

**2013 Bond Program  
Series 1, Bid Package #16A**

**International Academy East Flooring Rebid**

**PROJECT MANUAL**

**Issued: February 5th, 2016**

**Barton**  
 **Malow**



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REFER TO PROJECT MANUAL BOOK 2: TECHNICAL SPECIFICATIONS ISSUED BY TMP  
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END OF SECTION 00015



**SECTION 00030  
PROJECT MANUAL  
INFORMATION AND IDENTITIES**

This Project Manual has been prepared by CM and contains the Bidding and Contract Requirements for **Hamilton Elementary School and International Academy East Flooring rebid** project in **Troy, MI**

**PROJECT:** **Troy School District 2013 Bond Program  
Series 1, Bid Package 16A  
Hamilton Elementary School and International Academy East  
Flooring rebid**

**CONSTRUCTION MANAGER:** **Barton Malow Company  
(Direct all Questions to CM)  
1140 Rankin Drive  
Troy, MI 48083**

**Christa Amalio  
Phone: 586.295.1412  
Email: [Christa.Amalio@bartonmalow.com](mailto:Christa.Amalio@bartonmalow.com)**

**OWNER:** **Troy School District  
4400 Livernois  
Troy, MI 48098**

**ARCHITECT:** **TMP Architecture  
1191 W. Square Lake Road  
Bloomfield Hills, MI 48302  
Phone: (248) 338-4561**

**SECTION 00100**  
**Advertisement to Bid**

Bid Proposals will be received: Barton Malow Company requests Bid Proposals on behalf of Troy School District for the construction of the **Series 1, Bid Package 17 Hamilton Elementary School and International Academy East Flooring rebid.**

1.1. By delivery or mail by 1:00PM local time on February 23, 2016.

1.2. To the attention of:

Todd Hensley  
Troy School District  
1140 Rankin Rd.  
Troy, MI 48083

2. Proposals must be sealed with Bidder's name on the outside of the envelope and designated as follows:

Sealed Proposal

**Series 1, Bid Package 16A**  
**Hamilton Elementary School and International Academy East Flooring rebid**  
Bid Category:  
096000 - Flooring

Contractor Name, Address, Phone Number

3. Accepted Bidders will be required, as a condition precedent to award of Contract, to furnish, satisfactory Performance Bond and Payment Bond and Certificates of Insurance as required in the Project Manual
4. Unless otherwise specifically set forth, this Project is subject to state sales and/or use taxes and Bidder is required to include such taxes in its Bid Proposal.
5. Barton Malow Company has been contracted by the Owner in the capacity of CM for the Project, and shall act as representative of the Owner to the extent required/allowed under its Owner contract. Hereafter Barton Malow Company shall be referred to as the "CM".
6. Bid Proposals will be publicly opened by Troy School District, evaluated by CM, Owner and the Architect, with recommended awards subsequently made by Barton Malow Company. ***The Owner shall not open, consider, or accept a Bid Proposal that is received after the date and time specified for bid submission in this Advertisement for Bids.***
7. Bidding Documents will be available for examination and distribution on or after February 5, 2016. Examination may be made at: CM's Office (1400 Rankin Drive – Troy, MI 48083).
8. No Pre-bid meeting /walk-through is scheduled for BP 16A. Contractors can contact [Christa.Amalio@bartonmalow.com](mailto:Christa.Amalio@bartonmalow.com) for further information regarding site visits.
9. Electronic documents are free of charge and are made available by emailing: [Christa.Amalio@bartonmalow.com](mailto:Christa.Amalio@bartonmalow.com).
10. Bid Proposals shall be on forms furnished by CM. Bidders will be required to submit with their Bid Proposals a Bid Security by a qualified surety authorized to do business in the state where the Project is located. Bidders shall not withdraw Bid Proposals for a period of 90Days after date for receipt of Bid Proposals.
11. The successful Bidder(s) will be required to enter into an agreement with **Troy School District** on the Agreement Form identified in the Project Manual.

12. All Bid Proposals shall be accompanied by the following two forms found in Section 00410: Familial Disclosure Form (in accordance with MCL 380.1267) and an Iran Economic Sanctions Act Form (in compliance with Michigan Public Act No. 517 of 2012. Bid Proposals that do not include these two sworn and notarized forms shall not be accepted.

Barton Malow Company  
Christa Amalio  
Project Manager

END OF SECTION 00100

## SECTION 00200 INSTRUCTION TO BIDDERS

### 1. DEFINITIONS

- 1.1. Capitalized terms used in this Project Manual shall have the meanings set forth below. If a capitalized term is used herein but not defined in this Section, 00200, Part 1, it shall have the meaning set forth in the Contract Documents.
- 1.2. “**Addenda**” means the written and graphic instruments issued by the Architect and/or CM prior to the execution of the Agreement that modify or interpret the Bidding Documents by additions, deletions, clarifications, or corrections.
- 1.3. “**Agreement**” means the document defined in the Project Manual, including all other documents incorporated by reference in the Agreement.
- 1.4. “**An Alternate Bid**” (or “**Alternate**”) is an amount stated in the Bid Proposal to be added to or deducted from the amount of the Base Bid if the corresponding change in the Work, as described in the Bidding Documents, is accepted.
- 1.5. “**Architect**” means the person or entity listed in section 00030 of the Project Manual and may include professional engineers if so designated.
- 1.6. “**Base Bid**” is the sum stated in the Bid Proposal for which the Bidder offers to perform the Work described in the Bidding Documents as the base, to which Work may be added to or deducted from for sums stated in Alternate Bids.
- 1.7. A “**Bidder**” is a person or legal entity that submits a Bid Proposal in conformance with the Bidding Documents. After award of the Agreement, the Bidder will be referred to as Contractor. All Contractors on this project are considered prime/principal contractors.
- 1.8. “**Bid Categories**” are units of Work performed by a Contractor and its Subordinate Parties which form part of the total Project. The term “**Bid Category**” should not be confused with the term “**Technical Section**”. Technical Sections of the Specification establish quality and performance criteria, and the Bid Categories designate work scope and assignment.
- 1.9. “**Bidding Documents**” means the Bidding Requirements, the Contract Documents, and the Reference Documents collectively.
- 1.10. A “**Bid Package**” means a series of Bid Categories that are released for bidding in the same set of Bidding Documents.
- 1.11. “**Bidding Requirements**” include the Advertisement to Bid, Instructions to Bidders, Information Available to Bidders, and Bid forms and supplements.
- 1.12. “**Bid Proposal**” is a complete and properly signed proposal to do the Work of an individual Bid Category(ies) for the sums stipulated therein, submitted in accordance with the Bidding Documents.
- 1.13. The “**Contract Documents**” consist of all Contracting Requirements set forth in the Project Manual, including, but not limited to, the Contract Forms (the Agreement, Performance/Payment Bonds, and Certificates), the Conditions of the Contract (General, Supplementary or Special), the General Requirements of the Project Manual, the Technical Specifications, Drawings, and all other documents incorporated into the Agreement by reference, all Addenda issued prior to and all modifications issued after execution of the Agreement.
- 1.14. “**Contractor**” means the entity to which the Owner issues a contract for performance of the Work.
- 1.15. “**Day**” means calendar day, unless otherwise defined in the particular Contract Document.
- 1.16. “**Hazard Communications Program**” means Contractor’s own hazard communications program that will govern project safety for its Work. The Hazard Communications Program must be submitted to CM by each successful Bidder before commencing Work and be no less stringent than Section 00810 - On Site Safety and Loss Control Program.

- 1.17. **“Hazardous Materials”** means asbestos; asbestos containing material; lead (including lead-based paint); PCB; molds; any other chemical, material, or substance subject to regulation as a hazardous material, hazardous substance, toxic substance, or otherwise, under applicable federal, state, or local law; and any other chemical, material, or substance that may have adverse effects on human health or the environment.
- 1.18. **“Lowest Responsive, Responsible Bidder”** means a Bidder who’s Bid Proposal conforms in all material aspects to the terms, conditions, specifications and requirements of the solicitations and who has demonstrated the ability to properly perform the Work.
- 1.19. **“MBE/WBE/SBE”** means Minority Owned Business Enterprise/Women Owned Business Enterprise/ Small Business Enterprise as these terms are defined in the applicable ordinances and laws governing the Project.
- 1.20. **“Project Safety Program”** means the Contractor’s site safety program that will govern project safety for its Work. The Project Safety Program must be submitted to CM by each successful Bidder before commencing Work and be no less stringent than Section 00810 - On Site Safety and Loss Control Program.
- 1.21. **“Reference Documents”** are drawings that do not form a part of the Contract Documents and are included in the Bidding Documents as a courtesy only. The Bidder is not entitled to rely upon the accuracy of the Resource Drawings and they are not warranted to be correct or reliable by the Owner or CM. The Bidder is expected to have conducted its own investigation into the reliability or accuracy of any Reference Documents, and no adjustment to the Base Bid shall be made if such request arises or results from the Bidder’s failure to conduct such investigation.
- 1.22. **“Subordinate Parties”** means all of Contractor’s employees, workers, laborers, agents, consultants, suppliers or subcontractors, at any tier, who perform, assist with, or otherwise are involved in any of the Work.
- 1.23. A **“Unit Price”** is an amount stated in the Bid Proposal as a price per unit of measurement for materials or services as described in the Bidding Documents or in the proposed Contract Documents.
- 1.24. The **“Work”** includes all work and responsibilities performed or to be performed by Contractor under the Subcontract.

## 2. PART 2 - BIDDERS REPRESENTATIONS

- 2.1.1. The Owner reserves the right to request qualification forms or additional information from any Bidder before issuing documents, receiving Bid Proposals or awarding an Agreement. The Owner may, at their sole discretion, accept or reject Bidders as qualified. The right to waive any informalities or irregularities in qualification materials is reserved by the Owner.

### 2.2. BIDDER BY MAKING ITS BID REPRESENTS THAT:

- 2.2.1. Bidder has carefully read, reviewed and understands the Bidding Documents and its Bid Proposal is made in accordance therewith.
- 2.2.2. Bidder’s Bid Proposal is based upon the materials, systems, equipment, terms and conditions required by the Bidding Documents without exception.
- 2.2.3. Bidder certifies that it:
  - 2.2.3.1. has examined the Project site;
  - 2.2.3.2. has carefully reviewed the Bidding Documents
  - 2.2.3.3. has compared its examination of the Project site with the Bidding Documents;
  - 2.2.3.4. is satisfied as to the condition of the Project site, any surface or subsurface obstruction, the actual levels, and all excavating, filling in, removal and demolition, measurements and quantities involved in the Work;
  - 2.2.3.5. is familiar with weather conditions of the Project area;
  - 2.2.3.6. has taken account of all of these factors in preparing and presenting its Bid Proposal.

- 2.2.4. Bidder further certifies that it
  - 2.2.4.1. has fully acquainted itself with the character and extent of the Owner's, CM's and other Contractor 's operations in the area of the Work
  - 2.2.4.2. has taken account of coordination of operations of others in its construction plans set forth in the Bid Proposal.
- 2.2.5. No change orders will be issued to the Contractor for or on account of costs or expenses occasioned by its failure to comply with the provisions of this paragraph, or by reason of error or oversight on the part of the Contractor, or on account of interferences by the Owner's, CM's or other contractor's activities.
- 2.2.6. The Bidder, by submitting its Bid Proposal, represents that it has carefully reviewed the project schedule, along with the related requirements of the Project's Schedule and Phasing, and acknowledges that these are acceptable and have been taken into account in preparing its Bid Proposal.

### 3. BIDDING DOCUMENTS

#### 3.1. COPIES

- 3.1.1. Bidders shall use complete sets of Bidding Documents in preparing Bid Proposals. Neither the Owner, CM nor the Architect shall be responsible for errors, omissions or misinterpretations resulting from the Bidder's use of partial sets of Bidding Documents.
- 3.1.2. Copies of the Bidding Documents are being made available for the purpose of obtaining Bid Proposals for the Work only. Bidders shall not use the Bidding Documents for any other purpose. Neither the Owner, CM nor the Architect warrants the completeness and/or adequacy of the Bidding Documents.

#### 3.2. INTERPRETATION OR CORRECTION OF BIDDING DOCUMENTS

- 3.2.1. Bidder shall promptly notify the Barton Malow Company of all ambiguities, inconsistencies, or errors that it may discover upon examination of the Bidding Documents or upon examination of the Project site and local conditions. Bidders requesting clarification or interpretation of the Bidding Documents shall make a written request, which shall reach Barton Malow Company at least 5 days prior to the date for receipt of Bid Proposals. Direct all questions to:

**Contact Name:** Christa Amalio  
**Address:** 1140 Rankin  
**City, State, Zip:** Troy, MI, 48083  
**Phone:** 586.295.1412  
**Email:** [Christa.Amalio@bartonmalow.com](mailto:Christa.Amalio@bartonmalow.com)

- 3.2.2. Any interpretation, correction, or change of the Bidding Documents will be made by Addendum and/or Bid Clarification. Interpretations, corrections, or changes of the Bidding Documents made in any other manner will not be binding, and Bidders shall not rely upon such interpretations, corrections and changes. Advertisement to Bid

#### 3.3. ADDENDA and/or BID CLARIFICATIONS

- 3.3.1. Addenda and/or Bid Clarifications will be distributed to all who are known by CM to have received a complete set of Bidding Documents. Copies of Addenda and/or Bid Clarifications will be made available for inspection wherever Bidding Documents are on file for that purpose.
- 3.3.2. No Addenda or Bid Clarifications will be issued later than 3 days prior to the date for receipt of Bids except an Addendum or Bid Clarification withdrawing or postponing the request for Bid Proposals.

#### 3.4. ALTERNATES

- 3.4.1. Each Bidder must bid on all Alternates listed in the Bid Proposal that are applicable to its Bid Category. Alternates will be fully considered in awarding the Agreement.
- 3.4.2. The Owner shall be allowed a period of 90 Days after date of receipt of the Bid Proposals to exercise the right to accept or reject any or all Alternates submitted on the Bid Proposal.
- 3.4.3. Successful Bidders shall perform all Work required for complete execution of accepted Alternates, and the Bid Proposal shall include all overhead and profit for the Work required.

### 3.5. VOLUNTARY ALTERNATES

- 3.5.1. All Bid Proposals must be based upon the Bidding Documents. In addition to a Base Bid Proposal, the submission of Voluntary Alternates is acceptable and encouraged. If a Voluntary Alternate is submitted for consideration, it shall be expressed on the Bid Form as an add or deduct amount from the Base Bid. The [Owner or Owner and CM] reserve the right to unilaterally accept or reject Voluntary Alternates and to determine if the Voluntary Alternates will be considered in the awarding of the Agreement.

### 3.6. UNIT PRICES

- 3.6.1. Each Bidder must bid on all Unit Prices listed in the Bid Proposal that are applicable to its Bid Category. Unit Prices will be fully considered in awarding the Agreement.
- 3.6.2. Successful Bidders shall perform all Work required for complete execution of accepted Unit Prices, and such Unit Prices shall include all overhead and profit for the Work required.

### 3.7. NO DISCRIMINATION

- 3.7.1. All Bidders shall ensure that employees and applicants for employment are not discriminated against because of their race, color, religion, sex, national origin, age, marital status, sexual orientation, or disability and in conformance with local, state and federal laws, regulations and ordinances.
- 3.7.2. In regard to any Agreement entered into pursuant to this Bid Package, minority and women owned business enterprises will be afforded full opportunity to submit Bid Proposals and will not be discriminated against on the grounds of race, color, religion, sex, national origin, age, marital status, sexual orientation, disability or any other status protected by applicable law.

## 4. BIDDING PROCEDURE

### 4.1. FORM AND STYLE OF BIDS

- 4.1.1. Bid Proposals shall be submitted in accordance with the Bid Proposal Form.

### 4.2. BID SECURITY

- 4.2.1. Bid security in the form of a bid bond issued by a qualified surety, certified check or cashier's check in the amount of five percent (5%) of the Base Bid amount will be required at the time of submission of the Bid Proposal. Bid bonds shall be duly executed by the Bidder, as principal and by a surety that is properly licensed and authorized to do business in the state in which the Work is to be performed. All sureties providing bonds for this Project must be listed in the latest version of the Department of Treasury's Circular 570, entitled "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies", with the bond amount less than or equal to the underwriting limitation, and/or have an A.M. best rating of A- or better.
- 4.2.2. Bid bond shall pledge that the Bidder, with the understanding that if its Bid Proposal is accepted, will enter into the Agreement with the Troy School District for any of the Bid Category(ies) accepted from its Bid Proposal and will, if required, furnish performance and payment bonds covering the faithful performance of the Agreement and the payment of all obligations arising there under. The attorney-in-fact, who signs the surety bond must submit along with the bond, a certified and effectively dated copy of his/her power of attorney.

- 4.2.3. Bid bond form AIA Document A310 unmodified, is approved for use on this Project.
- 4.2.4. The bid security obligees shall be Troy School District and the amount of the bid security shall become their property in the event that the Bidder fails, within fifteen (15) days of notice of award or receipt of the Agreement form, to execute the Agreement, and deliver the performance and payment bonds as described in the Project Manual, section 00500. In such case, the bid security shall be forfeited to the Troy School District as liquidated damages, not as a penalty.
- 4.2.5. The Owner will have the right to retain the bid security(ies) of Bidders to whom an award is being considered until either (a) the Agreement has been executed and bonds, if required, have been furnished, or (b) the specified time has elapsed so that Bid Proposals may be withdrawn, or (c) all Bid Proposals have been rejected.
- 4.2.6. Bid security will be returned to the successful Bidders after the Agreement has been executed, and acceptance of required performance and payment bonds. The bid security of Bidders that are not under consideration for award of the Agreement will be returned to those Bidders.

#### 4.3. SUBMISSION OF BIDS

- 4.3.1. All copies of the Bid Proposal, the bid security and any other documents required to be submitted with the Bid Proposal shall be enclosed in a sealed opaque envelope. The envelope shall be labeled as specified as noted in Section 00100.
- 4.3.2. Bid Proposals shall be deposited at the designated location prior to the time and date for receipt of Bid Proposals indicated in the Advertisement to Bid, or any extension thereof made by Addendum or Bid Clarification. Bid Proposals received after the date and time for receipt of bids may be returned unopened.

#### 4.4. MODIFICATION OR WITHDRAWAL OF BID PROPOSAL

- 4.4.1. A Bid Proposal may not be modified, withdrawn or canceled by the Bidder after the stipulated time period and date designated for the receipt of Bid Proposals, and each Bidder so agrees in submitting its Bid.
- 4.4.2. Prior to the time and date designated for receipt of Bid Proposals, any Bid Proposal submitted may be modified or withdrawn by notice to the party receiving Bid Proposals at the place designated for their receipt. Such notice shall be in writing over the signature of the Bidder.
- 4.4.3. Withdrawn Bid Proposals may be resubmitted up to the time designated for the receipt of bids provided that they are then fully in conformance with these Instructions to Bidders.
- 4.4.4. Bid security as stated above shall be in an amount for the Base Bid as modified or resubmitted.

### 5. CONSIDERATION OF BIDS

#### 5.1. OPENING OF BIDS

- 5.1.1. Bid Proposals received on time will be opened publicly.
- 5.1.2. Bid Proposals shall be held open and irrevocable for ninety (90)Days after the date for receipt of bids.

#### 5.2. REJECTION OF BIDS

- 5.2.1. The Troy School District reserves the right to reject any or all Bid Proposals in accordance with all applicable laws.

#### 5.3. ACCEPTANCE OF BID (AWARD)

- 5.3.1. It is the intent of the Troy School District to award the Agreement to the Lowest Responsive and Responsible Bidder in accordance with the Bidding Documents. The Troy School District shall have the right to waive any informality or irregularity in any Bid Proposal received and to accept Bid Proposals which, in its judgment, are in its own best interest.



- 5.3.2. The Troy School District shall have the right to accept Alternates in any order or combination and to determine the low Bidder on the basis of the sum of the Base Bid, Voluntary Alternates and Alternates accepted.
- 5.4. To the extent that these Instructions to Bidders and applicable public bidding laws, rules, regulations or ordinances conflict with each other, the provisions of the applicable bidding laws, rules, regulations or ordinances shall govern.
- 5.5. The Owner expects all supplies, materials equipment or products proposed by a Bidder to meet or exceed the Specifications set forth in the Bidding Documents. Further, it is the Owner's intent that the Bidding Documents permit competition. Accordingly, the use of any patent, proprietary name or manufacturer's name is for demonstrative purposes only and is not intended to curtail competition. Whenever any supplies, material, equipment or products requested in the Bidding Documents are specified by patent, proprietary name or by the name of the manufacturer, unless stated differently, such specification shall be considered as if followed by the words "or comparable equivalent," whether or not such words appear. The Owner, in its sole and absolute discretion, shall have the right to determine if the proposed equivalent products/brands submitted by Bidder meet the Specifications contained in the Bidding Documents and possess equivalent and/or better qualities. It shall be the Bidder's responsibility to notify the Owner in writing if any Specifications or suggested comparable equivalent products/brands require clarification by the Owner prior to the Due Date for Bid Proposals.

## 6. POST BID INFORMATION

### 6.1. POST BID INFORMATION

- 6.1.1. After the Bids are received, tabulated, and evaluated, the apparent low Bidders when so requested shall meet with CM at a post-bid meeting for the purposes of determining completeness of scope and any contract overlaps or omissions. If requested, the Bidder shall submit additional information as requested by CM. The Bidder will provide the following information at the post-bid meeting:
  - 6.1.1.1. Designation of the Work to be performed by the Bidder with its own forces including manpower for the Contractor and that of its Subordinate Parties.
  - 6.1.1.2. Detailed cost breakdown of the Bidder's Bid Proposal including labor, equipment and material unit prices.
  - 6.1.1.3. A list of names of the Subordinate Parties proposed for the principal portions of the Work.
  - 6.1.1.4. The proprietary names and suppliers of principal items or systems of materials and equipment proposed for the Work.
  - 6.1.1.5. The names and backgrounds of the Bidder's key staff members including foremen and assistants. Bidder shall be requested to establish the reliability and responsibility of the persons or entities proposed to furnish and perform the Work described in the Bidding Documents.
  - 6.1.1.6. Commitment to construction schedules, identification of items requiring long lead deliveries and manpower information in accordance with Section 00230 of the Project Manual.
  - 6.1.1.7. Signed safety program compliance, as described in the Contract Documents
- 6.1.2. Prior to award of the Agreement, CM will notify the Bidder if either the Owner, the Architect, or CM, after due investigation, has reasonable objection to any proposed Subordinate Party. If the Owner, Architect or CM has reasonable objection to any proposed Subordinate Party, the Bidder may, at its option: (1) withdraw its Bid Proposal; or (2) submit an acceptable substitute Subordinate Party with an adjustment in its bid amount to cover the difference in cost occasioned by such substitution. The Troy School District, may, at its discretion, accept the adjusted bid amount or it may disqualify the Bidder. In the event of either withdrawal or

disqualification under this Subparagraph, bid security will not be forfeited, notwithstanding the terms in the Instructions to Bidders.

- 6.1.3. Upon the Award of the Agreement, the Contractor shall submit to CM a complete list of all items, products, and layouts for which shop drawings, brochures, or samples are required; name of each Subordinate Party; and date of planned submission.
- 6.1.4. The Bidder will be required to establish to the satisfaction of CM, Owner and Architect, the reliability and responsibility of the Subordinate Parties proposed to furnish and perform the Work described in the Bidding Documents.

