems, Inc.; Wiremold Company (The).
    - g. Wiremold Company (The); Electrical Sales Division.

## 2.7 BOXES, ENCLOSURES, AND CABINETS

- 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. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  - 2. EGS/Appleton Electric.
  - 3. Erickson Electrical Equipment Company.
  - 4. Hoffman.
  - 5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - 6. O-Z/Gedney; a unit of General Signal.
  - 7. RACO; a Hubbell Company.
  - 8. Robroy Industries, Inc.; Enclosure Division.

9. Scott Fetzer Co.; Adalet Division.
10. Spring City Electrical Manufacturing Company.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- E. Metal Floor Boxes: Cast or sheet metal, semi-adjustable, rectangular.
- F. Nonmetallic Floor Boxes: Nonadjustable, round.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- I. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
  1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  2. Nonmetallic Enclosures: Plastic.
- J. Cabinets:
  1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
  2. Hinged door in front cover with flush latch and concealed hinge.
  3. Key latch to match panelboards.
  4. Metal barriers to separate wiring of different systems and voltage.
  5. Accessory feet where required for freestanding equipment.

## 2.8 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. Description: Comply with SCTE 77.
  1. Color of Frame and Cover: Green.
  2. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
  3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
  4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  5. Cover Legend: Molded lettering, as indicated for each service.

6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
7. Handholes **12 inches wide by 24 inches long (300 mm wide by 600 mm long)** and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
8. 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. Armorcast Products Company.
  - b. Carson Industries LLC.
  - c. CDR Systems Corporation.
  - d. NewBasis.

B. Fiberglass Handholes and Boxes with Polymer-Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester-resin enclosure joined to polymer-concrete top ring or frame.

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. Armorcast Products Company.
  - b. Carson Industries LLC.
  - c. Christy Concrete Products.
  - d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete.

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. Carson Industries LLC.
  - b. Christy Concrete Products.
  - c. Nordic Fiberglass, Inc.

## 2.9 SLEEVES FOR RACEWAYS

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum **0.052- or 0.138-inch (1.3- or 3.5-mm)** thickness as indicated and of length to suit application.

- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

## 2.10 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
  - 1. Tests of materials shall be performed by a independent testing agency.
  - 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
  - 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

## PART 3 - EXECUTION

### 3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
  - 1. Exposed Conduit: Rigid steel conduit.
  - 2. Concealed Conduit, Aboveground: Rigid steel conduit.
  - 3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
  - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
  - 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Comply with the following indoor applications, unless otherwise indicated:
  - 1. Exposed, Not Subject to Physical Damage: EMT.
  - 2. Exposed, Not Subject to Severe Physical Damage: EMT.
  - 3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:
    - a. Loading dock.
    - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    - c. Mechanical rooms.
  - 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
  - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
  - 6. Damp or Wet Locations: Rigid steel conduit.
  - 7. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.

8. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: EMT.
  9. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: EMT.
  10. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, nonmetallic in damp or wet locations.
- C. Minimum Raceway Size: **1/2-inch (16-mm)** trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
  2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- F. Do not install aluminum conduits in contact with concrete.

### 3.2 INSTALLATION

- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- B. Keep raceways at least **6 inches (150 mm)** away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Support raceways as specified in Division 16 Section "Electrical Supports and Seismic Restraints."
- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
- H. Raceways Embedded in Slabs:
  1. Run conduit larger than **1-inch (27-mm)** trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.

2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
  3. Change from ENT to RNC, Type EPC-40-PVC, rigid steel conduit, or IMC before rising above the floor.
- I. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
  - J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
  - K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than **200-lb (90-kg)** tensile strength. Leave at least **12 inches (300 mm)** of slack at each end of pull wire.
  - L. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:
    1. **3/4-Inch (19-mm)** Trade Size and Smaller: Install raceways in maximum lengths of **50 feet (15 m)**.
    2. **1-Inch (25-mm)** Trade Size and Larger: Install raceways in maximum lengths of **75 feet (23 m)**.
    3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
  - M. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed **30 deg F (17 deg C)**, and that has straight-run length that exceeds **25 feet (7.6 m)**.
    1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
      - a. Outdoor Locations Not Exposed to Direct Sunlight: **125 deg F (70 deg C)** temperature change.
      - b. Outdoor Locations Exposed to Direct Sunlight: **155 deg F (86 deg C)** temperature change.
      - c. Indoor Spaces: Connected with the Outdoors without Physical Separation: **125 deg F (70 deg C)** temperature change.
      - d. Attics: **135 deg F (75 deg C)** temperature change.
      - e. Insert location and corresponding temperature change.
    2. Install fitting(s) that provide expansion and contraction for at least **0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C)** of temperature change.
    3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

- N. Flexible Conduit Connections: Use maximum of **72 inches (1830 mm)** of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
  - 1. Use LFMC in damp or wet locations subject to severe physical damage.
  - 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- O. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
- P. Set metal floor boxes level and flush with finished floor surface.
- Q. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

### 3.3 INSTALLATION OF UNDERGROUND CONDUIT

#### A. Direct-Buried Conduit:

- 1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 2 Section "Earthwork" for pipe less than **6 inches (150 mm)** in nominal diameter.
- 2. Install backfill as specified in Division 2 Section "Earthwork."
- 3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within **12 inches (300 mm)** of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 2 Section "Earthwork."
- 4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
- 5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
  - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with **3 inches (75 mm)** of concrete.
  - b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of **60 inches (1500 mm)** from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
- 6. Warning Planks: Bury warning planks approximately **12 inches (300 mm)** above direct-buried conduits, placing them **24 inches (600 mm)** o.c. Align planks along the width and along the centerline of conduit.



### 3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from **1/2-inch (12.5-mm)** sieve to **No. 4 (4.75-mm)** sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures **1 inch (25 mm)** above finished grade.
- D. Install handholes and boxes with bottom below the frost line, below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
- F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

### 3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Rectangular Sleeve Minimum Metal Thickness:
  - 1. For sleeve cross-section rectangle perimeter less than **50 inches (1270 mm)** and no side greater than **16 inches (400 mm)**, thickness shall be **0.052 inch (1.3 mm)**.
  - 2. For sleeve cross-section rectangle perimeter equal to, or greater than, **50 inches (1270 mm)** and 1 or more sides equal to, or greater than, **16 inches (400 mm)**, thickness shall be **0.138 inch (3.5 mm)**.
- E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- F. Cut sleeves to length for mounting flush with both surfaces of walls.

- G. Extend sleeves installed in floors **2 inches (50 mm)** above finished floor level.
- H. Size pipe sleeves to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and raceway unless sleeve seal is to be installed.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.
- K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 7 Section "Through-Penetration Firestop Systems."
- L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.
- M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for **1-inch (25-mm)** annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for **1-inch (25-mm)** annular clear space between raceway and sleeve for installing mechanical sleeve seals.

### 3.6 SLEEVE-SEAL INSTALLATION

- A. Install to seal underground, exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### 3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Through-Penetration Firestop Systems."

### 3.8 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 16130