END OF SECTION 00200

**SECTION 00210**  
**DESCRIPTION OF THE WORK/SPECIAL PROVISIONS**

**1. GENERAL**

**1.1. RELATED DOCUMENTS**

- 1.1.1. All Bidders shall review all of the Bidding Documents, all Bid Category Work descriptions and all Contract Documents, immediately advise CM of any adverse factors, conflicts or ambiguities that might affect the execution of Work of this Bid Package. Each Bidder is responsible to review all Bid Category descriptions and Contract Documents and coordinate the Work accordingly. Each Bidder shall incorporate into its Bid Proposal the cost of coordination of the Work with the requirements of all related Contract Documents, as shown, specified, or required.
- 1.1.2. Each Bidder shall thoroughly examine all of the Bidding Documents for the Work of all trades so as to familiarize itself both with the Work required under its Bid Category(ies) and with Work required under all other Bid Categories.
- 1.1.3. The Bidder shall perform all Work reasonably inferable from the Bidding Documents to produce the intended results. Bidders are required to visit and examine the Project site and may arrange the visit through CM.
- 1.1.4. A complete set of bid documents are available at CM's office

**1.2. PROJECT DESCRIPTION**

- 1.2.1. The Troy Schools bid package 16A consists of flooring for the International Academy East in rooms designated on the bid plans. Contracts are scheduled to be awarded in March 2016. All work may begin on June 20, 2016 and must complete prior to August 12, 2016.

**1.3. SUMMARY OF THE BID CATEGORIES/WORK SCOPES**

- 1.3.1. The following is a listing of Bid Categories for this project All work relative to the Bid Package is identified on plans and specifications as prepared by the Architect. Each Bid Category description identifies the scope of Work to be performed by the Bidder as designated by CM.

**BID CATEGORIES**

096000 - Flooring

**1.4. SPECIAL PROVISIONS**

- 1.4.1. The following special provisions form a part of each Bid Category Work Scope and apply to each Contractor's Scope of Work found in Section 00220.
- 1.4.2. The Bid Category/Work Scopes should in no way be construed as being all inclusive. The Work Scope is issued as a guide to aid in the assignment of Work. If conflict regarding assignment of Work exists between the drawing notes and these descriptions, the Description of the Work and Bid Category/Work Scopes will take precedence. The Contractor shall carefully review and compare the Drawings and Specifications with the Work Scopes, and if a conflict exists, the Contractor shall immediately notify CM in writing. The Bid Category numbers and the specification section numbers are not, in all cases, identical.
- 1.4.3. Bidders are required to bid the entire Bid Category. Bids will only be accepted for individual Bid Categories. A Bidder may bid more than one Bid Category. Combined bids covering several Bid Categories will not be accepted, unless separate bid amounts are listed for each Bid Category making up the combined bid amount. Review the "Instructions to Bidders" in Section 00200 for specific Bid Proposal instructions.
- 1.4.4. Each Bidder shall review the schedule enclosed in the Bidding Documents, and be prepared to review at the post-bid meetings a schedule for the engineering, fabrication, delivery and installation of its Work. . This information will be considered in the award recommendation.

- 1.4.5. All Contractors are to coordinate all Work with the work of other trades for proper function and sequence (see Section 01360). Contractor must furnish approved copies of shop drawings, mock-ups, and technical data to other contractors designated by the CM for the purposes of coordination of this Work. Contractor must provide to all other trades all information (drawings, diagrams, templates, embedments) and other related Work necessary for the proper coordination of the Work of all trades. Each phase of the Work shall be coordinated, and the coordination plan approved by CM prior to proceeding. Contractor shall keep informed as to Work of all trades engaged in the Project, and shall execute Work in such a manner as not to delay or interfere with the progress of other trades involved. Contractor is required to schedule its Work so that no other party is delayed in execution of its work. Contractor is required to employ competent supervision on the Project throughout the entire period of construction to ensure proper coordination.
- 1.4.6. Contractor will furnish before any Work is started, evidence of ISO Certification or documented procedures for process control, including drawings, submittals, inspection/surveillance and training. In lieu of defined procedures, Contractor will follow CM's documented procedures for process control.
- 1.4.7. When it is necessary to modify or tie into existing utility services, Contractor shall notify CM in writing a minimum of 48 hours prior to the planned disruption. All disruptions shall be scheduled with CM and shall be kept to a minimum time. Tie-ins and shutdowns of existing utilities may have to be performed during off hours. Contractors are to include any required premium time in the Base Bid.
- 1.4.8. If Owner will occupy the premises or a portion of the premises during the construction, Contractor shall cooperate with CM and Owner in all construction operations to minimize conflict, and to facilitate Owner occupancy.
- 1.4.9. Information pertaining to the existing building has been obtained through photographs and investigations and is indicated on the Resource Drawings. This information is not warranted to be complete or accurate. Contractor shall verify all dimensions in the field prior to ordering materials or construction and any costs or expenses arising out of its failure to do so shall be borne solely by Contractor.
- 1.4.10. The Contractor shall examine the existing site conditions and carefully compare them to the Drawings. All measurements must be verified from actual observation at the Project site. The Contractor is responsible for all Work fitting in place in approved, satisfactory and workmanlike manner in every particular. If the Contractor encounters unexpected existing site or building conditions, it shall cease operations immediately to minimize damage and shall immediately notify CM in writing. Contractor shall bear all costs, expenses or damages arising or resulting from its failure to comply with this paragraph.
- 1.4.11. Hoisting of material or equipment above occupied areas will NOT be permitted unless the existing structure has been properly verified by a licensed professional Engineer to be able to bear the load of the material or equipment being hoisted if accidentally released. It is the responsibility of the Contractor performing such hoisting to properly and adequately reinforce existing structure.
- 1.4.12. Space for electrical and mechanical lines is limited for the Project. Therefore, it is imperative that Contractor coordinate its Work with the Work of all other trades to ensure containment of electrical and mechanical lines in space provided. Priority of space will be decided in discretion of CM, with no additional compensation, where unresolved conflict exists. If Work is not properly coordinated, Contractor shall remove and relocate Work without additional compensation.
- 1.4.13. The Contractor shall maintain all project record documents for all concealed Work to mark actual construction. The Contractor shall turned over to CM all project record documents upon completion of Work by the Contractor, in a format to be determined by CM. The Contractor shall make all project record documents available to the Owner, CM and/or the Architect for inspection and review. The Contractor's failure to maintain such documents adequately shall

entitle the Owner and/or CM to withhold payment until such documents are current and up to date.

1.4.14. The Contractor shall submit a daily report to CM on a daily basis on the form provided to Contractor by CM.

1.4.15. All Contractors shall attend all meetings as required by CM.

1.5. OWNER EQUIPMENT COORDINATION

1.5.1. The Owner Furnished and Contractor Installed (OF/CI) equipment as listed in the Individual Contractor's Work scopes found in Section 00220 shows the Contractor responsible to schedule delivery, receive the equipment and accessories F.O.B. jobsite, inspect, protect, store, handle and move into position, provide all coordination with applicable trades for rough-in requirements and final connections, marshal the appropriate trades as a composite installation crew, and assist in initial startup.

1.5.2. Refer to the Drawings to determine quantities.

END OF SECTION 00210

## SECTION 00230 SCHEDULE AND PHASING

### 1. GENERAL

#### 1.1. MILESTONE SCHEDULE

- 1.1.1. The following are the milestone schedule dates for the listed Work and will become a part of the Contract Documents. The master construction schedule will be developed after award of the Agreement with Contractor input.

<b>MILESTONE ACTIVITY</b>	<b>SCHEDULED START</b>
BP16A Bids Due	February 23, 2016
Contracts Awarded	March 15, 2016
Start of summer construction BP16A	June 20, 2016
BP16A work completion	August 12, 2016
BP16A Punchlist Complete	September 5, 2016

- 1.1.2. It is expressly agreed that time is of the essence for the completion of Work under the Agreement and Contractor agrees to perform the Work within the allotted time and in the manner specified. Contractor shall be liable for any and all damages and expenses suffered by the Owner or CM arising or resulting from the failure of Contractor to perform the Work in accordance with the construction schedule.

#### 1.2. CONSTRUCTION SCHEDULE DEVELOPMENT PROCESS

- 1.2.1. Contractor agrees to commence Work in the field within five (5) Days after being notified to do so by the CM. Contractor shall diligently perform and fully complete all Work to the satisfaction of CM and Owner.
- 1.2.2. Work shall begin at such points as CM may designate and shall be carried to completion with the utmost speed.
- 1.3.2. Contractor shall submit to CM within fifteen (15) Days of award of the Agreement all necessary scheduling information, in form and substance satisfactory to CM of all activities contained in the Contractor's scope of Work, including activity descriptions and durations in working days, for shop drawings, fabrication, delivery and installation of products, materials and equipment. This schedule shall identify precedent relationships between Contractor's activities and those of other contractors, the dollar value, necessary manpower loadings, and precedent activities for other contractors. The activities on the schedule must be at a level of detail approved by CM and should agree with the terminology and building sequencing established by CM. CM will compile all Contractors' schedules and develop a project master construction schedule. Once the individual contractors schedules are agreed upon by CM, this project master construction schedule will become the project plan for construction.
- 1.3.3. Special requirements and/or sequencing issues should be brought to the attention of CM. It is intended the milestones remain in effect and all Bidders agree to accept the milestone dates. CM reserves the right to revise the project master construction schedule as deemed necessary. CM reserves the right to revise the project master construction schedule as deemed necessary.
- 1.3.4. CM shall periodically update the project master construction schedule and display it at the Project site. Contractor shall familiarize itself with the project master construction schedule and how it will affect or modify its operations, including coordination with the activities of other contractors. Reasonable changes in sequencing, durations and phasing are to be expected with

each master schedule update. These changes will be made by Contractor at no additional cost. Reasonable changes in sequencing, durations, and phasing are to be expected with each master schedule update. These changes will be made by Contractor at no additional cost.

- 1.3.5. If it is apparent Contractor is unable to perform its Work in the sequence indicated or the time allotted, Contractor must notify CM within five (5) Days after initial publication of the project master construction schedule. Contractor's schedule of activities may be re-sequenced, and the schedule may be adjusted, provided all Work is completed within the stated milestone dates and provided CM and affected contractors are notified of the change within five (5) calendar days of receipt of the schedule and the change does not otherwise negatively impact the other scheduled work; otherwise, the project master construction schedule shall be deemed accepted by all parties and becomes a contractual requirement for each Contractor.
- 1.3.6. If Contractor delays progress for any reason other than those delays specifically excused under the Contract Documents, Contractor will take all necessary steps to expedite its Work to maintain milestone target dates at no expense or additional cost to Owner or CM.
- 1.3.7. If Contractor is behind schedule and is so notified by CM, Contractor shall be required to accelerate the Work at its own expense. Contractor shall furnish to CM a short interval schedule of its Work showing location, number of men and crew required to get back on the agreed upon master construction schedule. If Contractor fails to maintain and meet the short interval schedule, Owner through CM reserves the right to take whatever steps it deems necessary in its sole discretion to recover the schedule at the Contractor's expense. The Contractor shall employ such means as overtime work, multiple work shifts, and additional equipment, all without additional compensation, and shall continue to do so until the progress of the Work, in the opinion of CM, is in conformance with the master project construction schedule.
- 1.3.8. Contractor agrees that it shall have no claim against the Owner, Architect, or CM for an increase in the contract price nor for a payment or allowance of any kind for damage, loss, or expense arising or resulting from delays, regardless of whether the delay is the basis for an extension of time. This provision includes claims for damage, loss, or expense arising or resulting from interruptions to, or necessary suspension of, Contractor's Work to enable other contractors to perform their work.

END OF SECTION 00230

**SECTION 00400**  
**BID PROPOSAL FORM**  
**(Submit in Triplicate - Fill in all Blanks)**

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

TO: Troy School District  
1140 Rankin  
Troy, MI 48083

PROJECT: Troy School District 2013 Bond Program  
Series 1, Bid Package #16A  
International Academy East Flooring

ATTN: Todd Hensley  
Purchasing Supervisor

CM :Barton Malow Company

Architect: TMP Architecture

**Name of Bidding Co.:**

**Contact Name:**

**Email Address:**

**Business Address:**

**Phone Number:**

**Bid Proposal for  
Category(ies):**

Bidder, in compliance with the Advertisement to Bid for construction contemplated for **Bid Package No. 16A – Hamilton Elementary School and International Academy East Flooring** having carefully examined the Bidding Documents and the site of the proposed Project and the conditions affecting the proposed Work in the Bid Category(ies) including the condition of the Project site, any surface or subsurface obstruction, the actual levels, all excavating, filling in, removal and demolition, measurements and quantities involved in the Work, the availability of labor, materials and equipment, and the weather conditions that may possibly may be experienced in the Project vicinity, proposes to furnish all labor, materials, tools, equipment, machinery, equipment rental, transportation, superintendence, and services as are necessary to perform all Work in the Bid Category(ies) stated in accordance with the Contract Documents for the Base Bid and Alternate amounts stated below.

If identified as one of the apparent lowest bidder(s) for a Bid Category Bidder agrees to meet immediately with CM and shall submit post bid information as described in Section 00200 Instructions to Bidders.

Bidder, if awarded a contract, agrees to: (1) execute the Agreement within fifteen (15) days of receiving notice of the award; (2) provide performance/payment bonds and insurance certificates in full compliance with the Contract Documents, (3) submit the Project Safety Program as described in Section 00200 Instructions to Bidders; (4) commence Work upon execution of the Agreement or at such other time as directed in the notice of award, and (5) to complete its Work in accordance with the Contract Documents and within the milestone activity dates and durations set forth in the Bidding Documents and subsequent construction project master schedule established by CM. In the event Bidder defaults in complying with any portion of this paragraph, Bidder specifically agrees that the entire bid security amount shall become the property of Owner as liquidated damages constituting the reasonable estimate of the damages that Owner would incur for delays and additional expenses in the event of such default, and not as a penalty.



**BASE BID:** Bidder agrees to perform all Work for Bid Category(ies) as described in the Contract Documents, for the Base Bid(s) stated below. The Base Bid(s) shall include the cost of Performance and Payment Bonds. For each Bid Category to be bid, include the Base Bid, written and in figures, the cost of the Performance Bond and Payment Bond which is included in the Base Bid, written and in figures, and the Bid Category and description.

(Show amounts in both words and figures. In case of discrepancy, amount shown in words will govern).

BID CATEGORY	WRITTEN DESCRIPTION/AMOUNT(S)	BID AMOUNT IN FIGURES
1. 096000 Flooring	_____	\$ _____
	_____ DOLLARS	

**HOURLY LABOR RATES:** All contractors are required to provide their company's hourly labor rates as they apply to this project. The contract may be awarded based on this information. Failure to quote the following hourly labor rates will result in an incomplete bid proposal form and may be disqualified by Troy School District.

JOB TITLE	HOURLY RATE
_____	\$ _____
_____	\$ _____
_____	\$ _____
_____	\$ _____

**UNIT PRICES:** The following Unit Prices to Base Bid Categories are required to be offered by the respective Bidders. Bidder agrees that the following amounts will be used in determining contract changes from the Base Bid for authorized Changes in the Work. Bidder shall not include these unit costs in the Base Bid amount(s). All unit prices shall include Bidder's mark-up for overhead and profit.

	BID CATEGORY CODE	DESCRIPTION OF UNIT PRICE	UNIT PRICE	
			ADD	DEDUCT
		Floor prep materials per sq ft.	\$	\$
2.		VCT per sq ft. installed	\$	\$
3.		Carpet per sq ft installed		

**EXPEDITED PAYMENT PROCESS:** The following is an option to receive payment within 30 days in lieu of 45 days (Quick Pay). Provide a deduct for this option.

Deduct \_\_\_\_\_ (\$ \_\_\_\_\_ )

**VOLUNTARY ALTERNATES:** The following voluntary Alternates are offered by the Bidder. Bidder agrees that the amounts indicated below shall be added to or deducted from the Base Bid, as indicated, for each voluntary Alternate that is accepted. (Show amount(s) in both words and figures for voluntary alternates. In case of discrepancy, amount shown in words will govern).

BID CATEGORY	WRITTEN DESCRIPTION OF VOLUNTARY ALTERNATE AMOUNT(S)	ADD	DEDUCT
1.		\$	\$

For the amount of:

\_\_\_\_\_ DOLLARS

Bidder is required to submit sufficient detailed information to fully describe each voluntary Alternate(s) on a separate sheet(s) attached to this Bid Proposal form.

All applicable taxes and bond costs are included in the above Base Bid and all listed Alternates and Unit Prices.

Bid Security in the form of a bid bond from a qualified surety ( ), certified check ( ), or cashier's check ( ), (check one) accompanies this proposal in the amount of five (5) percent of the Base Bid amount(s). Bidder agrees that this Bid Proposal shall be irrevocable for a period of 90 Days after the day and time designated for receipt of the Bid Proposal in Section 00100 of the Project Manual.

As of the date of submission of the Bid Proposal, Bidder's worker's compensation Experience Modification Rate (EMR) for the state in which the Work is to be performed is \_\_\_\_\_. Bidder has attached to the Bid Proposal form the OSHA Form 200 / 200S indicating recordable incidence rates for the last calendar year per 200,000 man-hours for the following categories:

- 1) Total Cases \_\_\_\_\_
- 2) Lost Workday Cases \_\_\_\_\_
- 3) Non-fatal Cases Without Lost Workdays \_\_\_\_\_
- 4) Employee Hours Worked Last Year \_\_\_\_\_
- 5) Fatalities in the last year (if yes describe below) \_\_\_\_\_

Has Bidder been cited by state or federal OSHA for any serious or willful violation? If yes, please describe:

---

---

Bidder understands that the Owner reserves the right to reject any or all Bid Proposals and to waive any informalities or irregularities therein.

Bidder acknowledges receipt of the following Addenda (identify no. and date of each): \_\_\_\_\_

---

Bidder acknowledges receipt of the pre-bid conference minutes dated \_\_\_\_\_

---

If awarded a contract, Bidder's surety will be \_\_\_\_\_ .

Check

☐ I have included a fully executed and notarized copy of the familial disclosure form set forth in Section 00410 of this Project Manual with my Bid Proposal.

Bidder accepts the provisions of the Bidding and Contract Documents and certifies that this Bid Proposal is submitted in good faith and without collusion with any other person or entity submitting a Bid Proposal for the Work. If Bidder is required to be licensed in the state where the work is performed add "Bidder certifies that it meets all licensing requirements of the state in which work is to be performed, its current license number and classification are as follows: \_\_\_\_\_ Bidder hereby affixes its authorized signature(s) representing (check one):

\_\_\_\_\_ An individual doing business as \_\_\_\_\_

\_\_\_\_\_ A partnership

\_\_\_\_\_ A limited liability company, organized in \_\_\_\_\_ (enter state)

\_\_\_\_\_ A corporation, organized in \_\_\_\_\_ (enter state)

\_\_\_\_\_ Joint venture formed between \_\_\_\_\_ and \_\_\_\_\_

\_\_\_\_\_ (Signature from authorized representatives of each partner are required)

\_\_\_\_\_ An Agent with a Current Power of Attorney must be attached to this bid form.

Signature(s): \_\_\_\_\_ Title: \_\_\_\_\_

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

Legal Name of Firm: \_\_\_\_\_

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

Telephone Number: \_\_\_\_\_ ( ) \_\_\_\_\_

(All interlinear marks, alterations or erasures shall be initialed by the signer of the Bid Proposal)

END OF SECTION 00400

**SECTION 00410**  
**FAMILIAL RELATIONSHIP DISCLOSURE FORM**

**SWORN AND NOTARIZED FAMILIAL DISCLOSURE STATEMENT**

All Vendor/Contractor(s) submitting proposals must provide familial disclosure and attach this information to the proposal. The proposal will be accompanied by a sworn and notarized statement disclosing any familial relationship that exists between the owner or key employee of the vendor submitting a proposal and any member of the Troy School Board or the Troy School Superintendent. The District will not accept a proposal that does not include this sworn and notarized disclosure statement.

The members of Troy School Board are: Nancy Philippart, Todd Milette, Paula Fleming, Ida Edmunds, Wendy Underwood, Gary Hauff and Karl Schmidt. The Troy Schools Superintendent is Dr. Barbara Fowler.

☐ **The following are the familial relationship(s):**

	<u>Owner/Employee Name</u>	<u>Related to:</u>	<u>Relationship</u>
1.	_____	_____	_____
2.	_____	_____	_____
3.	_____	_____	_____

Attach additional pages if necessary to disclose familial relationships.

☐ **There is no familial relationship that exists** between the owner or key employee of the Vendor/Contractor(s) submitting a proposal and any member of the Troy School Board, or the Troy Schools Superintendent.

INDIVIDUAL/FIRM NAME \_\_\_\_\_

BY (SIGNATURE) \_\_\_\_\_

PRINTED NAME AND TITLE \_\_\_\_\_

Subscribed and sworn before me, this \_\_\_\_\_

Seal:

day of \_\_\_\_\_, 20 \_\_\_\_, a Notary Public

in and for \_\_\_\_\_ County, \_\_\_\_\_

\_\_\_\_\_  
 (Signature)  
 NOTARY PUBLIC

My Commission expires \_\_\_\_\_

***CERTIFICATION OF COMPLIANCE – IRAN ECONOMIC SANCTIONS ACT******Michigan Public Act No. 517 of 2012***

The undersigned, the owner, or authorized officer of the below-named Company, pursuant to the compliance certification requirement provided in Troy School District's Request For Proposal, the "RFP", hereby certifies, represents, and warrants that the Company and its officers, directors and employees, is not an "Iran Linked Business" within the meaning of the Iran Economic Sanctions Act, Michigan Public Act No. 517 of 2012 (the "Act"), and that in the event the Company is awarded a contract by Troy School District as a result of the aforementioned RFP, the Company is not and will not become an "Iran Linked Business" at any time during the course of performing any services under the contract.

The Company further acknowledges that any person who is found to have submitted a false certification is responsible for a civil penalty of not more than \$250,000.00 or two (2) times the amount of the contract or proposed contract for which the false certification was made, whichever is greater, the cost of Troy School District's investigation, and reasonable attorney fees, in addition to the fine. Moreover, any person who submitted a false certification shall be ineligible to bid on a request for proposal for three (3) years from the date the it is determined that the person has submitted the false certification.

**Contractor:**\_\_\_\_\_  
Print Name of Contractor

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

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

Subscribed and sworn before me, this \_\_\_\_\_ Seal:

day of \_\_\_\_\_, 20 \_\_\_\_, a Notary Public

in and for \_\_\_\_\_ County, \_\_\_\_\_

\_\_\_\_\_  
(Signature)  
NOTARY PUBLIC

My Commission expires \_\_\_\_\_

END OF SECTION 00410

## SECTION 00500 AGREEMENT

### 1 AGREEMENT FORM

- 1.01 The form of Agreement that will be used for Work under this Bid Package shall be AIA Document 132 Standard Form of Agreement between Owner and Contractor, CMa 2009 Edition. The above Agreement Form is included immediately behind this section.

### 2. GENERAL CONDITIONS OF THE CONTRACT

- 2.1. AIA 232 Document **General Conditions of the Contract for Construction, 2009 Edition** is bound within this Project Manual and is a part of the Contract Documents.

### 3. INSURANCE

- 3.1. The description box on the ACORD certificate must be endorsed as follows:

For Troy School District 2013 Bond Projects: Barton Malow Company, Troy School District, are added as additional insureds on the Insured's commercial general liability policy, excess liability policy, automobile liability policy, and contractor's pollution liability policy, with respect to liabilities arising out of the operations or "work" performed by or on behalf of the Insured and in accordance with all Contractor requirements for such coverage. Coverage for the additional insureds is primary and non-contributory with any other insurance available to the additional insureds, whether such other insurance is available on a primary or excess basis. Waivers of subrogation apply in accordance with Contractor requirements.

- 3.2. A sample of the Certificate of Insurance (ACORD) form at the end of this Section.

- 3.3. CM Contractor Insurance Requirements for Agency Work, PRO 15.14, shall govern this Project. A copy of these Insurance Requirements is included in this Section.

### 4. BOND REQUIREMENTS

#### 4.1. PERFORMANCE BONDS AND PAYMENT BONDS

- 4.1.1. Troy School District will, require Contractor to furnish a Performance Bond and a Payment Bond, in amounts equal to the Agreement price, by a qualified surety naming both the Owner and CM as Obligees. All sureties providing bonds on this Project must be listed in the Department of Treasury's Circular 570, entitled "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" with the bond amounts less than or equal to the underwriting limitation indicated in the Circular, and/or must have an A.M. Best rating of A – VII or better. Bonds shall be duly executed by the Contractor, as principal, and by a surety that is licensed in the state in which the Work is to be performed
- 4.1.2. The Contractor shall deliver the required bonds to CM prior to execution of the Agreement. If the Work is to be commenced prior thereto in response to a letter of intent, the Bidder, at a minimum, shall submit evidence to the satisfaction of CM that such bonds will be furnished prior to commencement of on site Work. In no event may the Contractor commence on-site Work without the required bonds properly issued and delivered.
- 4.1.3. Performance Bond and Payment Bond unmodified form AIA Document or A312 (1984 Edition) must be used for this Project.
- 4.1.4. The Bidder's proposed surety must be acceptable to the Owner and CM. If, at any time, after acceptance of the Contractor's bonds, the surety fails to meet the stated criteria Contractor must, as a precondition to continuing Work and receiving further payments, replace the bonds with bonds from a surety that meets the stated criteria.
- 4.1.5. The Performance and Payment Bond penal sums (i.e., the Agreement price) must be listed as a separate line item in the schedule of values.

- 4.1.6. In the event of a Change Order, the penal sum of any required Performance and Payment Bonds shall be adjusted to equal the adjusted Contract Price. CM or Owner shall have the right to request submission of bond riders, issued by the original qualified surety, evidencing that such adjustments to the penal sum of the bonds have been accomplished. Notwithstanding the foregoing, in the next pay application after the Agreement price has been increased by twenty-five percent (25%) or more, as a condition precedent to payment, Contractor shall deliver a bond rider issued by the original qualified surety evidencing that the appropriate adjustment in penal sums has been accomplished.

END OF SECTION 00500



**SECTION 00810**  
**ON-SITE PROJECT SAFETY AND LOSS CONTROL PROGRAM**

**1 SUBCONTRACTOR'S SAFETY REQUIREMENTS**

**1.01 Generally the Subcontractor**

- 1.01.1 is responsible for its own Safety Program for Work on this Project that is at least as stringent as the requirements set forth in this section of the Project Manual.
- 1.01.2 shall provide a safe workplace and shall otherwise take all precautions for the safety of Subordinate Parties and persons and property in or near the premises where Work is being performed.
- 1.01.3 shall comply with all applicable federal, state and local laws, rules and regulations, including, but not limited to, applicable provisions of the Occupational Safety and Health Act ("OSHA") and/or the governing state law.
- 1.01.4 shall comply with all requirements stated in the Site Specific Safety Instructions (SSSI) form or elsewhere in the Contract Documents.
- 1.01.5 shall ensure that its employees understand and comply with applicable safety and health programs, rules, and regulations.
- 1.01.6 will assign an individual to act as Safety Representative who will have the responsibility of resolving safety matters, and act as a liaison among Subcontractor, CM and the Owner. The Safety Representative must be a person who is capable of identifying existing and predictable hazards in surroundings that are unsanitary, hazardous or dangerous to employees, and has the authority to take prompt corrective measures to eliminate them. The Safety Representative must meet the standards for a Competent Person under applicable law when required (scaffolding, confined spaces, etc.). The Safety Representative must be on site full time. The Safety Representative or an alternate must attend periodic safety meetings as directed by CM. The safety representative must have completed the OSHA 30 hour Construction Training Course.
- 1.01.7 shall ensure that its site supervisors and/or Safety Representative attend a pre-construction meeting where planning for safe execution of the project will be addressed.
- 1.01.8 is fully responsible for all Hazardous Materials it creates or releases in connection with, or brings to, the Project. Subcontractor shall immediately report to CM any Hazardous Materials that it discovers or which are released at the Project.
- 1.01.9 Minimum training for on-site employees shall include basic safety orientation, task-specific safety instruction, weekly Tool Box Talks, and other periodic safety meetings. Subcontractor shall document all such training.
- 1.01.10 shall self-inspect its areas of control to assure compliance with the safety requirements.
- 1.01.11 All on-site employees of either Subcontractor] or its Subordinate Parties are required to report any unsafe act or condition and any work-related injuries or illness immediately to a supervisor. If the act or condition can be safely and easily corrected, the employee or supervisor should make the correction.
- 1.01.12 shall notify CM immediately of all injuries requiring clinical attention and all property damage potentially in excess of \$1,000.
- 1.01.13 shall have emergency procedures to deal with the immediate removal and treatment, if necessary, of any employee who may be injured or become ill. Subcontractor] shall keep on the Project site a first-aid kit supplied according to current regulations, and shall have on-site a person trained to administer first aid.
- 1.01.14 shall inform CM of the arrival of any federal or state inspector or compliance officer prior to touring the site. Any reports, citations, or other documents related to the inspection shall be provided promptly to Barton Malow.

- 1.01.15 shall have a written Substance Abuse Policy. The use or possession of illegal drugs or the use of alcohol while performing Work on the Project are strictly prohibited and will lead to immediate removal from the Project.
- 1.01.16 shall be responsible for payment of all safety-related citations, fines and/or claims arising out of or relating to its Work levied against the Owner, Architect, CM, or their employees or affiliates.
- 1.01.17 CM has the right to require that Subcontractor H submit monthly its hours worked and incident rates for the Project.
- 1.02 Additional CM Requirements
  - 1.02.1 Work crews shall conduct a Job Hazard Analysis (JHA,) discussion (i.e. Huddle) to plan for safe performance before beginning any work task. Subcontractor is required to prepare a written record of each JHA.
  - 1.02.2 All workers, management, and visitors shall wear approved hard hats while on site, outside the trailers. Cowboy-style hard hats are prohibited. Hardhats must not be removed to use welding shields. Welding shields must attach to hardhats or be hand held.
  - 1.02.3 Sleeved shirts (minimum of four inches), long pants, and durable work boots are required minimum clothing.
  - 1.02.4 Personal cell phones are not to be used on construction sites except to report an emergency or on approved break time. Use of business cell phones must not interfere with jobsite safety.
  - 1.02.5 Personal radios or music players are not permitted.
  - 1.02.6 All persons working at elevations of six feet or greater must have 100% continuous fall protection. Engineering controls are preferred, but personal fall arrest systems are also permissible. An exception is permitted for safe use of ladders up to 24 feet long.
  - 1.02.7 Subcontractor is responsible to repair or restore any barricade that it modifies or removes.
  - 1.02.8 Class II III (household) stepladders are prohibited; metal ladders are strongly discouraged.
  - 1.02.9 All scaffolds must be inspected daily and before each use for safety compliance. Scaffold inspection tags must be used. Scaffolds shall never be left in an unsafe condition and must be removed/disabled immediately if not to be used again.
  - 1.02.10 All persons operating cranes must be certified as crane operators by the National Commission on the Certification of Crane Operators (NCCCO), Crane Institute Certification (CIC) or Operating Engineers Certification Program (OCEP). Daily written crane inspection reports must be prepared by the operator and kept with the crane, available for inspection.
  - 1.02.11 Riding the headache ball is prohibited.
  - 1.02.12 All dozers, loaders, tractors and end loader backhoes must have functioning backup alarms.
  - 1.02.13 Keep equipment at least 15 feet from energized power lines.
  - 1.02.14 Electrical, pneumatic, and other energy systems that could be accidentally energized or started up while work is in process must be locked out (not merely tagged out).
  - 1.02.15 Only fire retardant materials may be used to build shanties or other temporary enclosures inside of buildings finished or under construction. Shanties shall be continually policed by their occupants to prevent the accumulation of waste or other combustibles.
  - 1.02.16 Engineering controls must be used to restrain silica dust per applicable law. Dry cutting without engineering controls is prohibited.
  - 1.02.17 The Contractor is required to design and implement a Stretch and Flex program for their employees. The purpose of the program is to gently condition the muscles and tendons for the workers before they engage in their duties in order to avoid injury. All contractors of any tier shall ensure that all employees participate in stretching exercises at the beginning of the work

day. It is recommended that you consult with your insurance carrier, licensed physician or other medical personnel to develop suitable stretches for your work crew.

- 1.02.18 The Contractor is required to implement a glove program. All workers performing construction work must wear appropriate protective work gloves. When not performing work gloves must be kept available for immediate use. Cut resistant work gloves are required for any operation with sharp material or cut potential.

## 2 Subcontractor's SAFETY SUBMITTALS

- 2.01 Subcontractors shall provide copies of the following written safety submittals to CM at the times indicated:

<b>Submittal</b>	<b>Timing</b>
Contractor Safety Certificate, Barton Malow form SAF 6.3.3.3	Before on-site work begins
Site-specific Safety Program, including substance abuse policy, hazard communication program, and Material Safety Data Sheets (MSDS)	Before on-site work begins
Tool Box Talk Reports	Weekly
Incident Reports (OSHA form 301 or equivalent)	Within 24 hours of incident
Hours worked and incident rates	Monthly
Stretch and Flex program	Before on-site work begins

- 2.02 Barton Malow's receipt of the Safety Program or other submittals from Subcontractor does not constitute approval of the Program or submittal or permission to deviate from the requirements of the Contract Documents and applicable law.
- 2.03 Subcontractor will allow inspection of, and CM may request copies of, any and all safety-related documents and records in its possession relating to the Project.

## 3 CM RIGHTS

- 3.01 **Safety Hazard Notifications** may be issued to the Subcontractor when an unsafe act or condition is reported or observed. CM shall not be required to supervise the abatement or associated reprimand of unsafe acts or conditions within a Subcontractor's scope of work as this is solely the responsibility of Subcontractor. Nevertheless, CM has the right, but not the obligation, to require Subcontractor to cease or abate any unsafe practice or activity it notices, at Subcontractor's sole expense.
- 3.02 Contractor/Subcontractor's failure to comply with the contract safety requirements will be considered a default of the Agreement, and may result in remedial action including, but not limited to, withholding of payment of any sums due or termination.
- 3.03 CM's failure to require the submission of any form, documentation, or any other act required under this Section, 00810, of the Project Manual shall not relieve the Subcontractor from any of its safety obligations.
- 3.04 Nothing in this Section or in this Agreement makes CM responsible or liable for protecting Subcontractor's employees and other Subordinate Parties or assuring or providing for their safety or preventing accidents or property damage.
- 3.05 All requirements referenced in this Section 00810 are binding on Subcontractor and all of its Subordinate Parties, even where such requirements may exceed the standards of applicable law.

END OF SECTION 00810

**SECTION 00840**  
**HAZARDOUS MATERIALS**

**1. DEFINITION OF HAZARDOUS MATERIALS**

- 1.1. A “Hazardous Material”, as used in this Project Manual means asbestos; asbestos containing material; lead (including lead-based paint); PCB; molds; any other chemical, material, or substance subject to regulation as a hazardous material, hazardous substance, toxic substance, or otherwise, under applicable federal, state, or local law; and any other chemical, material, or substance that may have adverse effects on human health or the environment.

**2. AWARENESS OF HAZARDOUS MATERIALS**

- 2.1. Each Contractor shall be constantly aware of the possible discovery of Hazardous Materials. Should Contractor encounter any Hazardous Material or suspected Hazardous Material, the Contractor shall immediately stop Work in the area affected and report the condition to CM.
- 2.2. If the Contractor encounters any Hazardous Material or suspected Hazardous Material, the Contractor agrees to immediately initiate the required procedures of the Environmental Protection Agency (EPA), and/or state or local agencies having jurisdiction to protect any and all persons exposed to the affected areas or adjacent areas affected thereby
- 2.3. Contractor is fully responsible for all Hazardous Materials it creates or releases in connection with, or brings to, the Project
- 2.4. Each Contractor shall be responsible to bind ALL of its personnel and its Subordinate Parties to the provisions in the contract documents related to hazardous materials and to instruct each employee of its own duty to report any and all suspected Hazardous Materials and to comply with all applicable laws.
- 2.5. ABSOLUTELY NO MATERIAL SHALL BE BROUGHT ON OR TO THE PROJECT SITE THAT DOES NOT HAVE A MANUFACTURER'S LABEL STATING CONTENTS.
- 2.6. The Contractor shall comply with all applicable federal and state laws, rules, ordinances and regulations regarding transportation, storage, spills, releases and disposal of Hazardous Materials.
- 2.7. No asbestos or asbestos-containing material will be brought to the jobsite or incorporated into the Work by Contractor or its Subordinate Parties.

END OF SECTION 00840

## SECTION 00870 LABOR RELATIONS

### 1. PREVAILING WAGES

- 1.1. In any Agreement entered into pursuant to this advertisement, the Contractor shall comply with the provisions of the PREVAILING WAGE LAW.
  - 1.1.1. Prevailing Wage can be found in the folder structure.
  - 1.1.2. The Contractor will pay the latest prevailing wages and fringe benefits for all Work as required by State of Michigan/Public Act 166 dated 1965 as amended. The prevailing wage and fringe benefit rates are included immediately behind this Section
- 1.2. Additionally, **Contractor** is required to comply with all other provisions of the governing prevailing wage law, and shall ensure its Subordinate Parties' compliance therewith.
- 1.3. Allegations that individuals working on this Project are not receiving compensation required by law are considered seriously by the Owner and CM. In order to expedite the resolution of prevailing wage complaints related to this Project, the Owner and CM have determined that the Michigan Fair Contracting Center ("MFCC") is the organization best equipped to expedite the investigation of these matters. Any person or entity (the "Complainant") who reasonably believes that a particular contractor, subcontractor, supplier or other person or entity providing labor, materials, goods or services on this Project (each, an "Employer") is not paying prevailing wages as required by applicable law may ask the MFCC to determine whether proper rates are being paid either by completing and submitting to MFCC a request for assistance (the "RFA") or by contacting MFCC by telephone at (734) 462-2330 or (877) 611-6322. The RFA can be downloaded electronically at <http://mifcc.org/Brochures/KnowYourRights.pdf> and delivered to MFCC by facsimile to (734) 462-2318 or by mail to P.O. Box 530492, Livonia, Michigan 48153-0492.
- 1.4. Each and every Employer who is subject to an audit by MFCC pursuant to any RFA shall cooperate and comply fully with all requests, requirements and inquiries of MFCC. If, after investigation, MFCC determines that a Complainant's allegations are meritorious and the Complainant, MFCC and the Employer are unable to resolve the dispute following MFCC's determination, then, under the direction and with the assistance of MFCC, the Complainant shall file a Prevailing Wage Complaint (the "PWC") with the State of Michigan Department of Labor and Economic Growth Wage and Hour Division (the "Wage and Hour Division"). The PWC can be downloaded electronically at <http://mifcc.org/Brochures/PrevailingWageComplaint.pdf> and delivered by facsimile to (517) 322-6352 or by mail to 7150 Harris Drive, P.O. Box 30476, Lansing, Michigan 48909-7076.
  - 1.4.1. Upon commencement of the audit from MFCC, the Owner and/or CM reserves the right to hold all payments, pending the conclusion of the audit. If the Wage and Hour Division determines that the Employer has violated any applicable prevailing wage law, then the Owner and/or Construction Manager shall automatically be entitled to and will (a) withhold from such Employer any and all payments due and owing until the Employer remedies any and all violations cited by the Wage and Hour Division, and (b) backcharge the Employer for all costs actually incurred in MFCC's audit of the Employer.
  - 1.4.2. The Owner and/or CM shall keep a hard copy of these requirements posted at the Project site at all times.
- 1.5. The Contractor shall be financially responsible for the payment of prevailing wages by all Subordinate Parties that are subject to the prevailing wage law for Work on the Project.
- 1.6. If there is a dispute between any Contractor and the unions, the Contractor will be required to meet with CM and the Union involved to try and resolve the issue.
- 1.7. Because Work on this Project is covered by the Michigan Prevailing Wage Act ("Act"), the Contractor and its subcontractors and other Subordinate Parties that are governed by the prevailing wage law shall pay all hours at the prevailing wage rates at the applicable hourly rate; no Work performed by or on

behalf of the Contractor on this Project will be paid on a lump sum basis or a piece rate basis in violation of the Act.

- 1.8. The Contractor will pay its workers at wage and fringe benefit rates consistent with the Act regardless of whether the workers are classified as employees or independent contractors.
- 1.9. The Contractor shall not misclassify any work assignments, but shall in each and every case follow proper jurisdictional assignments in compliance with the Act.
- 1.10. The Contractor shall assure that any persons paid at apprentice rates under the Act are properly classified as apprentices by actual participation in a BAT certified program or as may otherwise be permitted by the Act.

**END OF SECTION 00870**

**SECTION 00880**  
**REGULATORY REQUIREMENTS**

**1. STANDARDS, CODES AND REGULATION**

- 1.1. All Work is to comply with the rules and regulations of governing bodies having jurisdiction.
- 1.2. Standards, codes and regulations published by Manufacturer's associations, governmental agencies and other regulatory authorities form a part of these Specifications as minimum requirements. Such references include the latest issue and legal requirements in force.
- 1.3. Where differences occur between the Contract Documents and such standards, the strictest requirements shall take precedence.
- 1.4. Supply all materials and perform all Work in accordance with the Manufacturer's specifications and installation procedures, and in conformance with published Trade and Manufacturers' association standards, unless specifically noted otherwise in the Contract Documents.

**2. PERMITS AND FEES**

- 2.1. The Troy School District will obtain and pay for the General Building Permit.
- 2.2. Other than the general building permit, Contractor shall provide and pay for all other permits, assessments, governmental fees, bonds, connection charges, licenses and inspection fees and any other charges necessary for the proper execution and completion of the Contractor's Work.
- 2.3. Contractor is to provide, pay for and coordinate all other permits, fees, inspections, and city, county, state, federal and governing authority approvals required for the successful completion of the Work contained within its respective Bid Category and deliver required certificates of inspection and approvals to CM.
- 2.4. This Project is under but not limited to the jurisdiction of the
  - MICHIGAN DEPARTMENT OF LABOR FOR MECHANICAL AND ELECTRICAL
  - STATE OF MICHIGAN FIRE MARSHAL DIVISION
  - MICHIGAN DEPARTMENT OF PUBLIC AND (COUNTY) DEPARTMENT OF PUBLIC HEALTH
  - Site water and sewer utilities are under the jurisdiction of the COUNTY DRAIN/ROAD COMMISSION authorities

**3. TAXES**

- 3.1. This Project is subject to all applicable state Sales Tax and/or Use taxes, and Bidder must include such taxes in its Bid Proposal. All other taxes applicable to the project at the time of the bid are to be included in the bid amount and will be the responsibility of Bidder.

END OF SECTION 00880

**SECTION 01140  
USE OF PREMISES**

**1 RULES AND ENFORCEMENT:**

- 1.1. Contractor and its Subordinate Parties shall be subject to rules and regulations for the conduct of the Work as stated herein and as the Owner or CM may establish.
- 1.2. Willful disregard of the following will be grounds for requiring the offending person(s) to be removed from the Project, and may subject the Contractor to termination under the Agreement.

**2 USE OF PREMISES AND DELIVERIES**

**2.1. ACCESS TO WORK:**

- 2.1.1. Before starting the Work, Contractor shall ascertain from CM what entrances, routes or roadways shall be used for access to the Work, and use only those designated for movement of personnel, materials and vehicles to and from the Project site.
- 2.1.2. Close coordination is required of Contractor with the Owner, CM, other contractors, the city and others having an interest in the Project to assure that Work on the site, access to and from the site and the general conduct of operations is maintained in a safe and efficient manner, and that disruption and inconvenience to existing streets and property is minimized.
- 2.1.3. Contractor is responsible to review the site and be familiar with all existing conditions within and around the Owner's property including local conditions and requirements.

**2.2. ENTRANCES AND DRIVES**

- 2.2.1. Specific entrances for material deliveries, equipment deliveries and worker access to the Project site will be as designated/directed by CM.
- 2.2.2. Selected entrances to the Project site will remain open for use during normal working hours.
- 2.2.3. At no time are vehicles to be parked, whether attended or not, in the Owner's entrances or drives.
- 2.2.4. Any material delivery which will tie up the Owner's entrances or drives shall be pre-scheduled with the Owner through CM.
- 2.2.5. Owner's deliveries and operations will take precedence over scheduling of construction deliveries.

**2.3. ACCESS TO BUILDINGS:**

- 2.3.1. Maintain free access to all buildings and areas of the site for designated vehicles, service vehicles and fire fighting equipment, and at no time shall block off or close roadways or fire lanes without providing auxiliary roadways and means of entrance acceptable to the Owner and CM.
- 2.3.2. Maintain a clean and safe passageway for the Owner's operations and personnel in existing areas, and maintain clearances adjacent to and in connection with the Work performed. Fire hydrants must remain accessible at all times.
- 2.3.3. Give the Owner and the local fire department at least forty-eight (48) hours notice of any such changes of routes.

**2.4. SITE PARKING:**

- 2.4.1. There is on-site parking for Contractors and their Subordinate Parties' employees.
- 2.4.2. Contractor, Subordinate Parties and their personnel will be allowed to park in the Owner's parking area. Each Contractor is responsible for providing transportation to and from the site, if required.



- 2.5. **LOADING OF STRUCTURE:** Each Contractor on behalf of itself and its Subordinate Parties shall not load or permit any part of a structure to be loaded with a weight that will endanger its safety.
- 2.6. **USE OF OWNER'S EQUIPMENT:** Contractors and their Subordinate Parties will not be allowed to use any Owner tools or equipment during the course of the Project.
- 2.7. **USE OF EXISTING ELEVATORS**
  - 2.7.1. Contractor may subject to the approval of CM and Owner, use the existing elevator(s) designated by the Owner within the contract boundaries for movement of personnel and materials to a construction area.
  - 2.7.2. In those cases where an elevator is to be shared with Owner services, the Owner's employees and services take priority over construction activities.
  - 2.7.3. Contractor is responsible for proper conduct with regard to the use of the elevator. Any damage to the elevator due to oversize load, excess weight or other conditions is the individual Contractor's responsibility.
  - 2.7.4. Use of the elevator(s) at times other than normal working hours shall be coordinated with CM and Owner.
- 2.8. **USE OF EXISTING FACILITIES**
  - 2.8.1. Limit the usage of the occupied areas of the facility to that which is absolutely necessary for the installation of the Work. Parts of the facility not in the construction area are "off limits" unless a specific work task is being performed as designated by CM.
  - 2.8.2. Use of the Owner's cafeteria, parking, telephones, toilet facilities, tools, equipment, or any other item or facility belonging to the Owner is not allowed unless specifically authorized by Owner and CM.
  - 2.8.3. Restrict all Work activities associated within an area undergoing renovation to the boundaries indicated by the Contract Documents. Any means of access or egress from the stipulated boundaries shall be coordinated with CM and the Owner.
- 3 **WORK HOURS:**
  - 3.1. Normal working hours are; 7:00 AM to 3:30 PM, Monday through Friday.
  - 3.2. Work operations shall comply with all applicable laws, ordinances, and regulations, and not create a public nuisance nor disturb the peace.
  - 3.3. Compensation to CM for supervisory staff due to abnormal working hours will be at the requesting Contractor's expense.
  - 3.4. Whenever Contractor intends to depart from normal work hours, it shall notify CM in writing at least forty-eight (48) hours in advance. Failure of Contractor to give such timely notice may result in CM directing the removal or uncovering of the Work performed during such abnormal hours at Contractor's expense. Special arrangements can be made for emergency work or shutdowns as may be required.
  - 3.5. Required off-hours work:
    - 3.5.1. Contractors may be requested to work split shifts, weekends, off peak Owner loading periods, etc., to accommodate Owner's utility and service requirements, such as, but not limited to, medical gas systems, electrical power, HVAC systems, storm and sanitary lines.
    - 3.5.2. All Work shall be bid on a straight time basis. Should premium time be required by the Owner, the cost for premium time labor, which may be required, is the Contractor's responsibility and is to be included in the base bid.
- 4 **USE OF EXPLOSIVES:** Is NOT permitted.
- 5 **DUST, DIRT, NOISE:** Each Contractor shall effectively confine or eliminate dust, dirt and noise to the actual construction area and in compliance with all applicable laws, rules and regulations.

- 6 BEHAVIOR AND CONDUCT: The Owner and CM expect Contractors and their Subordinate Parties to exercise common sense and good judgment, and to conduct themselves in a manner which would be a credit to the Owner. Without limiting other applicable provisions of the Contract Documents, Contractor shall not engage in the following:
- 6.1. Conduct that interferes with Work or work of others.
  - 6.2. Conduct that interferes with or is detrimental to safety, well-being of the owner, their operations and/or good reputation.
  - 6.3. Unauthorized use of confidential information.
  - 6.4. Discourtesy toward Owner's staff, visitors and the general public (including abusive, vulgar or other language.)
  - 6.5. Soliciting, canvassing, posting, or distributing literature or materials for any purpose while on the job site.
  - 6.6. Disregard of safety, sanitation, or security laws, rules and regulations.
  - 6.7. Stealing.
  - 6.8. Gambling.
  - 6.9. Possession and/or use of narcotics or intoxicants.
  - 6.10. Threats or abuse of others.
  - 6.11. Disorderly conduct or fighting.
  - 6.12. Playing of loud music.
  - 6.13. Falsification of information.
  - 6.14. Unauthorized travel of Contractor's employees outside the designated project Work areas.
  - 6.15. Discriminating behavior.
  - 6.16. Possession and/or use of weapons or firearms.
  - 6.17. Sexual or Ethnic harassment.
  - 6.18. Smoking: Contractors and their Subordinate Parties shall be responsible for adhering to the smoking policies and regulations of the Owner and the Owner's facilities.
- 7 TEMPORARY PARTITIONS:
- 7.1. Partition construction shall provide a fire-resistant classification approved by the authorities having jurisdiction. Openings in such partitions shall be protected by fire doors consistent with the rating of the partition. Any trade creating penetrations through the temporary partitions shall fire stop openings to match the rating of the wall.
- 8 PROTECTION OF FACILITIES
- 8.1. Each Contractor on behalf of itself and its Subordinate Parties shall be responsible for all damage to the Project including the existing buildings and grounds arising or resulting from its operations under the Agreement. Repair or replacement of damaged items shall be to the satisfaction of the Owner and CM.
  - 8.2. Each Contractor shall provide and maintain proper shoring and bracing for existing underground and aboveground utilities, foundations, structure and systems encountered during its Work and shall
    - 8.2.1. protect the project, or any part thereof, and surrounding areas from collapse or movement, or any other type of damage until such time as they are to be removed, incorporated into the new Work or can be properly supported or backfilled upon completion of new Work.
    - 8.2.2. limit disruptions to a maximum of four (4) hours.

- 8.2.3. prior to beginning any Work that may affect underground facilities, contact MISS DIG and utility companies for the location of all existing underground services.
    - 8.2.3.1. Provide, documentation of such contact to CM.
    - 8.2.3.2. If necessary, Contractor shall pay for layout and locating of existing utilities.
  - 8.3. Utilities and/or other services which are shown, or not shown but encountered, shall be protected by the Contractor from any damage arising or resulting from Work, unless or until they are abandoned. If the utilities or services are damaged from Contractor's Work, Contractor shall immediately repair any damage and restore the utilities and services to an equal or better condition than that which existed prior to the damage. Contractor will be responsible for all liabilities, expenses, lawsuits or claims arising or resulting from such damage and will defend, hold harmless and indemnify Owner and CM from any claims or lawsuits or other expenses.
  - 8.4. Each Contractor on behalf of itself and its Subordinate Parties shall be responsible for all damage to the Project and surrounding areas including the existing building and grounds arising out of or resulting from their performance of the Work. Repair or replacement of damaged items shall be to the satisfaction of the Owner and CM.
  - 8.5. Preservation of existing trees and other vegetation on the site to the maximum extent possible is required.
    - 8.5.1. Each Contractor must plan its Work and instruct its Subordinate Parties to conduct their operations to avoid damage to trees and vegetation (provide barriers as required.)
    - 8.5.2. Indiscriminate driving about the site, disposing of waste, storage of materials upon or against trees or any other activity which is harmful to trees or vegetation will not be tolerated.
    - 8.5.3. Any case of damage to any tree shall be reported to CM immediately so that professional repairs can be made. The cost of such required repairs or treatment shall be charged to the responsible Contractor.
- 9 OWNER'S OPERATIONS & INTERRUPTION OF OCCUPANCY /SEQUENCING
- 9.1. The Owner shall have the option to curtail or delay any activity that affects its operations. Should a Contractor be asked to stop its Work, the Contractor shall do so immediately and proceed with other activities with no additional cost to the Owner or CM.
  - 9.2. The Owner may occupy the premises during the entire period of construction to conduct operations.
  - 9.3. Each Contractor is responsible to plan, coordinate and execute its Work in such a manner that there will be no disruption of or the least disruption to the Owner's operations. If an interruption of operations is unavoidable, then this Work will be scheduled with the Owner through CM.
  - 9.4. Contractors is responsible to provide temporary utilities and systems to maintain services to the facility while Work is being performed.
  - 9.5. No interruptions to Owner's power, lighting, signal, or alarm circuits will be permitted without the express written permission of the Owner through CM. Arrangements for interruptions shall be made with the Owner at least forty-eight (48) hours prior to the interruption and shall be made at such time and duration as authorized by them. Temporary feeders, transformer jumpers, connections, circuits, etc., shall be used as required to accomplish the above at no additional cost to the Owner and CM.
- 10 MATERIAL STORAGE
- 10.1. All Contractors are required to provide and pay for off-site storage facilities as required for their Work.
  - 10.2. All Contractors will not be allowed on-site storage facilities. Material, equipment and tools, shall not be stored on-site in excess of five (5) working days prior to installation or use without CM's approval.
  - 10.3. Storage of combustible materials within or adjacent to the building is prohibited.
  - 10.4. All Contractors shall

- 10.4.1. Stock the job with sufficient materials to maintain progress and schedule and without interfering with the Work or storage of others.
- 10.4.2. Assume full responsibility for the protection and safekeeping of products under their control which are stored on the site.
- 10.4.3. Move any stored products under their control, which interfere with operations of the Owner or separate contractors as directed by CM.
- 10.4.4. Provide sufficient protection for its materials and equipment from damages by weather or construction work or other hazards.
- 10.4.5. Remove all debris and leave the area in a clean and orderly condition during progress of Work and upon completion of the Work.
- 10.4.6. Submit a receipt of shipment for all equipment stored on-site or off-site to CM. No materials or equipment shall be removed from the site without the permission of CM

END OF SECTION 01140

## SECTION 01250 CHANGES IN THE WORK

### 1 SUMMARY

- 1.01 This section describes the following requirements including:
  - 1.01.1 Types of Change Documentation
    - 1.01.1.1 PCO – Potential Change Order
    - 1.01.1.2 CO – Change Order
  - 1.01.2 Compensation of Overhead and Profit for Changes in the Work
  - 1.01.3 Itemization of Cost of Changed Work
- 1.02 This section is not intended to include RFI's, ASI's (Architects Supplemental Instructions), or other documents that clarify the work but have no substantive cost or schedule impact to the work.

### 2 TYPES OF CHANGE DOCUMENTATION

Changes to the work which may involve a change in the contract price or schedule will be accompanied by the Barton Malow form entitled "PCO- Quotation Only". In the event that the timing does not allow the For Quote Only process, then CM will issue its form entitled "PCO-Notice to Proceed."

#### 2.1. PCO- NOTICE TO PROCEED AND FOR PCO- QUOTATION ONLY FORMS

- 2.1.1. A PCO- Notice to Proceed is used when Work must be performed with swiftness and authorization to proceed by Change Order is inappropriate due to time restrictions. In order for a PCO- Notice to Proceed to be valid, it must be signed by CM. The terms for establishing the additional cost and processing of the PCO- Notice to Proceed into a Change Order shall be identified prior to its release by CM.
- 2.1.2. If a change results in a change in cost, CM will issue a PCO with the supporting change documents.
- 2.1.3. Contractor shall prepare a detailed cost quotation for the PCO. This quotation shall include an itemized takeoff of labor, equipment and material with a unit cost for each item together with backup and breakdown documentations satisfactory to CM. The PCO must be returned as directed
- 2.1.4. Contractor shall sign and date the PCO and submit it with proper backup. The PCO will then be reviewed, evaluated, negotiated and then, when acceptable, processed
- 2.1.5. The PCO- Quotation Only is a document used for processing Contractor's quotations and is **not** a Change Order. Therefore, completion of the PCO- Quotation Only does **not** release the Work to begin.
- 2.1.6. PCO's will precede a Change Order. Contractors shall receive an approved PCO- Notice to Proceed or an executed Change Order before starting Work. Any changed Work performed by Contractor without a properly executed PCO- Notice to Proceed or a properly executed Change Order is at Contractor's sole risk and expense. BILLINGS AGAINST CHANGES WILL NOT BE ACCEPTED AFTER A PCO- NOTICE TO PROCEED OR FOR QUOTE ONLY IS ISSUED, BUT ONLY AFTER A CHANGE ORDER HAS BEEN PROCESSED AND SIGNED BY ALL PARTIES.

## 2.2. CHANGE ORDER

- 2.2.1. Change Orders will be issued by CM. CM will first issue the Change Order to the Contractor for signature. The Change Order will then be returned to CM. Once all appropriate signatures are secured, an executed copy will be sent to the Contractor.
- 2.2.2. Once the Change Order has been processed and signed by all parties, the Contractor may invoice for payment on the completed portion of Work.
- 2.2.3. Agreement on a Change Order shall constitute a final settlement of all matters relating to the changed Work that is the subject of the Change Order.

## 3. COMPENSATION OF OVERHEAD AND PROFIT FOR CHANGES IN THE WORK

### 3.1. CONTRACTOR'S OVERHEAD AND PROFIT

- 3.1.1. For changes resulting in increase of cost:
  - 3.1.1.1. Overhead and profit for the Contractor shall not exceed the following when change Work is performed by
    - 3.1.1.1.1. Contractor itself: fifteen percent (15%).
    - 3.1.1.1.2. Contractor subordinate party: five percent (5%)
  - 3.1.1.2. Overhead and profit for the subordinate party shall not exceed the following when change Work is performed by
    - 3.1.1.2.1. Subordinate party itself: fifteen percent (15%)
    - 3.1.1.2.2. Contractor to the subordinate party: five percent (5%)
- 3.1.2. For changes resulting in reduction of cost
  - 3.1.2.1. Deductive costs shall include commensurate deductive credits for overhead and profit based on the percentages stated above.
- 3.1.3. Contractor's and Subordinate Party's overhead and profit shall include cost (at the Project Site, home office and otherwise) of supervision, telephone, travel, copying, administrative services, office, power, light, tools, jobsite vehicles, and all other general expenses including bond premiums. In no event shall these items be charged as cost of the Changed Work.

## 4. ITEMIZATION OF COST OF CHANGED WORK

### 4.1. EXTRA WORK TICKETS

- 4.1.1. If extra work is to be completed above and beyond the terms of the contract, as determined by (and approved in advance by) the CM, the Contractor is required to:
  - 4.1.1.1. Provide an Extra Work Order ticket to the CM within three (3) days of completing the work.
    - 4.1.1.1.1. Extra Work Order tickets will be rejected if they are not turned in to the CM within three (3) days of completing the work.
    - 4.1.1.1.2. Extra Work Order tickets are to be completed in triplicate and a copy is to be left with the CM.
      - 4.1.1.1.2.1. The CM will sign all copies of the Extra Work Order tickets and return two (2) to the Contractor in a prompt manner, keeping one for record.
    - 4.1.1.1.3. A copy of the signed ticket(s) must accompany the Request for Change Order(s) quote from the Contractor. A change order will not be processed and the Request for Change Order(s) will be rejected if there is no signature from the CM.

4.1.1.2. Provide the CM with a Request for Change Order for the extra work within ten (10) days of receiving the signed ticket.

4.1.1.2.1. The Request for Change Order must be accompanied by a copy of the signed Extra Work Order ticket from the Contractor.

4.1.1.2.2. The Request for Change Order will be rejected and no PCO or Change Order will not be processed if the quote is not received within ten (10) days of the date signed by the CM.

#### 4.2. CORRELATION WITH CONTRACTOR'S SUBMITTALS

4.2.1. Contractors shall

4.2.1.1. Revise the Schedule of Values and Request for Payment forms to record each Change Order as a separate item of Work, and to record the adjusted contract price.

4.2.1.2. Revise the Construction Schedule to reflect each change in Contract Time approved by a Change Order.

4.2.1.3. Revise sub-schedules to show changes for other items of Work affected by the changes.

4.2.1.4. Enter and revise Record Documents to reflect changes

#### 4.3. COST OF THE CHANGED WORK

4.3.1. The "Cost of the Changed Work" shall be approved by CM and shall mean the costs necessarily incurred by the Contractor in the proper performance of the Changed Work. Such rates shall not be higher than those customarily paid at the place of the Project. The Cost of the Changed Work shall only include those items set forth below.

WAGES OF LABOR	Wages of construction workers directly employed by Contractor to perform the construction of the changed Work at the site
PAYROLL MARKUP	The amount approved by CM and Owner which covers the costs paid by the Contractor for taxes, insurance, contributions, assessments, and benefits required by law or collective bargaining agreements and for personnel not covered by such agreements, customary benefits such as sick leave, medical and health benefits, holidays vacations and pensions, provided that such costs are based on the wages and salaries of labor performing the changed Work.
COST OF EQUIPMENT, MATERIALS, AND SUPPLIES	Costs of materials, equipment and supplies to be incorporated into the changed Work less all savings, discounts, rebates and credits accruing to the Contractor.
RENTAL CHARGES FOR EQUIPMENT NOT OWNED BY CONTRACTOR	Rental charges for equipment not owned by Contractor that is necessary for completion of the Changed Work. Rates and quantities rented must be approved in advance by CM.
TAXES	Sales or use taxes imposed by a governmental authority which are directly attributable to the changed Work and for which the Contractor is liable.
SUBORDINATE PARTY COSTS	Payments made to the Contractors for proper execution of Changed Work, subject to the limits set forth above for overhead and profit.

4.2.2. In no event shall the Cost of Changed Work include:

- 4.2.2.1. Salaries or wages of persons other than those directly performing the changed Work, including Contractor's personnel stationed at the principal office;
- 4.2.2.2. Expenses of the Contractor's principal office and offices other than the site office, except as provided above;
- 4.2.2.3. Overhead and general expenses of any nature, except as set forth above;
- 4.2.2.4. Capital expenses of Contractor, including interest on the Contractor's capital employed for the Changed Work;
- 4.2.2.5. Rental costs for machinery or equipment, except as allowed above, or tools of any kind, unless specifically identified and approved in advance in writing by CM;
- 4.2.2.6. Costs due to the negligence or failure to perform of the Contractor or its Subordinate Parties;
- 4.2.2.7. Costs designated above as being included in Overhead and Profit
- 4.2.2.8. Any cost not specifically described above, or otherwise approved in advance and in writing by CM and Owner.
- 4.2.2.9.** Any bond premiums of portion of increased bond costs directly attributable to the changed Work.

#### 4.3. QUOTATION FORMAT

Based on the above, the following formula will be utilized by all of the Contractors.

Number of PCO \_\_\_\_\_  
 Date of PCO \_\_\_\_\_  
 Description of Change \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

#### Cost of Changed Work

##### Labor:

Carpenter	(No. of Hrs. x Rate)	xxx.xx	
Labor	(No. of Hrs. x Rate)	xxx.xx	
Ironworker	(No. of Hrs. x Rate)	<u>xxx.xx</u>	
Subtotal			xxx.xx
OH&P @ 15%			xxx.xx

##### Equipment, Materials, Supplies:

Ace Hardware	xxx.xx		
Acme Products	xxx.xx		
Concrete Supplier		<u>xxx.xx</u>	
		xxx.xx	
Subtotal			xxx.xx
OH&P @ 15 %			<u>xxx.xx</u>
<b>Subtotal (1)</b>			<b>xxx.xx</b>

##### Contractor Costs

ABC Welding	xxx.xx		
XYZ Resteel		<u>xxx.xx</u>	
Subtotal			xxx.xx
OH&P @ 5 %			<u>xxx.xx</u>
<b>Subtotal (2)</b>			<b>xxx.xx</b>

#### TOTAL QUOTATION AMOUNT



**Total Quotation (Subtotal 1 plus Subtotal 2)**

**XXX.XX**

END OF SECTION 01250

## **SECTION 01290 PAYMENT PROCEDURES**

### **1. SUMMARY**

1.1. This Section describes the following requirements including:

- 1.1.1. Schedule of Values
- 1.1.2. Application for Payment Process
- 1.1.3. Reduction of Retention
- 1.1.4. Payment for Materials Stored Off-site
- 1.1.5. Waivers of Lien and Sworn Statements

### **2. PAYMENT PROCEDURES**

#### **2.1. SCHEDULE OF VALUES**

- 2.1.1. Once the Agreement is awarded, each Contractor must submit a Schedule of Values for its entire Work to CM for approval. This Schedule of Values must be submitted either within fifteen (15) days of award or fifteen (15) days prior to the first payment application deadline (per the Application for Payment Schedule), whichever comes first. The Schedule of Values must include labor and material line items for each portion of the Work (larger portions of Work such as concrete, curtainwall, drywall, mechanical, and electrical shall be broken down by elevation, floor, and areas appropriate), the Contractor shall separate bond costs, and general conditions line items as appropriate.
- 2.1.2. The Schedule of Values will be submitted in a format as prescribed by, and to the level of detail specified by, CM.
  - 2.1.2.1. The sum of the parts of the Schedule of Values shall equal the contract price.
  - 2.1.2.2. The minimum level of breakdown and order on the application for payment will be:
    - 2.1.2.2.1. Bond costs, if applicable
    - 2.1.2.2.2. General conditions line item(s)
    - 2.1.2.2.3. Division 1 cost breakdown as required
    - 2.1.2.2.4. Costs associated with preparation of closeout paperwork and documentation
    - 2.1.2.2.5. Major portions of the Work shall be broken down into labor and material line items for specific areas of the facility
    - 2.1.2.2.6. A listing of approved and executed Change Orders to the Contract, if any, in sequential order.
  - 2.1.2.3. Schedule of Values items shall have a direct and understandable relation to the Project master construction schedule.
  - 2.1.2.4. Overhead and profit shall be listed as a separate line item on the schedule of values.
- 2.1.3. The Schedule of Values, unless objected to by CM, Owner or Architect, shall be the basis for the Contractor's application for payments.
- 2.1.4. CM shall have the right to require the Contractor to alter the value or add/delete categories listed on the Schedule of Values at any time for the following reasons:
  - 2.1.4.1. The Schedule of Values appears to be incorrect or unbalanced.

- 2.1.4.2. A revision of the Schedule of Values is required due to the Contractor revising the sequence of construction or assembly of building components that in turn invalidates the Schedule of Values.
- 2.1.4.3. Change Orders are issued to the Contractor and shall be incorporated into the Schedule of Values as a separate line item at the bottom of the Schedule of Values.
- 2.1.5. The Contractor is required to correlate the documentation for payment of stored materials requested in the application for payment against the agreed upon breakdown of the Schedule of Values as described in Payment for Stored Materials. CM reserves the right to not process the application for payment if this correlation has not been submitted in conjunction with the application.

## 2.2. APPLICATION FOR PAYMENT PROCESS

### 2.2.1. Step 1: JOB-SITE INSPECTION - DRAFT PAYMENT REQUEST

#### 2.2.1.1. The Contractor shall

- 2.2.1.1.1. have a representative walk the Project site with CM's representative on or before the tenth (10<sup>th</sup>) of the month,
- 2.2.1.1.2. invoice for Work from the tenth (10<sup>th</sup>) of last month to the tenth (10<sup>th</sup>) of the present month.
- 2.2.1.1.3. submit during the review, the itemized rough draft of the Application and Certificate for Payment (AIA Documents G702 and G703 Continuation Sheet) identifying the Work completed, if any, during the current calendar month; shall review same with CM and obtain a preliminary approved copy of the draft for official submission
- 2.2.1.1.4. Contractor's pay application shall only reflect Work completed through the date of submission. In no event will payments be authorized for forecasted Work.

NOTE: No payment shall be issued to a Contractor for materials stored off-site unless supported by proper documentation as required by CM (upon advance notification of such requests only) as described in Part 3 Payment for Stored Materials.

### 2.2.2. Step 2: PAYMENT REQUEST PREPARATION/SUBMISSION

- 2.2.2.1. With the information agreed upon in Step 1, the Contractor will prepare a formal application for payment request.
- 2.2.2.2. Three (3) originals of the request and three (3) originals of the sworn statements must be submitted to CM's Site office on or before the fifteenth (15<sup>th</sup>) of the month.
- 2.2.2.3. Late or incomplete application packets will not be accepted.**
- 2.2.2.4. The payment request will be made on an Application and Certificate for Payment form (AIA documents G702 and G703).
- 2.2.2.5. Before submitting these documents to CM, each request for payment must be signed by a duly authorized agent of the Contractor and notarized.
- 2.2.2.6. The Contractor must include with each request for progress payment a waiver of lien for all previous payments, Contractor's sworn statement and any necessary backup data as described in Part 4, Waivers of Lien and Sworn Statements.
- 2.2.2.7. In addition, at submission of the final pay application Contractor shall provide unconditional final waivers of lien for all Subordinate Parties, as well as all close out documentation and all additional back up data described in Part 4, Waivers of Lien and Sworn Statements.

- 2.2.2.8. In requests for payment which follow the execution of a Change Order in excess of twenty-five percent (25%) of the Agreement price, Contractor must present a bond rider evidencing that the penal sum of any required payment and performance bonds have been increased to one hundred percent (100%) of the adjusted Agreement price, or such other percentage as set forth in Section 00200 of the Project Manual, Instructions to Bidders. Submission of the required back-up data is a condition precedent to payment.

2.2.3. Step 3: CHECK DISTRIBUTION

- 2.2.3.1. CM will issue individual checks to each Contractor. The Contractor will receive the waiver of lien with the check and will be required to sign three (3) originals of the waiver upon receipt of the check each month (see Part 4).
- 2.2.3.2. The Contractor shall provide all supporting documentation substantiating the Contractor's right to payment as the Owner, CM and the Architect may require.

2.3. REDUCTION OF RETENTION

- 2.3.1. CM shall be entitled to withhold ten (10%) percent of each payment due to a Contractor until Substantial Completion of the Contractor's Work.
- 2.3.2. The Contractor, when requesting a reduction of retention, shall submit to CM, an AIA G707, Consent of Surety to Reduction In or Partial Release of Retention form in Section 01600 Forms.
- 2.3.3. Within thirty (30) days after Certificate of Substantial Completion has been issued for all portions of its Work, the Contractor's retention may be reduced to a sum as CM/the Architect may determine is suitable to protect CM and the Owner for all incomplete Work and any unsettled claims.
- 2.3.4. Notwithstanding the foregoing, payment of retention shall be subject to all other conditions precedent that applies to payment as set forth in the Contract Documents.

3. PAYMENT FOR MATERIALS STORED OFF-SITE

3.1. PAYMENT FOR MATERIALS STORED OFF-SITE

- 3.1.1. The Contractor, if intending to use an off-site storage area or facility for stored materials, shall submit a written request to the CM and obtain approval prior to submitting the first application for payment as described in Part 2 Applications for Payment.
- 3.1.2. Payments will be made for materials properly stored off site.
  - 3.1.2.1. "Properly stored" shall mean in an insured warehouse with the Owner and CM being named as insureds, and all material identified as property of the Owner.
  - 3.1.2.2. The Contractor is responsible for all associated off site storage costs, transportation, insurance, including insurance coverage for stored material, while in transit, unless Contractor obtains written documentation that the material is covered during transit under a Builder's Risk Policy applicable to the Project.
  - 3.1.2.3. Contractor shall provide CM and the Owner verification in writing for all material so stored. Such materials shall be protected from diversion, destruction, theft, and damage to the satisfaction of CM, Owner and the Lender (if any), specifically marked for use on the Project, and segregated from other materials at the storage facility.
  - 3.1.2.4. The Contractor bears all risk of loss to materials and equipment stored off site.
- 3.1.3. Contractor is to provide supporting documentation in the form of invoices, insurance policies, and any other pertinent documentation as requested by CM or Owner for items the items stored off-site. Documentation shall include the following:

- 3.1.3.1. Detailed description of the material including quantities that will serve as a material description for the billing and as information to file a claim with an insurance company.
  - 3.1.3.1.1. Stored Materials - Each item must be identified as to manufacturer, model number, and serial number, if applicable, or other identifiers should be listed for each item. Each listing must be accompanied by invoices, shipping tickets, consent of surety, and any other applicable supporting documentation.
  - 3.1.3.1.2. Stored Manufactured Building Materials - Each item must be identified as to type, manufacturer's number or designation, and should also list the number of cartons and the contents therein storage. Each listing must also be accompanied by supporting documents including all invoices, shipping tickets and consent of surety.
  - 3.1.3.1.3. Stored Fabricated Materials - A listing specifying the number of pieces, items, and marks as may be applicable to the particular type of items. Photographs should accompany the request.
- 3.1.3.2. Individual itemized costs of materials and the total cost value, which shall not exceed the Contractor's subcontractor or material supplier cost. The total cost value shall be supported by the Contractor's subcontractor or material supplier invoices for the stored material.
- 3.1.3.3. Estimated cost value for those materials that are fabricated by the Contractor's subcontractor or material supplier.
- 3.1.3.4. The location where the material is physically stored, including the warehouse address and storage location within the warehouse, such as bin number, aisle number or other designation. All material shall be segregated and marked.
- 3.1.3.5. Copies of the insurance policies that cover the stored materials and that name CM and the Owner as insureds. The limit of the insurance policy shall be equal to or greater than the replacement value of the stored materials.
- 3.1.4. When Applications for Payment include products stored off the Project Site or stored on the Project Site but not incorporated in the Project, for which no previous payment has been requested, a complete description of such product shall be attached to the application.
- 3.1.5. Contractor shall submit a certificate of title listing the Owner's ownership in the off-site stored materials equal to the amount paid effective at the time funds are delivered.
- 3.1.6. If the size, quantity, and/or type of material or product is such that a bonded warehouse is deemed unsuitable, then, with CM's approval, the Contractor may elect to prepay its subcontractor or supplier for certain material and products which are to remain on and be stored on that subcontractor/supplier's premises until needed by the Project. In such event, the Contractor shall enter into a security agreement with the subcontractor/supplier under which the Contractor shall be granted a security interest in and to all such material and products fabricated and/or to be supplied by the subcontractor/supplier for this Project and stored on the subcontractor/supplier's premises. This Security Agreement shall be a part of the financing statement, which shall be presented to a filing officer for filing pursuant to the Uniform Commercial Code. All expenses incurred in obtaining this security agreement shall be at Contractor's sole cost and expenses, and shall not accrue to the Owner, CM, Architect, nor the Project. A copy of each and every security agreement shall be filed with CM with the first Application for Payment which requests payment for such material or products.
- 3.1.7. All payment requests for off-site stored materials must be accompanied using the "Payment Request for Stored Materials" and a "Subcontractor Affidavit for Stored Materials." Payment requests for stored materials not complying with the foregoing requirements will not be approved. Contractors are to notify the CM in ample time to conduct verification procedures.

- 3.1.8. Contractors may not apply the cost of materials stored off-site towards a reduction in the retention amount.
- 3.1.9. Representatives of CM and Owner shall have the right to make inspections of the storage areas at any time.

#### 4. WAIVERS OF LIEN AND SWORN STATEMENTS

##### 4.1. WAIVERS OF LIEN

- 4.1.1. The Contractor's first Application for Payment will be based upon 100 percent of the value of Work installed. The first payment, amounting up to 90 percent of application, will be made to the Contractor without supporting documentation. Subsequent Applications for Payment must be accompanied by lien waivers from the Contractor, its Subordinate Parties or receipted invoices covering payment to the Contractor for previous calendar month period. Lien waivers must be unconditional and must show the amount paid.
- 4.1.2. An "Acknowledgment of Payment and Partial Unconditional Release" will be distributed with the check to each Contractor by CM for payment of the previous month's application. The Waiver of Lien is to be signed by an authorized representative of the Contractor. Under no circumstances will payment be released until the completed "Acknowledgment of Payment and Partial Unconditional Release" has been submitted and signed by the Contractor from the previous month.
- 4.1.3. Final payment will not be made until a "Final Release Subcontractor/Materialman has been submitted. This will also be distributed by the CM for Contractor signature and must be returned by the Contractor. The Final Release must be signed by an authorized representative of the Contractor and must be notarized.
- 4.1.4. Final unconditional waivers will be required for all of Contractor's Subordinate Parties listed on Contractor's sworn statement. These final waivers must be submitted along with the final release, before payment can be made.

##### 4.2. SWORN STATEMENTS

- 4.2.1. The appropriate number of original "Sworn Statements" must be completed to the satisfaction of CM, signed and notarized by an authorized representative of the Contractor and submitted with the Contractor's Application for Payment, monthly to the CM.
- 4.2.2. The Contractor's Subcontractor's sworn statements, waivers and other supporting documentation will be required with each pay application.

END OF SECTION 01290

## **SECTION 01310 MEETINGS**

### **1. GENERAL**

#### **1.1. DESCRIPTION OF REQUIREMENTS**

- 1.1.1. The CM shall schedule, chair, and administer all periodic meetings throughout the progress of the work for the purpose of coordinating and expediting the Work. Such meetings shall be held at the job site bringing together responsible representatives of active Contractors for the purpose of planning, assessing progress and discussing problems of mutual concern. Each Contractor, and its Subordinate Parties' representative attending the meetings shall be authorized to act on behalf of and make decisions/commitments for the entity each represents, the decisions made at the meetings and each Contractor who should be in attendance will be held responsible for information and directions given at the meeting.
- 1.1.2. The CM will prepare and distribute the minutes of all meetings, if CM determines minutes are required. If the attendees do not object in writing to any part of the meetings within ten (10) days of distribution of the minutes, the minutes shall be accepted as written.
- 1.1.3. The scope of meetings include, but are not limited to:
  - 1.1.3.1. Preconstruction Meeting
  - 1.1.3.2. Job Progress/Coordination Meetings
  - 1.1.3.3. Other Meetings

### **2. TYPES OF MEETINGS**

#### **2.1. PRECONSTRUCTION MEETING (KICK-OFF)**

- 2.1.1. A Preconstruction (kick-off) meeting will be conducted with representatives of all the Contractors within fifteen (15) days after the Agreement is awarded at the jobsite or as designated by the CM. The agenda may include:
  - 2.1.1.1. Discussion on major subcontracts and suppliers
  - 2.1.1.2. Major and/or critical work sequencing regarding the project schedule
  - 2.1.1.3. Project coordination and designation of responsible personnel
  - 2.1.1.4. Procedures and processing of field instructions, requests for proposal, submittals, change orders, applications for payment, etc.
  - 2.1.1.5. Quality assurance/control issues
  - 2.1.1.6. Adequacy of distribution of contract documents
  - 2.1.1.7. Procedures for maintaining record documents
  - 2.1.1.8. Use of premises, office, work and storage areas and other CM requirements
  - 2.1.1.9. Construction facilities/temporary utilities
  - 2.1.1.10. Safety and security procedures
  - 2.1.1.11. Other administrative procedures
  - 2.1.1.12. Review of Owner expectations

#### **2.2. JOB PROGRESS/COORDINATION MEETINGS**

- 2.2.1. On-site project coordination/progress meetings will be held on a bi-weekly basis or as appropriate throughout the life of the Project. The [CM/Owner] will set the agenda for the Project progress meeting. At a minimum, each Contractor shall be prepared to discuss the following:
  - 2.2.1.1. Actual vs. scheduled progress for the prior two-week period

- 2.2.1.2. Planned construction activities for the next four weeks
- 2.2.1.3. Problems with, revisions to and corrective measures and procedures to regain the construction schedule, if required
- 2.2.1.4. Review of off-site fabrication, delivery schedules
- 2.2.1.5. Document clarification requests
- 2.2.1.6. Coordination items with other Contractors
- 2.2.1.7. Changes in the work affecting cost and/or time
- 2.2.1.8. Submittals and shop drawings
- 2.2.1.9. Field observations, problems, conflicts
- 2.2.1.10. Quality control issues and non-conformance resolutions
- 2.2.1.11. Safety issues

### 2.3. OTHER MEETINGS

- 2.3.1. QUALITY ASSURANCE MEETINGS - CM may conduct quality assurance/quality control meetings as necessary during the progress of the Work. CM will set the agenda for the quality meeting. At a minimum, the Contractor shall be prepared to discuss the following:
  - 2.3.1.1. Testing and inspection procedures
  - 2.3.1.2. Tolerance requirements
  - 2.3.1.3. Quality samples
  - 2.3.1.4. Reporting of non-conformance items
  - 2.3.1.5. Corrective actions assigned
  - 2.3.1.6. Disposal of non-conforming items
  - 2.3.1.7. Job procedures
- 2.3.2. SAFETY MEETINGS - Refer to Section 00810 Safety and Loss Control Program for more information.
- 2.3.3. INSPECTIONS TOURS - Formal inspections/tours may be made of the Project progress by the Owner, Architect, local, state or federal officials, insurance representatives, or others as the occasion warrants and as scheduled by CM. If requested by CM, each Contractor shall be prepared to show and explain Work throughout the building to the inspecting parties, in addition to providing Work in compliance with these inspections.
- 2.3.4. CHANGE REQUEST MEETINGS - Upon issuance of a major Proposal Request (a.k.a. bulletin), CM may conduct a meeting as necessary with all significant Contractors to review its contents and determine cost, delivery and schedule impacts. At a minimum, the Contractor shall be prepared to discuss the following:
  - 2.3.4.1. Impact of out-of-sequence work
  - 2.3.4.2. Identification of pertinent long-lead material and system impact
  - 2.3.4.3. Alternative recommendations
  - 2.3.4.4. Evaluation of approximate cost magnitude
  - 2.3.4.5. Evaluation of impact on completion
  - 2.3.4.6. Alternate sequencing
  - 2.3.4.7. Due date for Contractor pricing and scheduling impact

END OF SECTION 01310



## **SECTION 01320 COMMUNICATIONS**

### **1. SUMMARY**

1.1. This Section describes the following requirements including:

- 1.1.1. Meetings / Communications
- 1.1.2. Contractor Correspondence
- 1.1.3. Contractor's Daily Report
- 1.1.4. Request for Information (RFI)

### **2. METHODS OF COMMUNICATION**

#### **2.1. MEETINGS (previous Section 01310 – Meetings)**

- 2.1.1. The CM shall schedule, chair, and administer all periodic meetings throughout the progress of the work for the purpose of coordinating and expediting the Work. Such meetings shall be held at the job site office bringing together responsible representatives of active Contractors for the purpose of planning, assessing progress and discussing problems of mutual concern. Each Contractor, and its Subordinate Parties' representative attending the meetings shall be authorized to act on behalf of and make decisions/commitments for the entity each represents, the decisions made at the meetings and each Contractor who should be in attendance will be held responsible for information and directions given at the meeting.
- 2.1.2. The CM will prepare and distribute the minutes of all meetings, if CM determines minutes are required. If the attendees do not object in writing to any part of the meetings within ten (10) days of distribution of the minutes, the minutes shall be accepted as written.
- 2.1.3. The scope of meetings include, but are not limited to:
  - 2.1.3.1. Preconstruction Meeting
  - 2.1.3.2. Job Progress/Coordination Meetings
  - 2.1.3.3. Other Meetings
    - 2.1.3.3.1. Quality Assurance
    - 2.1.3.3.2. Safety
    - 2.1.3.3.3. Inspection Tours
    - 2.1.3.3.4. Change Request

#### **2.2. CONTRACTOR CORRESPONDENCE**

- 2.2.1. All field and/or construction correspondence and/or communications must be directed through CM,. All correspondence should list the following as appropriate:
  - 2.2.1.1. Project Name: BP16 IAE and Hamilton Upgrades
  - 2.2.1.2. CM Job#: 140077
  - 2.2.1.3. Architect Job#: 13160B, 13175C
  - 2.2.1.4. Contractor Contact Information
  - 2.2.1.5. Subject: clearly indicate subject matter of correspondence

#### **2.3. CONTRACTOR'S DAILY REPORT**

- 2.3.1. Each Contractor will prepare and distribute daily to CM a comprehensive daily report to include pre-task planning and maintain it during the entire project period. The daily report shall be

submitted to CM's superintendent by the end of the day for that day's Work. Each Contractor is responsible for specifically alerting CM to items which could result in claims or delays.

- 2.3.2. Each Contractor may provide its own daily report if it covers the same issues as addressed in CM's Contractor Daily Report / Pre-Task Plan form. The CM suggested report form will be provided to the Contractor and is in Section 01600 - Forms.

#### 2.4. REQUEST FOR INFORMATION (RFI)

- 2.4.1. The Request for Information (RFI) is in Section 01600 Forms.
- 2.4.2. In the event that a clarification is required due to a question raised by the Contractor pertaining to the Contract Documents, the Contractor shall submit a Request for Information (RFI) to the CM, which will be forwarded to the Architect. The RFI should be sufficiently detailed to accurately describe the problem and provide a possible solution.
- 2.4.3. The Architect will return the RFI to CM as expeditiously as possible with its reply. In some instances, the Architect may issue its reply to the RFI on other documents, in which case, the RFI will simply reference these documents.
- 2.4.4. The RFI will be returned to the Contractor by CM. The Contractor is responsible to give proper notice as set forth in the Contract Documents if a response will cause the Contractor to incur additional expense or expend additional time which could impact the schedule. If extra work or an additional cost may exist due to the clarification, CM may issue a PCO- Quotation Only or PCO-Notice to Proceed to the Contractor.

END OF SECTION 01320

## **SECTION 01330 SUBMITTALS**

### **1 SUMMARY**

1.1. This Section describes the following requirements including:

- 1.1.1. Scope
- 1.1.2. Submittal Register
- 1.1.3. Submittal Requirements
- 1.1.4. Submittal Process and Responsibilities
- 1.1.5. Re-submission Requirements

### **2 SCOPE**

- 2.01 Where requirements of this Section vary from the requirements of the General Conditions, this Section's requirements shall take precedence.
- 2.02 CM will prepare and submit a submittal register/schedule including close-out documentation for Contractor's use in preparing submittals required for the Project. Contractor's shall complete the submittal schedule/register showing the dates for submission, lead times required and their expected delivery dates to maintain and follow the construction schedule. Dates for submission noted by Contractor must assume re-submittals will be required. Submittals received on the date scheduled will be processed as specified. CM/Owner/Architect will not be held responsible for delays due to receiving submittals after the date indicated in the Contractor's submittal schedule.
- 2.03 Submittals shall be submitted based on each technical specification section. Submittals containing information about more than one specification section will be returned for re-submittal.
- 2.04 Contractor is responsible to provide all submittals required under the Contract Documents, whether or not listed in the submittal register.
- 2.05 Furnish approved copies of shop drawings, diagrams, templates, catalog cuts, technical data, etc. to others for the purposes of coordination of this Work.
- 2.06 Coordination: Each Contractor shall coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
  - 2.06.1 The Contractor, by providing the submittal assures the product or system submitted is available and deliverable in accordance with the schedule requirements.
  - 2.06.2 Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.
  - 2.06.3 Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination.
  - 2.06.4 CM reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
  - 2.06.5 Coordinate each submittal as required with all trades and with all public agencies involved.
  - 2.06.6 Secure all necessary approvals from public agencies and others; signify by stamp or other means that all required approvals have been obtained.
  - 2.06.7 Material Compliance Certificate:
    - 2.06.7.1 The following forms are available upon request from the CM:
      - 2.06.7.1.1 Material Compliance Certificate
      - 2.06.7.1.2 Approved Submittal List for Material Compliance Certificate Use

- 2.06.7.2 Contractors may choose to complete the *Material Compliance Certificate* form which will serve as the Contractor's official submittal document and must meet all general submittal requirements. Only approved submittals listed on the *Approved Submittal List for Material Compliance Certificate Use*, prepared by CM, will be reviewed in this format.
- 2.06.7.3 Items available to utilize the Material Compliance Certificate can include a submittal that establishes a level of quality by complying with the manufacturer and manufacturer's designated identifier as called for in the Contract Documents. The Contractor is committed to using this exact specified component. This Certificate is contractually binding.
- 2.06.7.4 This form can be used for multiple submittal items. The Architect/Engineer will review and approve the Material Compliance Certificate in the same manner as a standard submittal.
- 2.06.7.5 In the event additional information would be required after submission and/or approval of the Material Compliance Certificate, the Contractor must provide this information promptly through the standard revision process.

### 3. SUBMITTAL REQUIREMENTS

#### 3.1. GENERAL

- 3.1.1. Each submittal shall show Contractor's review stamp, with handwritten signature, certifying review of the submittal, verification of field measurements and compliance with the Contract Documents.
- 3.1.2. Each submittal shall be accompanied with a Submittal Transmittal Form. The following information shall be furnished by the Contractor on the submittal transmittal form:
  - 3.1.2.1. Original Date of submission and Revision Date(s).
  - 3.1.2.2. Project name and Architect's and the CM's project number
  - 3.1.2.3. Names of:
    - 3.1.2.3.1. Contractor
    - 3.1.2.3.2. Second-Tier Contractor (if applicable)
    - 3.1.2.3.3. Supplier
    - 3.1.2.3.4. Manufacturer
  - 3.1.2.4. Identification of product or material
  - 3.1.2.5. Technical Section number, clearly identified. On multiple submittals, a separate transmittal should be completed for each specification section on items being submitted.
  - 3.1.2.6. Reference to construction drawings by drawing number
  - 3.1.2.7. The quantity of each Shop Drawing, Product Data or Sample submitted
  - 3.1.2.8. Notification of deviations from Contract Documents
  - 3.1.2.9. For Shop Drawings, show relationship to adjacent structure or materials
  - 3.1.2.10. For Shop Drawings, show field dimensions, clearly stated as such.
  - 3.1.2.11. Applicable standards such as ASTM or Federal Specifications.
  - 3.1.2.12. Other pertinent data
  - 3.1.2.13. Submittals not so transmitted will be returned un-reviewed. Re-submissions shall be so noted on the transmittal.

3.1.3. Unless noted otherwise on the submittal, all submissions will be considered to be "as specified."

### 3.2. REQUIRED QUANTITIES OF SUBMITTALS (ELECTRONIC REVIEW VERSION)

3.3.1. In general, all submittals, except color or physical samples, are to be posted electronically in PDF document form for CM and the Architect/Engineer to be electronically reviewed and approved. CM will use Prolog Web as a posting site for the facilitation of this review and approval process. The following number of originals and copies will be required for each type of submittal.

Submittal Type:	Required submit quantities:	
	Electronic <sup>1</sup> )FTP upload(	Other
.1 Shop Drawings – Structural Steel and all MEP	1	
.2 Shop Drawings – all other	1	
.3 Product Data – Structural Steel and all MEP	1	
.4 Product Data – all other	1	
.5 Samples		2
.6 Certificates <sup>4</sup>	1	
.7 Warranties / Guarantees <sup>4</sup>	1	
.8 Test Reports <sup>4</sup>	1	
.9 Close-Out Materials : <sup>4</sup> O&M Manuals and all Data	1	1-paper
<b>NOTES :</b> <sup>1</sup> ALL electronic submittals shall be in PDF format <sup>2</sup> Provide on compact disk as well as upload to the FTP site (INSERT IF NECESSARY) <sup>3</sup> Unless amount specified within the technical specifications is greater <sup>4</sup> Items #6-9 above are to be submitted together as part of the Close-Out Packet when requested by CM		

3.3.2. All submittals will be reviewed electronically via Prolog Web, an electronic submittal transmittal is required. Reviewed versions will be posted back to Prolog Web. CM will notify Contractor of the posting and availability for Contractor to download the reviewed version. Paper copies will not be returned to the Contractor.

## 4. TYPES OF SUBMITTALS

### 4.1. SHOP DRAWINGS

- 4.1.1. Provide Shop Drawings as complete submittals (no partial sets) on original drawings or information prepared solely by the fabricator or supplier. In no instance shall the Contract Drawings be reproduced for Shop Drawing submittals.
- 4.1.2. Sheet sizes shall not exceed the size of the Contract Drawings or smaller than 8-1/2" X 11".
- 4.1.3. Each drawing shall have blank spaces large enough to accept three (3) 3" x 6" review stamps of the Contractor, the CM, and the Architect.

### 4.2. PRODUCT DATA

- 4.2.1. Modify Product Data sheets to delete information that is not applicable to the Project. Provide additional information if necessary to supplement standard information.
- 4.2.2. Product Data Sheets that are submitted with extraneous information not deleted and/or modified will be returned without review to the Contractor for re-submittal.

### 4.3. SAMPLES

- 4.3.1. Provide physical Samples to illustrate materials, equipment or workmanship, and to establish standards by which completed work may be judged as required by the technical section.
- 4.3.2. Provide Office Samples in sufficient size or as defined in the technical specifications and quantity to clearly illustrate full range of colors, textures, etc. available and the functional characteristics of the product or material.
- 4.3.3. Erect Field Samples or mock-ups as required by the technical sections and/or CM, at the Project site in a location designated by CM. Construct field samples complete, including Work of all trades required in finishing the Work. Provide Field Samples at the request of the Architect and/or CM where construction materials and/or methods deviate from the requirements of the intent of the Contract Documents or conventional construction practice.
- 4.4. CERTIFICATIONS
  - 4.4.1. Certifications shall clearly identify the materials in reference and shall state that the material and the intended installation methods, where applicable, are in compliance with the Contract Documents for this project. Attach manufacturer's affidavits where applicable.
- 4.5. WARRANTIES/GUARANTEES
  - 4.5.1. Provide warranties and/or guarantees as required by the various technical sections and other Contract Documents on the Contractor's letterhead in accordance with the requirements of the documents.
  - 4.5.2. Refer to Section 01700 for additional close-out information and requirements including the standard CM Contractor's Guarantee Form that must be signed, without modification, in order to receive final payment. A copy of this form is either found in Section 01600 or is available upon request.
- 4.6. OPERATING AND MAINTENANCE MANUALS
  - 4.6.1. Provide operating and maintenance manuals/data as required by the various technical sections in accordance with the requirements of the documents.
- 5. SUBMITTAL PROCESS AND RESPONSIBILITIES
  - 5.1. Contractor's RESPONSIBILITIES
    - 5.1.1. After the CM's and Architect's review, within one (1) week of receipt, Contractor is to distribute copies of the reviewed submittal to any supplier/fabricators, second or lower tier Contractors or other Contractors that must coordinate with this work. Contractor must maintain one copy at the Project Site for reference use.
    - 5.1.2. Do not begin Work which requires submittals until return of submittals with CM's and Architect's stamp and initials indicating review with direction to proceed from either CM or Architect..
    - 5.1.3. Contractor's responsibility for errors and omissions in submittals is not relieved by CM's or Architect's review of submittals.
    - 5.1.4. Contractor's responsibility for deviations in submittals from requirements of Contract Documents is not relieved by CM's or Architect's review of submittals unless CM and Architect give written acceptance of specific deviations.
  - 5.2. CM'S RESPONSIBILITIES
    - 5.2.1. CM's review is for general administrative purposes only and neither this review, nor any subsequent approval by CM of a submittal, shall relieve Contractor from its obligations to comply fully with the Contract Documents.
    - 5.2.2. CM will make changes or notations directly on the submittals, identify such review with its review stamp, sign and forward acceptable submittals to the Architect.

- 5.2.3. After the Architect's review, CM will forward submittals to the Contractor and retain one copy.

### 5.3. ARCHITECT'S RESPONSIBILITIES

- 5.3.1. Architect will review submittals within fourteen (14) Days after receipt, checking only for conformance with the design compliance of the Project and compliance with information given in the Contract Documents. If the submission is large and/or requires detailed or lengthy review by the Architect, additional time may be required.
- 5.3.2. Architect will return to CM without review any submittals not bearing the Contractor's or CM's review stamp or not showing that it has been reviewed by the Contractor and CM.
- 5.3.3. Architect will make changes or notations directly on the submittal, identify such review with its review stamp, obtain and record Architect file copy and return the submittal to CM.

### 5.4. RE-SUBMISSION REQUIREMENTS

- 5.4.1. For Shop Drawings: Review returned CM and/or Architect drawings and resubmit as specified. All changes made must be identified through bubbling or other approved method.
- 5.4.2. For Product Data and Samples Resubmit new data and samples as required.

END OF SECTION 01330

**SECTION 01360**  
**COORDINATION (GENERAL)**

**1 COORDINATION OF WORK/COOPERATION**

- 1.01 All Contractors are required to review, discuss and coordinate their Work with the Work of other contractors, Owner and CM with regard to sequence, timing, built-in Work and equipment, layout, location, compatibility of materials and sizes and required clearances prior to beginning the work to avoid construction delays which impact the Owner's occupancy of the facility.
- 1.02 Each Contractor
- 1.02.1 Coordinate installation of different components to assure maximum accessibility for required maintenance, service and repair.
  - 1.02.2 Make provisions to accommodate items scheduled for later installation.
  - 1.02.3 Provide to all other trades all information (drawings, diagrams, templates, embedments, etc.) necessary for the coordination of the Work.
  - 1.02.4 Layout and install its Work at such time and in such manner as not to delay or interfere with the carrying forward of the Work of others.
  - 1.02.5 Verification and Acceptance of previous work
    - 1.02.5.1 As Work under each Agreement commences, the condition of preceding Work under other agreements shall be verified and accepted by each subsequent Contractor when appropriate.
    - 1.02.5.2 Report in a prompt manner any interferences, discrepancies or incompatibilities discovered to CM, whose decision as to the Contractor at fault and as to the manner in which the matter may be resolved, shall be binding and conclusive on Contractors involved. CM may direct layout/ location changes as required to make the entire work fit together. Reasonable changes of this nature will not entitle any Contractor to an increase in contract price.
    - 1.02.5.3 Verification may, at CM's discretion, include a joint review by the subsequent Contractor, previous contractor(s), and CM to note any corrective Work required, similar items affecting the Work and particularly items which prevent acceptance by the subsequent contractors.
    - 1.02.5.4 The verification review procedures and findings shall be submitted in writing by subsequent Contractors to the CM.
    - 1.02.5.5 Any corrective work necessary to satisfy requirements of the Contract Documents shall be performed promptly by the previous Contractor to prevent delay to the work under the subsequent Contracts.
    - 1.02.5.6 After corrective work is accomplished the subsequent Contractor shall furnish written acceptance of the work as noted above.
    - 1.02.5.7 CM's participation in a joint review under this paragraph shall in no event be deemed to constitute approval of any layout or other Work that fails to comply with the **Contract Documents**.
  - 1.02.6 Observation of the Work by others shall not relieve Contractor from its responsibility for coordination, supervision, or scheduling and direction of the Work.
  - 1.02.7 Failure of a Contractor to notify others and CM of a potential interference, incompatibility, or discrepancy and any failure to coordinate Work with that of others prior to installation and/or fabrication shall be at the Contractor's risk.

END OF SECTION 01360



## **SECTION 01370 COORDINATION DRAWINGS**

### **1. GENERAL REQUIREMENTS**

- 1.1. Contractor if required by its Work scope, shall be responsible for developing coordination drawings and participating in coordination meetings as defined herein, and shall have included the cost for such Work in its Bid Proposal.
- 1.2. Coordination Drawings shall be utilized to establish installation sequence, resolve trade coordination issues prior to installation and to make the most efficient use of space allocated for systems such as mechanical/electrical/plumbing installations without sacrifice to systems performance. This is also required to determine inter-relationships and possible interference's between all of the trades' Work and the architectural or structural features.
- 1.3. Contractors are required to attend coordination meetings as required by CM. The representative(s) from each Contractor is required to be familiar with the Work and have the expertise and authority to answer questions and make decisions and changes to its systems at these meetings.
- 1.4. The coordination drawings may also be used by Contractor as part of its required shop drawing and as-built drawing submittals.
- 1.5. Each Bidder should anticipate that each floor may require several meetings. However, in the interest of time, multiple floors or areas may be reviewed in one meeting. Development of coordination drawings will be by area and floor with order of priority established by CM.

### **2. COORDINATION DRAWING PROCESS**

- 2.1. CM, after the award of the Agreements, will obtain 1/4" scale, screened mylars of the Structural, Reflected Ceiling and Architectural floor plans of the Project. CM will provide these mylars to the Contractors involved. The Electrical [Contractor, following an HVAC coordination kick-off meeting, shall immediately begin Work and prepare 1/4" scale layout drawings of all ductwork and piping. These drawings shall also show registers, grilles, diffusers, and similar features. Contractor shall include locations of all valves, dampers and shall note any items requiring access for service and maintenance as well as access doors in inaccessible ceilings. Drawings shall also show the size, layout and routing of all metal and flex ductwork, re-heat coils, terminal units, filters, and major hangers and supports. Contractor shall provide notation for diffuser boot sizes and heights and any other special features. Contractor shall provide cross sections and additional details through areas where clearances are tight and further detail as appropriate and/or required. Where piping or ductwork has external insulation, Contractor shall note or show locations and thickness. Contractor shall indicate bottom elevation of duct, pipes and equipment and elevation changes, to be measured to the lowest point including insulation and hangers where applicable.
- 2.2. In areas where no HVAC work occurs, but where other mechanical and electrical installations are installed, the Electrical Contractor will issue or note on transparencies indicating "No HVAC Work Required".
- 2.3. Within fifteen (15) working days of issuance of the mylars, the Electrical Contractor shall have completed layout drawings and provide to CM sixteen (16) prints for the first scheduled area. At this time all Contractors shall attend a Coordination Kick-Off Meeting at which time the first distribution of HVAC prints is made and procedures and schedule are reviewed.
- 2.4. As layout drawings for HVAC Work for subsequent areas are completed, the Electrical Contractor shall provide sixteen (16) prints of the completed layout drawings to CM. CM will in turn distribute two (2) prints to each required Contractor to include Plumbing, Fire Protection and Electrical Work. Respective Contractors shall then layout their own routings on the 1/4" scale mylars previously provided. Drawings shall include other major items such as valves, access panels, switch panels, pull boxes also noting items requiring access for service and maintenance, etc. as well as access doors in inaccessible ceilings.
- 2.5. Information for specific trades is required but not limited to the following:

- 2.5.1. Plumbing - Size, layout and routing of piping, valves, boxes, supports, etc., for all utilities regardless of material size. Show or note all pipe sizes and working clearances around valves, etc. For pitched piping, identify bottom elevations at key points and at least every column line. Note thickness and location of all external insulation. Bottom elevations shall be measured to the lowest point including hangers and insulation where applicable.
  - 2.5.2. Sprinkler Piping - Size, layout and routing of mains and branch piping, hanger and supports, valves, working clearances, and bottom of pipe and bottom of hanger support elevations. Sprinkler head locations shall be shown on ceiling plans. For pitched piping, identify bottom elevation at key points and at least at every column line.
  - 2.5.3. Electrical - Size, layout and routing and size of conduit and wire 2" or larger for normal and emergency power distribution systems, 1-1/2" or larger for communication systems telephone, nurse call, physiological monitoring, etc., include all systems specified, boxes larger than 4" x 4" x 4", hangers, supports, and electrical fixtures including lights, speakers, detectors, sensors, cable trays, raceways, etc. Size and clearance of ceiling and above ceiling mounted items shall be noted as a depth from finished ceiling to top of fixture or top of clear area required. Provide bottom elevations of conduits and equipment. Bottom elevation shall be measured from the lowest point, including hangers.
    - 2.5.3.1. Within four (4) feet of all panels, or areas where more than 4 conduits, regardless of size, are routed or grouped together, identify an easement or right-of-way for the groups of conduit.
    - 2.5.3.2. Also show all wall mounted items located within 12" of the ceiling plane.
  - 2.6. All Contractors, including Electrical Contractor, within ten (10) working days of issuance of HVAC prints, shall be prepared to attend coordination meetings as required by CM. They shall come to meetings with their completed mylars and two prints. Contractors, at the meeting, will work to review and overlay the mylars to identify and resolve interference's and coordination problems. Following the meeting, Contractors shall revise their mylars, if necessary, based upon the agreed changes and be prepared to meet again within five (5) working days of the first coordination meeting as scheduled by CM.
  - 2.7. When the mylars have been fully revised with no exceptions taken by respective Contractors, including the Electrical Contractor, the Contractors shall sign them, indicating their awareness of and agreement with the indicated routings and layouts and their inter-relationship with the adjoining or continuous Work of all Project contracts. Thereafter, no unauthorized deviations from the information provided will be permitted, and if made without the knowledge or agreement of the Architect and CM, this unauthorized Work will be subject to removal and correction at no additional cost to the Owner or the CM.
  - 2.8. Within five (5) Days of the signing of the coordination drawings, each Contractor shall provide CM with one (1) sepia mylar and sixteen (16) prints of the signed mylar. CM will in turn distribute two (2) prints each to the other contractors and retain one set of mylars and two sets of prints on file at the Project site.
3. EXECUTION
- 3.1. In the preparation of all coordination drawings, 1/2" scale details as well as cross and longitudinal sections are required to fully delineate all conditions. Particular attention shall be given to the locations, size and clearance dimensions of equipment items, shafts, corridors and similar features.
  - 3.2. After completion of the final coordination drawings, minor changes in duct, pipe or conduit routings that do not affect the intended function may be made as required to avoid space conflicts, when mutually agreed to by all parties involved. However, items may not be re-sized or exposed items relocated without CM's written approval. No changes shall be made by Contractors in any wall or chase locations, ceiling heights, door swings or locations, windows or other openings, or other features affecting the function or aesthetic effect of the building. If conflicts or interference's cannot be satisfactorily resolved, Contractors shall notify CM who will, in turn, obtain a decision from the Architect.

- 3.3. Other Contractors responsible for supplementary composite drawings, as indicated herein, shall make similar distribution to that described in item 1.03 Paragraph E. All trades desiring additional prints of such drawings, beyond the basic distribution indicated above, shall arrange for and pay the cost of same.
- 3.4. Record copies of final drawings shall be retained by CM and each Contractor as working reference. All shop drawings, prior to their submittal to CM shall be compared with the final drawings and developed accordingly by the Contractor responsible. Any revision to the drawings which may become necessary during the progress of the Work shall be noted to and by all Contractors and shall be neatly and accurately recorded on the record copies. Each Contractor shall be responsible for the up-to-date maintenance of its own record copies of the final drawings, and any subsequent changes thereto shall be utilized by CM and each Contractor in the development of As-Built/Record drawings described in Section 01720 of the Project Manual.
- 3.5. The HVAC drawings need not be submitted as a whole, but they shall be submitted in all cases per CM's project master construction schedule and in ample time to avoid construction delays. The coordination drawings of all trades may lack complete data in certain instances pending receipt of shop drawings, but sufficient space shall be allotted for the affected items. When final information is received, such data shall be promptly inserted on the final drawings.
- 3.6. No extra compensation will be paid for relocating any duct, pipe, conduit, or other material that has been installed without proper coordination between all Contractors involved. If any improperly coordinated Work, or Work installed that is not in accordance with the approved coordination composites, necessitates additional Work by the other Contractors, the costs of all such additional Work shall be solely borne by the Contractor responsible.
- 3.7. All changes in the Scope of Work due to revisions formally issued and approved shall be shown on that trade's final drawings and thoroughly coordinated with the other trades.
- 3.8. All Work on the coordination composite drawings shall be performed by competent draftsmen and shall be clear and fully legible. CM shall be sole judge of the acceptability of the drawings. All drawings shall be drawn dimensionally and graphically correct.
- 3.9. In general and before the first meeting the following guidelines shall be followed:
  - 3.9.1. All trades shall coordinate with the Electrical Contractor for the size, height and clearance requirements for recessed or semi recessed light fixtures, recessed speakers/detectors, and other electrical ceiling devices.
  - 3.9.2. Sprinkler heads shall be centered in the center of lay-in ceiling tiles unless approved shop drawings note otherwise.
  - 3.9.3. All elevations shall be based on height above finished floor using established benchmarks.
  - 3.9.4. Standard suspended ceiling systems requires 3" minimum clearance for materials and installation.
  - 3.9.5. Review of other drawings may be necessary for special structural and suspended equipment requirements.
  - 3.9.6. All trades to hang work as high as possible in above ceiling areas, allowing access to equipment for maintenance, repairs, connections, filters and removal without demolition of other Work.
- 3.10. Coordination drawings submitted during this process are not considered shop drawing submittals. The coordination drawings may be part of the required shop drawing submittal, but are made separate from the distribution specified in this section.

END OF SECTION 01370

## SECTION 01400 QUALITY REQUIREMENTS

### 1. DOCUMENT CONTROL PROCEDURE

- 1.1. Each Contractor is to provide CM its document control procedure to include drawing submittals and surveillance. In the absence of such a procedure, the Contractor will use the following procedure for document control.

**“A log is maintained identifying the drawing revision status, issue date and distribution (internal and external). The transmittal issuing the changed documents will indicate what changes are made and indicate that the documents are approved for use. Contractor meetings include a review of approved drawings. The review is documented in the meeting minutes. Superintendent surveillance activities include monitoring Contractor drawing use.”**

### 2. QUALITY CONTROL

- 2.1. Each Contractor is responsible to provide the Owner with a completed quality product for its Work. Each Contractor shall be responsible for any costs associated with re-testing and re-performing the Work as a result of the Contractor's poor performance or workmanship or other failure to comply with the Contract Documents.
- 2.2. All Work shall be done by persons qualified in their respective trades, and the workmanship shall be first-class in every respect. **Each Contractor is responsible for ensuring employees are appropriately trained.** All materials and equipment furnished shall be the best of their respective kinds for the intended use and unless otherwise specified, same shall be new and of the latest design.
- 2.3. The Contractor shall provide CM, Owner and Architect access to the Work in preparation and progress wherever the Work is located at all reasonable times.

Note: CM and the Architect will have the authority to reject Work that does not conform to the Contract Documents or may require special inspection or testing, whether or not such Work is to be then fabricated, installed or completed. The Architect shall make all decisions with respect to questions concerning the quality or fitness of materials, equipment and workmanship.

- 2.4. Failure by a Contractor to conduct its operations, means and methods and coordinate proper sequencing of the Work may cause the Troy School District to withhold payment or any other means deemed necessary to correct non-conforming Work.

### 3. NOTIFICATIONS AND CORRECTIONS OF NON-CONFORMANCE

- 3.1. CM and the Architect may conduct observations/evaluations of the Contractor's Work. CM and/or Architect's reviews do not relieve the Contractor from compliance with the Contract Documents or necessary corrections for deficiencies thereof. Contractors whose Work does not meet the standards set by the Contract Documents will be notified by representatives of the CM using a Corrective Action Report. The Contractor, upon receipt of the Corrective Action Report, shall complete and return the form and provide the corrective actions necessary in a timely manner as outlined.
- 3.2. The **Corrective Action Report (CAR) (CON 18.2)** is in Section 01600 Forms.

### 4. CONTRACTOR PERFORMANCE EVALUATION

- 4.1. CM will be evaluating Contractor's performance and will provide feedback during the life of the Project, on Contractor's performance, for the purpose of improving CM's Contractor selection process for future project endeavors.
- 4.2. This Contractor Performance Evaluation form is generated by the CPS Database.

END OF SECTION 01400

**SECTION 01450**  
**TESTING AND INSPECTION SERVICES**

**1. CONTRACTOR'S RESPONSIBILITIES**

- 1.1. The testing firm will report directly to the Troy School District. Copies of test and inspection reports will be furnished to the appropriate Contractors. The laboratory and its representatives will be instructed to promptly call to the attention of the Contractor any instance of non-compliance with the requirements of the Contract Documents. Failure to so notify the Contractor shall not relieve the Contractor of any of its responsibilities for compliance or making good workmanship or materials which are not in compliance with the requirements of the Contract Documents.
- 1.2. Each Contractor shall cooperate with the testing firm and provide labor to assist and lifts, ladders or other means to permit full access for testing firm and to assist with sample preparations where applicable.
- 1.3. The Contractor is responsible to pay the cost of additional testing in the event that additional testing of the Contractor's materials, installation, and other Work is required by the independent testing laboratory because of test results not in compliance with the Contract Documents and/or additional testing required as a result of Contractor's negligence or poor workmanship.

**2. CONTRACTOR RESPONSIBILITIES**

**2.1. CONTRACTOR SHALL:**

- 2.1.1. Notify CM sufficiently in advance of operations (24-hours minimum) to allow for laboratory assignment of personnel and scheduling of tests.
  - 2.1.1.1. When tests or inspections cannot be performed after such notice, reimburse Troy School District for all expenses incurred arising out of or resulting from Contractor's negligence.
- 2.1.2. When the Contractor is providing the testing and prior to start of Work, submit testing laboratory name, address, and telephone number, and names of full time registered engineer and responsible officer. Submit copy of report of laboratory facilities inspection made by Materials Reference Laboratory of National Bureau of Standards (NBS) during most recent tour of inspection, with memorandum of remedies of any deficiencies reported by the inspection.

**3. RE-TEST RESPONSIBILITY**

- 3.1. Where the results of required inspections, tests, or similar services prove unsatisfactory and do not indicate compliance with the requirements of the Contract Documents, the re-tests shall be the responsibility of the Contractor regardless of whether the original test was the Contractor's responsibility.
- 3.2. Re-testing of Work revised or replaced by the Contractor is the Contractor's responsibility where required tests were performed on original Work. All costs and fees for re-testing shall be paid by the Contractor.
- 3.3. Schedule delays and costs which are the result of non-conforming work or remedy will be the responsibility of the offending Contractor.

END OF SECTION 01450

## SECTION 01500 INTERIM LIFE SAFETY PLAN

### 1. PURPOSE AND POLICY

- 1.1. **PURPOSE:** To provide interim life safety measures during a construction Project. To protect Owner personnel, visitors, [patients] and property from fire and injury during Upgrades or construction. This policy is used wholly or in conjunction with the safety program in the Project Manual.
- 1.2. **POLICY:** During a construction Project it shall be the responsibility of the Director of Facilities (or designee) and CM (through trade Contractors) to maintain compliance with the Life Safety Code NFPA Section 101. Compliance will be through the implementation of the following:

### 2. NOTIFICATIONS

- 2.1. Contractor shall communicate and coordinate through CM for all changes to Life Safety measures including changes to: egress, the fire suppression system, the fire alarm system or any other Life Safety related changes to the construction site. Contractor is required to simultaneously notify the appropriate Owner personnel / departments: Owner's PM, Security, Facilities, Safety, Local and/or state fire, 911 emergency services, etc.
- 2.2. Advanced notification using the appropriate form shall be submitted not less than twenty-four (24) hours in advance of the work. Forms can be obtained through CM.

SHUTDOWN REQUEST TYPE	FORM NAME [VERIFY WITH OWNER'S REQUIREMENTS]	SUBMIT FORM IN ADVANCE OF PROPOSED WORK BY:	SUBMIT FORM TO:
CHANGE IN EGRESS:	Submit egress plan of existing exiting and proposed change	3 Weeks	CM; CM to schedule a review meeting with the Owner and Architect for final approval
Change in Fire Suppression	Sprinkler Shut-Down Request	1 Week	CM for initial review 5 days prior; upon approval from CM simultaneously submit to CM, Safety, Security, OTHERS
Change in Fire Alarm	Fire Alarm Shut-Down Request	1 Week	CM for initial review 5 days prior; upon approval from CM simultaneously submit to CM, Safety, Security, Owner's Insurance Agency, State and/or Local Fire Department, VERIFY OTHERS
Mechanical Piping, HVAC or Electrical Shut-Down	Utility Shut-Down Request	1 Week	CM for initial review 5 days prior; upon approval from CM simultaneously submit to CM, Safety, Facilities, Security, OTHERS

### 3. INTERRUPTION OF EXIT - EGRESS CORRIDOR

- 3.1. Should construction of temporary structures for egress/exit be necessary:

- 3.1.1. Contractor will review with and obtain approval from CM any changes to the means of egress. This review and approval shall include the Owner and Architect to confirm appropriate travel distances to exits are maintained/established.
- 3.1.2. Contractor shall obtain approval from the appropriate agency for any planned temporary exiting structure prior to construction/implementation.
- 3.1.3. All Contractors shall be responsible for maintaining temporary egress/exits:
  - 3.1.3.1. Each Contractor is responsible to protect, kept free of restrictions or obstructions, and maintain in full use all entrances to and exits from existing buildings and the construction site at all times. The safety and well-being of all persons must be of prime concern.
  - 3.1.3.2. Contractor shall maintain and not disturb any temporary construction, including stairs, ramps, protected walkways, railings, lights and direction signage as required to maintain adequate exiting from the existing building.
- 3.2. Should an alternate egress route be necessary:
  - 3.2.1. Contractor shall submit the appropriate forms to CM so all affected departments will be notified. Contractor shall not begin any work associated with a change in egress until the Owner has verified its internal departments are notified and prepared for the change.
  - 3.2.2. Contractor shall install and maintain temporary exit signage and Contractor shall install and maintain temporary directional signage prior to starting Work associated with the change in egress..
- 4. INTERRUPTION OF THE SPRINKLER SYSTEM
  - 4.1. Refer to the above matrix for advanced notification times and shut-down request distribution.
  - 4.2. Priority will be given to localized interruption of these systems on first shift Monday through Friday when full staff is available when any shut down is necessary:
  - 4.3. Contractor will provide an organized fire watch until the system is fully functional.
- 5. INTERRUPTION OF FIRE/SMOKE DETECTION AND ALARM SYSTEM
  - 5.1. Refer to the above matrix for advanced notification times and shut-down request distribution.
  - 5.2. Contractor shall maintain the operation of the total fire detection/alarm during the construction.
    - 5.2.1. It is acceptable for the Contractor to place a thin plastic cover over the detector head during high dust producing activities with Contractor's prompt removal upon completion of the work.
    - 5.2.2. At all other times the system will be returned to normal operating status.
  - 5.3. Should the fire/smoke detectors and alarms systems be interrupted:
    - 5.3.1. Contractor will provide an organized fire watch until the system is fully functional.
    - 5.3.2. Temporary alarm pull stations will be established as a minimum should the interruption last more than twenty-four (24) hours.
- 6. CONSTRUCTION SITE MAINTENANCE
  - 6.1. For interior construction. Contractor **shall**:
    - 6.1.1. Refer to the above matrix for prior notifications.
    - 6.1.2. Maintain existing Fire/Smoke Barriers and compartments.
    - 6.1.3. Provide and maintain temporary partitions adjacent to functioning departments that are a UL rated 2-hour assembly and smoke/dust tight and non-combustible. Provide documentation of the UL rated assembly type to CM prior to constructing this Work.

- 6.1.4. Maintain temporary enclosures, fire-rated dust curtains, and all other necessary materials and equipment as required to prevent introduction of dust, dirt or debris into occupied portions of the building.
  - 6.1.5. Coordinate locking of the construction area with CM and the Owner.
- 6.2. For exterior construction - Contractor shall:
  - 6.2.1. Maintain site clearance for access to the external fire department connections.
- 7. REFERENCES
  - 7.1. All current Life Safety codes

END OF SECTION 01500



## **SECTION 01520 TEMPORARY CONSTRUCTION**

### **1 SUMMARY**

- 1.01 This Section describes the following requirements including:
- 1.01.1 Project Signage
  - 1.01.2 Snow Removal
  - 1.01.3 Security
  - 1.01.4 Temporary Field Office, Facilities and Parking
  - 1.01.5 Temporary Fencing
  - 1.01.6 Temporary Toilet Facilities
  - 1.01.7 Drinking Water/Temporary Water
  - 1.01.8 Roof Protection
  - 1.01.9 Scaffolding
  - 1.01.10 Water Control
  - 1.01.11 Temporary Material Hoist/Elevator
  - 1.01.12 Fire Precautions and Protection
  - 1.01.13 Noxious Odors and Fumes
  - 1.01.14 Temporary Stairs, Ladders, Ramps, Runways, and Barricades
  - 1.01.15 Temporary Electrical Power and Light
  - 1.01.16 Temporary Heating and Weather Protection
  - 1.01.17 Temporary Enclosures

### **2 CONSTRUCTION FACILITIES**

#### **2.01 PROJECT SIGNAGE**

- 2.01.1 The CM shall provide a project sign. No other signs or advertising shall be displayed on the premises without the approval of the Architect, Owner, and CM. This does not exclude the posting of required trade notice and cautionary signage by Contractors.

#### **2.02 SNOW REMOVAL**

- 2.02.1 Contractors performing Work under exposed conditions shall remove snow and ice for the protection and execution of their Work. Keeping public traffic areas and circulation routes free of snow shall be the responsibility of the CM/DESIGNATED CONTRACTOR.

#### **2.03 SECURITY**

- 2.03.1 The services of a security guards will not be provided by CM.
- 2.03.2 Each Contractor, at its own cost and expense, may provide security guard, protective service or other means of site security as it deems necessary.
- 2.03.3 Contractors shall advise CM of any theft or damage which might delay the execution of the Work and furnish the Owner and CM with a copy of any theft report filed with local, county or state agencies.
- 2.03.4 Neither CM nor Owner assumes any responsibility for loss, theft or damage to the Contractor's materials or for damage to Work in place before the completion of the construction. In the instance of any such loss, theft or damage, the Contractor shall be responsible to renew, restore or

remedy the Work, tools, equipment and construction in accordance with requirements of the Contract Documents without additional cost to CM.

- 2.03.5 CM is not responsible for damage, liability, theft, casualty or other hazard to the automobiles or other vehicles, nor to injury, including death, to occupants of automobiles or other vehicles on the Owner's property.
- 2.03.6 CM may establish additional security policies and procedures. All Contractors will be required to cooperate with CM in implementing these procedures.
- 2.03.7 Site-parked equipment, operable machinery and hazardous parts of the new construction subject to mischief and accidental operation shall be inaccessible, locked or otherwise made inoperable when left unattended.

#### 2.04 TEMPORARY FIELD OFFICE, FACILITIES AND PARKING

- 2.04.1 The Owner may designate an area for construction trailers. Placement and scheduled duration shall be coordinated by CM. Each Contractor is responsible to verify that all field offices, trailers and storage sheds shall be in accordance with the local Fire Marshal having jurisdiction. Each Contractor shall arrange and pay for its own telephone hookup and use. Each Contractor shall arrange and pay for its own temporary electrical hook-up, water and toilets. The Contractor shall pay for all power used for the Contractor's temporary field office and temporary electrical service. Construction personnel will be allowed to use the existing Owner parking facilities. Designated Contractors will be allowed to have on-site construction trailers. Construction trailers shall be limited to 10' x 30' or smaller.
- 2.04.2 Contractors shall maintain the use of designated space for offices and sheds. This includes removal of weeds, debris, trash and clean-up of the area after removal of such temporary structures.
- 2.04.3 Temporary field offices and sheds shall not be used for living quarters.
- 2.04.4 Offices and sheds shall be of suitable design, maintenance and appearance, and meet the approval of CM and all applicable local codes and ordinances.
- 2.04.5 All temporary offices and sheds including foundations, must be removed within ten (10) days of written notice from CM including restoration of grade. Structures not removed in a timely manner will be removed by CM at Contractor's expense.
- 2.04.6 If a temporary office is built in the building, it must be fire treated in accordance with Section 01510, Fire Precautions and Protection.

#### 2.05 TEMPORARY FENCING

- 2.05.1 The DESIGNATED CONTRACTOR shall provide temporary fencing with gates for required access and remove same at the completion of the Project.
- 2.05.2 The Contractors shall repair or replace fencing damaged as a result of its operation. Contractors shall remove and replace fencing and gates required to provide access for oversized items.
- 2.05.3 Contractor's personnel are not allowed to work outside of the construction fence without permission of CM.

#### 2.06 TEMPORARY TOILET FACILITIES

- 2.06.1 The CM shall provide and maintain temporary toilet facilities for the construction of the Project. The use of the Owner's existing permanent facilities is as described in Section 01140 Use of Premises.
- 2.06.2 During renovation activities, CM may obtain, through the Owner, permission to use designated toilet facilities within the contract boundaries for construction use. The use of the Owner's existing permanent facilities outside the construction boundaries is strictly not allowed.

#### 2.07 DRINKING WATER/TEMPORARY WATER

- 2.07.1 The Owner will pay for water used on this. Each Contractor shall be responsible to provide containers, paper cups, ice, hoses, etc. for its needs.
- 2.07.2 Immediately after award of the Agreement, the Mechanical Contractor shall furnish, install, maintain and subsequently remove a temporary hookup to the Owner's potable water system where directed by CM for construction purposes. The Contractor shall provide all temporary piping and approved backflow prevention as necessary for distribution from the source. Distribution of temporary water will be paid for by Contractors requiring same. A minimum of two (2) hose bibs shall be provided by the Mechanical Contractor as directed by CM.

## 2.08 ROOF PROTECTION

- 2.08.1 Contractors and their Subordinate Parties, shall be responsible for damages to roofing, sheet metal and roof structure while performing Work. The Roofing Contractor will perform the repair Work at the expense of the Contractor responsible for the damage.
- 2.08.2 All Contractors will protect adjacent existing roof surfaces while performing their Work. No construction materials will be allowed to be placed on existing roof surfaces without prior approval of the Owner through CM.

## 2.09 SCAFFOLDING

- 2.09.1 Each Contractor is responsible for providing and maintaining any and all ladders, scaffolds and other staging as required to complete its Work. All such ladders, scaffolds and staging equipment shall be erected, maintained and subsequently removed by each Contractor in accordance with all applicable safety laws, rules and regulations.

## 2.10 WATER CONTROL

- 2.10.1 All pumping, bailing or well point equipment necessary to keep excavations and trenches free from the accumulation of water during the entire excavating and backfilling progress of the Work shall be the responsibility of the Contractor performing said excavations and trenches due to its scope of Work.
- 2.10.2 Each Contractor shall be responsible for keeping the building at grade and below free from water from the time the building backfill is completed until the building is watertight.
- 2.10.3 Dispose of water in such a manner as will not endanger public health or cause damage or expense to public or private property. Abide by the requirements of any public agencies having jurisdiction.

## 2.11 TEMPORARY MATERIAL HOIST/ELEVATOR

Each Contractor is responsible for its own hoisting and material/ equipment movement costs as required to complete the Work under its Agreement.

- 2.11.1 CM may operate and maintain a permanent elevator until such time as all material hoisting requirements have been met. Elevator requirements in excess of the capacity or size of this elevator shall be provided by each Contractor at its expense. This elevator shall not be used for the placement of concrete, the transporting of workers, or other means inconsistent with its use as directed by CM. The operating cost for all overtime use of the elevator shall be paid by the Contractor requiring such services.
- 2.11.2 The Elevator Contractor shall be obligated to extend warranty and guarantee periods on any permanent equipment used prior to Substantial Completion.
- 2.11.3 Transportation of construction materials through the Owner's facility shall be accomplished in accordance with the requirements described in Section 01140 Use of Premises in such a manner so as to:
  - 2.11.3.1 Not damage any of the existing facility.
  - 2.11.3.2 Not impair the Owner's use of the facility.

2.11.3.3 Not create any type of mess or additional cleaning requirements in Owner occupied areas.

2.11.4 The Owner's lifting equipment is not available for the unloading, conveying or installation of Contractor's materials.

### 3 FIRE PRECAUTIONS AND PROTECTION

#### 3.01 All Contractors and their Subordinate Parties shall

3.01.1 Assume full responsibility and take all necessary precautions to guard against and eliminate all possible fire hazards and to prevent damage to any construction work, building materials, equipment, temporary field offices, storage sheds, and all other property, both public and private.

3.01.2 Conspicuously post the location of the nearest fire alarm pull box and the telephone number of the local fire department within the field offices and on the construction site adjacent to its Work

3.01.3 Take precautions to prevent fire hazards in accordance with all fire protection and prevention laws and codes. No open fires shall be permitted.

3.01.4 Shall not be permitted to perform welding, flame cutting, or other operations involving the use of flame, arcs, or sparking devices without submitting a Hot Work Permit to CM a minimum of 24 hours prior or without adequate protection and shielding. Hot Work Permits can be obtained through CM. All combustible and flammable material shall be removed from the immediate area of the hot work. Material shall be protected with a fire resistant tarpaulin to prevent sparks, flames, or hot metal from reaching materials.

3.01.4.1 Only fire resistant tarpaulins shall be used on this Project.

3.01.5 Provide the necessary personnel and fire fighting equipment to effectively control incipient fires resulting from the hot work.

3.01.6 Provide its own fire extinguishers in the immediate area of the Work.

3.01.7 Review the entire Project at least once a week to make certain it has adhered to the conditions and requirements set forth herein.

3.01.8 Shall not bring into building at any one time more than a one day supply of flammable liquids such as oil, gasoline, paint or paint solvent

3.01.8.1 All flammable liquids having a flash point of 110 degrees F or below, which must be brought into any building, shall be confined to Underwriter's Laboratories' labeled safety cans.

3.01.8.2 The bulk supply of all flammable liquids shall be detached at least 75 feet from the building and from yard storage of building materials.

3.01.8.3 Spigots on drums containing flammable liquids are prohibited on the project site. Drums are to be equipped with approved vent pumps.

3.01.9 Not store or leave overnight within the confines of the permanent building any combustible materials.

3.01.9.1 This includes all internal combustion engines using gas or fuel oil.

3.01.9.2 Hoisting of flammable or combustible materials to the roof shall only be in quantities as needed for immediate use

3.01.10 Agree that, in the event of fire, all its workers anywhere on site will assist in extinguishing the fire

3.01.11 Coordinate with the Owner and CM the permanent fire protection water supply, fire extinguishing equipment, shut down and tie-ins between new and existing fire protection systems shall be installed at the earliest possible date.

- 3.01.11.1 As each sprinkler system is completed and placed in service, the control valve shall be sealed. Permission to break seals and close sprinkler valves shall be given only by CM with approval of the Owner.
  - 3.01.12 Not place shanties of combustible construction inside of any structure.
    - 3.01.12.1 Such shanties shall be detached at least seventy-five (75) feet from the building or as directed by CM with approval of the Owner.
    - 3.01.12.2 Totally incombustible shanties may be, if approved in writing by CM, located inside of the structure
    - 3.01.12.3 Use of only Underwriter's Laboratory approved heaters and/or stoves is permitted in field offices or storage sheds and they shall have fire resistive material underneath and at the sides near partitions and walls. Pipe sleeves and covering shall be used where stove pipe runs through walls or roof
- 3.02 FIRE EXTINGUISHERS
  - 3.02.1 Fire extinguishers shall be "all purpose", and not a water type, to meet the approval of the Fire Underwriter's Laboratory, and will be inspected at regular intervals and recharged if necessary.
  - 3.02.2 In areas of flammable liquids, asphalt or electrical hazards, extinguishers of the 15 lb. carbon dioxide type or 20 lb. dry chemical type shall be provided
  - 3.02.3 **CM** will provide and maintain in working order at all times during construction not less than a fire extinguisher for each 3000 sq feet with travel distance not to exceed 100 feet.
  - 3.02.4 All other required extinguishers shall be provided by the Contractor creating such hazard
- 3.03 NOXIOUS ODORS AND FUMES
  - 3.03.1 Combustion engine equipment, tar kettles and any other items causing noxious odors or fumes, including diesel powered equipment, will NOT be allowed in the building or near air intake louvers or building entrances and exits. If intake louver locations are in doubt, consult with CM.
- 4 TEMPORARY STAIRS, LADDERS, RAMPS, RUNWAYS, AND BARRICADES
  - 4.01 Each Contractor is to provide and maintain all necessary temporary stairs, ladders, ramps, and runways to facilitate conveyance of workers, materials, tools, and equipment for proper execution of its Work. All protection and safety barricades, devices, covers, and all other necessary items shall be provided by each Contractor as it relates to the safe conduct of its Work and protection of people and property in its Work area in accordance with applicable law.
  - 4.02 Any Contractor or Subordinate Party performing excavation Work shall be responsible to furnish, install and maintain temporary barricades and/or fencing of all open excavations until such time as the backfilling is complete. Flasher lights shall be provided on barricades and fencing by the Contractor as requested by CM and in accordance with applicable law. As a minimum, all barricades across roads and walks shall have lights on them in working condition.
  - 4.03 Prior to the removal of all shoring and forms, the DESIGNATED CONTRACTOR shall be responsible for temporary protection at the building floor perimeters and openings. Immediately after the removal of all shoring and forms, the DESIGNATED CONTRACTOR shall furnish, install, and maintain all necessary temporary protections at the building floor perimeters and openings. Protection shall be OSHA 29 CFR Part 1926.502 (B) "Guardrail Systems" and shall include but not be limited to two line rails and toe boards. Each Contractor that disturbs any temporary protection for its Work is responsible to reinstall to its original condition the guardrail or barricade system for the protection of the workers and others until final construction of perimeter exterior wall and/or shaft openings is completed. All other protection and safety barricades, devices, covers, etc., including those at all roof areas, shall be provided by the DESIGNATED CONTRACTOR] Contractor as it relates to the safe conduct of its Work in accordance with all local, state and federal law, rules and regulations and the requirements of the Contract Documents and shall be in accordance with the most stringent requirements.

- 4.04 The DESIGNATED CONTRACTOR shall provide temporary guardrails at the building floor perimeters, interior shafts, all roof areas, or other openings, immediately after the erection of the steel or precast frame and with the installation of metal or decking. Protection shall be OSHA 29 CFR Part 1926.502 (B) "Guardrail Systems" and shall include but not be limited to two line rails and toe boards. This temporary protector shall be left in place after completion of the steel or precast frame for the use of all other Contractors. The DESIGNATED CONTRACTOR shall maintain and remove said guardrails and patch concrete. Each Contractor that disturbs any temporary protection for its Work is responsible to protect the area during its Work and to reinstall to its original condition the guardrail or barricade system for the protection of the workers and others until final construction of perimeter exterior wall and/or shaft openings is completed. All other protection and safety barricades, devices, covers, etc. shall be provided by this Contractor as it relates to the safe conduct of its Work in accordance with all local, state and federal regulations and the requirements of the Contract Documents, and shall be in accordance with the most stringent requirements.
- 4.4. Each Contractor and its Subordinate Parties shall provide and maintain in good repair barricades, overhead protection, guard rails, etc., as required by law or necessary for the protection of the public and personnel engaged in the Work from hazards incidental to performance of the Work. Contractor shall do everything necessary to protect the Owner's employees, the public and workers from injuries and to protect vehicles and other property from damage.

## 5. TEMPORARY ELECTRICAL POWER AND LIGHT

### 5.1. Electrical Energy Costs

- 5.1.1. The Owner will pay for electrical energy to operate temporary electrical power and lighting for the duration of the project at designated locations. Temporary power will be provided free of charge.

### 5.2. Power Source

- 5.2.1. The Electrical Contractor shall provide, install, and pay for labor, equipment and materials required to make connections to the Owner's power source and to provide temporary electrical power and light distribution. The Electrical Contractor shall coordinate the location of the electrical power and lighting as directed by CM.
- 5.2.2. The Electrical Contractor will provide for the CM's construction trailer a 120/208 volt (or 120/240 volt), 100 ampere single phase power source. The cost of hook up and removal of temporary electrical service to other contractor's trailer shall be each Contractor's responsibility.
- 5.2.3. Protection shall be provided for the power supply source complete with disconnect switch and other required electrical devices.

### 5.3. Rules and Regulations:

- 5.3.1. All temporary equipment and wiring for power, lighting and distribution requirements shall conform to OSHA/NFPA requirements and be in accordance with applicable provisions of governing laws, codes, and ordinances.
- 5.3.2. All temporary wiring and distribution equipment shall be maintained so as not to constitute a hazard to persons or property.

### 5.4. Temporary Power Distribution:

- 5.4.1. The Electrical Contractor will provide and maintain temporary power distribution as follows:  
Construction power shall be 120/208 volts, 3 phase, 4 wire plus ground. Provide the following outlets together with feeders, grounding, protective devices and ground fault interrupting devices.
- 5.4.1.1. Power centers - on each floor of the new building, provide a minimum of two (2) power centers or not less than one (1) per 10,000 s.f. rated not less than 100 amperes at 120/208 volt, 3 phase. 4 wire plus ground. Within the Upgrades areas, provide at least one (1) additional similarly rated power center. Locate the power centers such that each will serve approximately equal areas and as far as possible, each be in the center of the respective area served.

- 5.4.1.2. 120 volt duplex outlets - Provide weatherproof, G.F.I. protected, 20 ampere grounded outlets at a minimum rate equal to 1 - duplex outlet per 400 square feet. Outlets may be grouped in clusters of up to six duplex types with corresponding pro-rated increase in area served, provided that every portion of the construction and Upgraded premises can be reached from the nearest outlet using a flexible cord no more than 50 feet in length.
- 5.4.2. As partitions are erected, locations of power distribution points shall be added or relocated.
- 5.4.3. Ground Fault Circuit Interrupter (GFCI) protection will be provided on all temporary power receptacles and, where possible, directly on the circuit breaker supplying temporary power as referenced in NEC 305-6(a).
- 5.4.4. The assured equipment grounding conductor program is only to be used on circuits greater than 20 amps as referenced in NEC 305-6(b).
- 5.5. Temporary Electrical Light Distribution:
  - 5.5.1. The Electrical Contractor shall provide and maintain temporary electrical light distribution as follows:
    - 5.5.1.1. Lighting shall be achieved using 120 volt guarded incandescent fixtures, or other suitable fixture types, to Federal or State OSHA required minimum levels of illumination.
    - 5.5.1.2. 120 volt temporary lighting as required in interior work areas. In addition to these minimum requirements provide adequate security lighting at guarded entrances outside storage areas, parking areas, and in areas of Contractor's and Architect's field offices and sheds.
  - 5.5.2. As partitions are erected or other interferences which hamper achieving the minimum levels of illumination, locations of lighting distribution points shall be added or relocated.
  - 5.5.3. Task lighting in addition to OSHA required lighting shall be provided by each Contractor.
- 5.6. Temporary Power and Light for Special Conditions:
  - 5.6.1. Special conditions for temporary electrical power and lighting required by others shall be provided as follows:
    - 5.6.1.1. Each Contractor requiring service of capacity or characteristics other than specified must make arrangements with the Electrical Contractor and pay for their own installation, removal, and service.
    - 5.6.1.2. Where 3 phase power is required, the Contractor must pick up service at the distribution panel located outside the building addition.
    - 5.6.1.3. The necessary grounded portable cords, lamps, light-stands, and fuses from the distribution outlets to points of use shall be provided by each Contractor to suit its own requirements.
    - 5.6.1.4. Temporary power cannot be used for welding operations.
- 5.7. Servicing of Temporary Power and Lighting:
  - 5.7.1. The Electrical Contractor shall be responsible for the following:
    - 5.7.1.1. Servicing, repairing and rearrangement of service equipment, temporary power, temporary lighting, and re-lamping.
    - 5.7.1.2. Removal and disposal of temporary electrical power and lighting at completion of the Project or when so directed by CM and repair of damage caused by installation or removal.
- 5.8. Permanent Electrical Power and Lighting:

- 5.8.1. When permanent electrical power and lighting systems are in operating condition, they may be used for temporary power and lighting for construction purposes provided the Electrical Contractor:
  - 5.8.1.1. Obtains the approval of the Architect and/or Owner through CM.
  - 5.8.1.2. Assumes full responsibility for operation of the entire power and lighting systems.
  - 5.8.1.3. Verifies that warranty dates are established prior to usage of equipment and lamps.
  - 5.8.1.4. Pays costs for operation, maintenance, and restoration of the systems.
- 5.8.2. As permanent power and lighting becomes available, these systems will generally supplant the appropriate portions of the temporary installation.

## 6. TEMPORARY HEATING AND WEATHER PROTECTION

- 6.1. Temporary heating requirements during the course of construction shall be divided into two categories as follows:
  - 6.1.1. Cold weather protection.
  - 6.1.2. Temporary heating.
- 6.2. Cold Weather Protection:
  - 6.2.1. Heating required during the construction period prior to enclosure of the building shall be classified as "cold weather protection."
  - 6.2.2. Each Contractor shall provide temporary heating and protection, necessary to allow its Work to continue during cold weather to meet the project milestone dates prior to building enclosure, including:
    - 6.2.2.1. The heating of materials (such as water and aggregate) as well as space heating for protection of newly placed or built construction at required temperatures (but not lower than 50 degrees F) and for the time specified.
    - 6.2.2.2. Fire retardant tarpaulins and other materials used for temporary enclosures.
  - 6.2.3. Each Contractor shall provide plan to allow Work to continue without regard to temperature.
  - 6.2.4. Heat shall be provided by smokeless UL approved portable unit heaters, using fuel of types and kinds approved by Underwriter's Laboratories, Factory Mutual, and the Fire Marshal.
    - 6.2.4.1. The Contractor shall provide fuel, power, maintenance, and attendance required for operation of portable heaters.
    - 6.2.4.2. Interior or exterior surfaces damaged by the use of portable heating units shall be replaced with new materials at the responsible Contractor's expense.
  - 6.2.5. It shall be the responsibility of each Contractor to protect its own Work.
- 6.3. Temporary Heating:
  - 6.3.1. Daily construction heat required after the building is enclosed shall be classified as "temporary heating" and will be the responsibility of the Mechanical Contractor to install and maintain.
  - 6.3.2. The building or buildings or any portions thereof shall be considered enclosed when in the opinion of CM:
    - 6.3.2.1. The exterior wall system and temporary interior wall enclosures are in place.
    - 6.3.2.2. Openings in exterior walls are covered to provide reasonable heat retention.
    - 6.3.2.3. The building is ready for interior drywall, masonry and plastering operations.
    - 6.3.2.4. The permanent roof is substantially installed.



The CM shall provide and maintain the temporary interior wall enclosures. If the exterior wall system is not complete in time to provide building enclosure of a portion of the new structure as scheduled, the CM shall provide and maintain temporary exterior wall enclosures of polyethylene and, in addition to exercising all other rights and remedies under the Contract Documents and law, CM shall be entitled to deduct the cost of such enclosures from the moneys due or to become due the Contractor(s) responsible for failure to meet said schedule.

- 6.3.3. In areas of the building or buildings where Work is being conducted, the temperature shall be maintained as specified in the various sections of the specifications, but not less than 50 degrees F for interior rough-in and not less than 60 degrees F during finishes installation. The temperature shall not be allowed to reach a level that will cause damage to any portion of the Work, including materials stored in the building, which may be subject to damage by low temperatures.
- 6.3.4. Until the permanent heating system, or suitable portion thereof, is in operating condition, provide sufficient and UL approved space heaters of suitable capacity to maintain required temperatures in areas where work is being conducted and materials are stored. Include all necessary maintenance, venting and attendance for this temporary heating to meet all applicable laws, rules and regulations.
- 6.3.5. When the permanent heating system, or a suitable portion thereof, is in operating condition, the system may be used for temporary heating, provided the Electrical Contractor:
  - 6.3.5.1. Obtains approval from CM in writing for its use and any special provisions required for its temporary operation.
  - 6.3.5.2. Assumes full responsibility for the entire heating system until final acceptance of the system by the Owner.
  - 6.3.5.3. Uses supply only, not return if temporary heating utilizes the building's ductwork system.
  - 6.3.5.4. Pays all costs for maintenance, attendance and restoration to "like new" condition of the system including final cleaning of equipment and ductwork and all necessary touch-up painting.
  - 6.3.5.5. Turns over satisfactory evidence to CM showing the extended warranties from manufacturers and proper maintenance procedures.
  - 6.3.5.6. Provides and maintains temporary filters, boxes and other parts used for the temporary condition and replaces same with the new permanent filters at time of occupancy consistent with the warranty provisions. The Electrical Contractor shall pay the cost of extending warranty and guarantee periods on any permanent equipment used prior to substantial completion.
- 6.3.6. Electrical power required for temporary heating will be furnished free of charge. The installation and service of the necessary temporary electrical feeders will also be the responsibility of the Electrical Contractor.

#### 6.4. TEMPORARY ENCLOSURES

- 6.4.1. The Carpentry Contractor (or as specified in the Work Scopes) shall provide temporary (insulated) weather-tight closures of openings in exterior surfaces to provide acceptable working conditions and protection for materials, to allow for temporary heating, and to prevent entry of unauthorized persons. Provide doors with self-closing hardware and locks.
- 6.4.2. The Roofing Contractor (or as specified in the Work Scopes) shall provide temporary roofing as required to provide and maintain a watertight enclosure during construction.
- 6.4.3. The Drywall Contractor (or as specified in the Work Scopes) shall provide temporary partitions and ceilings as required to separate Work areas from Owner occupied areas, to prevent penetration of dust and moisture into Owner occupied areas and to prevent damage to Owner's facilities and equipment.

END OF SECTION 01520

**SECTION 01530**  
**FIELD ENGINEERING AND LAYOUT**

**1 LAYOUT OF THE WORK;** Each Contractor shall

- 1.1. be responsible for the layout and engineering of its own Work from the established points and lines given by a registered surveyor employed by CM and to coordinate with all other trades.
- 1.2. be responsible for detailed and accurate layout of its own and its Subordinate Parties' Work to dimension from the principal lines.
- 1.3. make provisions to preserve all control points, such as monuments, stakes, bench marks or other datum points and shall replace at its own cost any of these which might be lost or displaced through its neglect.
- 1.4. examine the conditions under which the Work is to be installed, shall take field measurements and verify field conditions and shall carefully compare such field measurements and conditions and other information known to the Contractor with the Contract Documents before commencing activities. Any errors, inconsistencies, omissions, discrepancies or conditions detrimental to proper performance of the Work that are discovered shall be reported to CM at once. Contractors are not to proceed until the required corrections are accomplished.

**2. Verification and Documentation**

- 2.1. The exactness of grades, elevations, dimensions, or locations given on any Drawings issued by Architect or the work installed by other contractors, is not guaranteed by Owner or CM.
- 2.2. In all cases of interconnection of its Work with existing or other Work, it shall verify all dimensions relating to such existing or other Work. Any errors due to the Contractor's failure to verify all such grades, elevations, dimensions, or locations shall be promptly rectified by the Contractor without any additional cost to the Owner or CM..
- 2.3. As the Work progresses, the Contractor shall prepare lay out drawings showing the exact locations of Work under its Contract as a guide to all trades. Prior to any installation, the separate Contractors shall exchange layout drawings and coordinate the Work and be subject to verification by all subsequent Contractors.
- 2.4. Each Contractor shall be responsible to take such field measurements as may be required to determine the size of ordered material. In the event "guaranteed dimensions" are required, the Contractor shall promptly advise other Contractors through CM by use of drawings, templates or mock-ups of the required conditions.
- 2.5. All Work, and in particular, piping, ducts, conduit and similar items, shall be neatly and carefully laid out to provide the most useful space utilization and the most orderly appearance. Except as otherwise indicated or directed, piping and similar Work shall be installed as close to above ceiling floor slabs and walls as conditions reasonably permit, located to prevent interference with other Work or with the use of the spaces. Before Contractor installs a valve in an exposed location, it must make all efforts to install it in an accessible, concealed location. Contractors shall carefully plan the layout and review any questionable installations with CM.
- 2.6. The Owner or CM may utilize a registered land surveyor to verify alignment and layout of certain portions of the Work. If that Work is out of tolerance or incorrect, the installing Contractor will be responsible for prompt correction of the Work to comply with the Contract Documents, along with all expenses incurred by Owner or CM in such verification process, including, but not limited to, the cost for the surveying services, as well as the additional time expended by CM personnel at standard billing rates.

END OF SECTION 01530

## **SECTION 01540 CUTTING AND PATCHING**

### **1 INSPECTION**

- 1.01 Before cutting , examine surfaces to be cut, including elements subject to damage or movement during cutting and patching work. Report any unsatisfactory or questionable conditions to CM in writing.
- 1.02 Before proceeding, meet at the site with CM and the parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference, conflict and possible effects on the Owner's existing operations. Coordinate procedures, temporary support, methods of dust and water protection, etc. and resolve potential conflicts before proceeding.
- 1.03 When working in and around existing buildings, if any hazardous material is encountered or is suspected to be present, immediately notify CM and stop work in this area as described in Section 00840 Hazardous Materials until further direction is given by CM or the Owner.

### **2 PREPARATION**

- 2.01 Provide adequate temporary support to assure the structural value and integrity of the affected portion of the work. Where specified or required, submit temporary support methodologies for approval.
- 2.02 Provide devices and methods to protect adjacent areas or other portions of the Project from damage including dust protection, water protection, and exposure.
- 2.03 Maintain excavations free of water.

### **3 EXECUTION**

- 3.01 The use of gasoline powered equipment, jackhammers or power actuated tools, explosives is prohibited on this Project.
- 3.02 Each Contractor shall:
  - 3.02.1 On behalf of itself and its Subordinate Parties be responsible for the cutting of all holes and openings through existing walls, partitions, ceilings, floors and roofs as necessary for the installation of its Work. Holes and openings shall be neatly cut and of minimum size to allow the Work to be installed. Execute cutting and demolition by methods which will prevent damage to other Work, and will provide proper surfaces to receive installation of repairs.
  - 3.02.2 Execute work in such a manner as to minimize disruptions to or interference with the Owner's normal operations or functioning in the existing buildings and provide all means necessary to provide safety and convenience of those employed in and about the premises.
  - 3.02.3 Be responsible for patching of all holes and openings it makes. Fit work should be airtight to pipes, sleeves, ducts, conduit and other penetrations through surfaces. Patching is to match adjacent surfaces in materials and finish.
  - 3.02.4 Utilize only tradesmen skilled in the specific finish and material involved in making the patches. All patching is to be done in a neat and workmanlike manner to the satisfaction of CM. Defective Work shall be corrected at no cost to the Owner and CM.
  - 3.02.5 Do all necessary cutting and fitting required to make a satisfactory connection where new Work connects with existing so as to leave the entire Work in finished and workmanlike condition. Furnish all labor and materials to this end, whether or not shown or specified. All measurements must be verified at the site.
  - 3.02.6 Employ the original installer and fabricator, when possible, to perform cutting and patching for, weather-exposed or moisture-resistant elements, sight-exposed finished surfaces.
  - 3.02.7 Execute fitting and adjustment or products to provide a finished installation to comply with the specified products, functions, tolerances and finishes.

- 3.02.8 Restore Work which has been cut or removed and shall install new products to provide completed Work in accordance with the Contract Documents. Each Contractor will be responsible to pay the appropriate contractor as designated by CM for restoring any portion of the Project that is disturbed, including but not limited to, slabs, walls, ceilings, fire rated partitions, spray-on fireproofing, and finishes, to their original state as a result of Contractor's action.
- 3.02.9 Refinish entire surfaces as the Contractor's Work scope requires to provide an even finish to match adjacent surfaces and finishes, for continuous surfaces, refinish to nearest intersection, for an assembly, refinish the entire unit.
- 3.02.10 Be held responsible for reckless cutting of holes in slabs, walls or other finishes, or for scraping off areas of fireproofing larger or greater than that which is necessary for installation of its Work.
- 3.03 Removal and replacement of ceilings not scheduled to be replaced shall be the responsibility of the Contractor requiring access.

END OF SECTION 01540

## **SECTION 01550 CLEAN-UP AND FINAL CLEANING**

### **A. SUMMARY**

Execute final cleaning at completion of the Work, as required by this Section. For Contractor's daily clean-up, dust control and rubbish removal operations during construction, refer to Section 01520 Temporary Construction Controls.

#### **a. DISPOSAL REQUIREMENTS**

- i. Conduct final cleaning and disposal operations to comply with codes, ordinances, regulations, and anti-pollution laws.
  - 1. Do not burn or bury rubbish and waste materials on Project site.
  - 2. Do not dispose of volatile wastes such as mineral spirits, oil or paint thinner in storm or sanitary drains.

### **2 PART 2 - SITE CLEAN-UP/RUBBISH REMOVAL PROCEDURE**

#### **2.1. REQUIREMENTS**

##### **2.1.1. General. Contractor shall:**

- 2.1.1.1. Be responsible for daily, weekly and final clean-up of its Work and the work of its Subordinate Parties as defined herein.
- 2.1.1.2. Comply with applicable labor agreements and jurisdictional rules in the hiring of laborers to perform its clean up obligations under the Contract Documents.
- 2.1.1.3. Control of dust generated by its operations on a daily basis.
- 2.1.1.4. Maintain roadways clear of all debris at all times.
- 2.1.1.5. Only use cleaning materials which will not create hazards to health or property and which will not damage surfaces. Only those cleaning materials and methods recommended by the manufacturer of the surface material to be cleaned shall be used.
- 2.1.1.6. Only use sweeping compounds that do not leave residue on concrete floor surfaces and that will not affect installation of finish flooring materials

##### **2.1.2. Dumpsters:**

- 2.1.2.1. Unless stated otherwise in the Work Scopes, the CM will provide and maintain the job site dumpsters for unidentifiable debris for use as specified below.
- 2.1.2.2. Each Contractor and its Subordinate Parties shall be responsible for daily clean-up, removal and placement in dumpsters of all debris and waste resulting from its operations.
- 2.1.2.3. No overfilling of dumpsters will be allowed. All adjacent areas are to be kept clean. Excavation, demolition, masonry, drywall and hazardous waste materials are NOT to be placed in CM's dumpster.
- 2.1.2.4. Each Contractor will be responsible for removing its own excavation, demolition, masonry, drywall and Hazardous Materials from the site in strict accordance with applicable laws and regulations regarding disposal.
- 2.1.2.5. Contractor shall indemnify, defend and hold harmless the Owner and CM from claims, damages, suits, costs, or expenses of any kind (including attorney's fees and costs) arising out of, resulting from or in connection with Contractor's misuse of dumpsters.

##### **2.1.3. Daily Clean Up, Each Contractor shall:**

- 2.1.3.1. Be responsible, DAILY for the clean -up, transport and removal from the site of identifiable debris including but not limited to, bulky debris, packaging, containers, unused materials and equipment, (i.e., masonry and concrete materials, drywall, steel, crates, carton, demolition debris, other packaging, and combustible items).
- 2.1.3.2. Leave no piles of debris in the building overnight. The cost of any overtime premium required to remove debris immediately at the end of each workday shall be included in the Contractor's Work.
- 2.1.3.3. handle materials in a controlled manner so that dust and other contaminants, do not affect the Owner's or other Contractor operations and equipment
- 2.1.3.4. Be responsible to leave its Work and work area in a clean condition. This includes, but is not limited to, removal of all grease, dust, dirt, stains, labels, fingerprints and other foreign matter.
- 2.1.4. Weekly Clean Up: Each Contractor shall:
  - 2.1.4.1. While on site, provide to CM one (1) person for each five tradesmen (or portion thereof) employed at the site, one day per week, for up to four (4) hours, for the exclusive purpose of performing overall project weekly clean-up of unidentifiable debris. The cost of this (these) person(s) shall be included in Contractor's Work.
  - 2.1.4.2. Include sweeping, loading and disposal of miscellaneous debris such as mud tracked through the building, drinking cups, bottles, lunch wrappers and other unidentifiable debris. Trash and debris from this operation shall be placed in the dumpster(s)
- 2.1.5. Final Clean Up:
  - 2.1.5.1. Final clean-up, will be done at a time designated by CM.
  - 2.1.5.2. Normally, Final Clean Up will occur before punchlist inspection or prior Owner Occupancy turnover.
  - 2.1.5.3. The Contractor's duties for Final Cleaning are:
    - 2.1.5.3.1. Prior to final completion or Owner occupancy, whichever occurs first, conduct an inspection of sight-exposed interior and exterior surfaces, and all Work areas, to verify that the entire Work is left in a broom clean condition and that all Final Cleaning as set forth above has been performed.
    - 2.1.5.3.2. Tunnels and closed off spaces shall be cleaned of packing boxes, wood frame members and other waste materials used in the construction.
    - 2.1.5.3.3. Temporary labels, stickers and similar items shall be removed from fixtures and equipment. Unless otherwise directed in the technical specifications, Contractors shall not remove permanent name plates, equipment model numbers, ratings, or other items intended to be permanently affixed to the fixture or equipment.
- 2.1.6. Use of Owner's Facilities: The Owner's facilities are not to be used by Contractor for the disposal of trash or debris from its Work.
- 2.1.7. Failure to perform Clean Up:
  - 2.1.7.1. If any Contractor or its Subordinate Parties fails to maintain a satisfactory clean-up program, CM will issue written notice, to the responsible Contractor, that the necessary clean-up must be performed within twenty-four (24) hours after the notice is given. The establishment of a definite deadline for the removal of debris and rubbish will supersede the necessity for any formal notification that such work must be done.

- 2.1.7.2. If Contractor(s) fail to perform the clean-up, by the deadline, CM may perform clean-up on the Project and back charge the responsible Contractor(s) for the costs. If necessary in order to remove unidentifiable debris beyond what is removed during weekly clean up, CM will perform such clean-up and shall pro-rate the cost among the Contractors in its discretion, based on Contractor(s) type of work and manpower on site. Back charges may be deducted from the monthly invoices of the Contractor(s) and/or final payment.
- 2.1.8. Hazardous Materials: Contractors or Subordinate Parties shall dispose of Hazardous Materials in strict accordance with applicable federal, state, and local laws and regulations. Hazardous Materials may not be placed in dumpsters and/or containers not so designated for such placement.

END OF SECTION 01550



## SECTION 01600 FORMS

### 1 USE OF FORMS

- 1.01 Upon award of the Agreement, the various forms described and referenced in the Project Manual will be provided by CM and therefore are not bound in the Project Manual. Copies of forms are available for inspection at CM Office.
- 1.02 Following is a list of the key forms:
- 00810 Safety and Loss Control Program
    - Trade Contractor Safety Certificate (SAF 6.3.3.3)
  - 01250 Changes in the Work
    - PCO- Notice to Proceed
    - PCO- Quotation Only
    - Change Order Form (CMS.9.1 or CMS.9.2)
  - 01290 Payment Procedures
    - Application and Certificate for Payment (CON.27.1) and Continuation Sheet (CON.27.2)
    - Consent of Surety to Reduction In or Partial Release of Retainage (CON.26.6)
    - Payment schedule (PSI.10.1)
    - Payment Request for Stored Materials Form (CON.26.5)
    - Acknowledgment of Payment and Partial Unconditional Release Form (CON.26.3)
    - Unconditional Final Release and Waiver Subcontractor/Materialman Form (CON.26.4)
    - Sworn Statement Form (CON.26.2)
  - 01320 Communications
    - Trade Contractors Daily/Pre-Task Plan (CON.14.4)
    - Request for Information Form (CON.25.2) (in company approved software, if necessary)
  - 01330 Submittals
    - BMC Submittal Transmittal Form (CON.9.6)
  - 01400 Quality Requirements
    - Corrective Action Report (CAR)/Notice of Non-Conformance (NCR) (CON.18.2)
  - 01700 Contract Close-out
    - Consent of Surety Company to Final Payment Form (CON.26. 7)
    - Consent of Surety to Reduction in or Partial Release of Retainage Form (CON.26.6)
    - Certificate of Contract Completion Form (CLO.7.5)
  - 01720 Project Record Documents
    - Closeout Submittal (CLO.7.2)
  - 01740 Warranties and Guarantees
    - Contractor's Guarantee (CLO.7.3)
  - 01750 Systems Demonstration, Training and Start-up

- Equipment/Systems Acceptance Form (CLO.2.1)
- Owner Training Register (CLO.2.2)

END OF SECTION 01600

**SECTION 01630  
PRODUCT SUBSTITUTIONS**

**1. WORK INCLUDED**

- 1.1. Furnish and install Products specified, under options and conditions for substitutions stated in this Section.

**2. BIDDER'S OPTIONS**

- 2.1. For products that are specified only by reference standard, select Product meeting that is standard by any manufacturer.
- 2.2. For Products specified by naming several Products or manufacturers, select any one of products and manufacturers named which complies with Specifications.
- 2.3. For Products specified by naming several Products or manufacturers and stating "or equivalent", or "or equal", or "or Architect approved equivalent", or similar wording, submit a request as for substitutions, for any Product or manufacturer which is not specifically named for review and approval by the Architect.
- 2.4. For Products specified by naming only one Product and manufacturer, there is no option and no substitution will be allowed.

**3. SUBSTITUTION PROCESS**

**3.1. SUBSTITUTIONS**

- 3.1.1. Base Bid shall be in accordance with the Contract Documents.
- 3.1.2. Substitutions for products may be made during the bidding period by submitting completed Substitution Request Form and substantiating product data/literature a minimum of ten (10) Days prior to Bid date to CM who will then forward to the Architect.
- 3.1.2.1. Architect will consider requests from the Bidder for substitution of products in place of those specified as set forth in this section.
- 3.1.2.2. Those submitted the specified calendar days prior to Bid Date will be included in an addendum if acceptable.
- 3.1.2.3. After the end of the bidding period, requests will be considered only in case of Product unavailability or other conditions beyond the control of Contractor.
- 3.1.2.4. Bid Proposals shall not be based on assumed acceptance of any item which has not been approved by addendum.
- 3.1.3. Bidders are required to submit a separate Substitution Request Form for each proposed substitution. Each substitution request should be accompanied by the following supporting documentation:
- 3.1.3.1. A full explanation of the proposed substitution.
- 3.1.3.2. Complete data substantiating compliance of the proposed substitution with the requirements stated in the Contract Documents.
- 3.1.3.2.1. Product identification, including the manufacturer's name and address.
- 3.1.3.2.2. Manufacturer's literature; identifying:
- 3.1.3.2.2.1. Product description and technical information.
- 3.1.3.2.2.2. Reference standards.
- 3.1.3.2.2.3. Performance and test data.
- 3.1.3.2.2.4. Installation instructions, operating procedures and other like information.
- 3.1.3.2.3. Samples, as applicable.

- 3.1.3.2.4. Names and addresses of similar projects on which product has been used, and date of each installation.
    - 3.1.3.3. Itemized comparison of the proposed substitution with the product specified, listing all significant variations.
    - 3.1.3.4. Data relating to changes in delivery or construction schedule.
    - 3.1.3.5. A list of all effects of the proposed substitution on separate contracts.
    - 3.1.3.6. Accurate cost data comparing the proposed substitution with the product specified.
      - 3.1.3.6.1. Amount of any net change to Contract Sum.
    - 3.1.3.7. Designation of required license fees or royalties.
    - 3.1.3.8. Designation of availability of maintenance services and sources of replacement materials.
  - 3.1.4. Substitutions will not be considered for acceptance when:
    - 3.1.4.1. They are indicated or implied on shop drawings or product data submittals without a formal request from Bidder.
    - 3.1.4.2. Acceptance will require substantial revision of Contract Documents.
    - 3.1.4.3. In judgment of Architect, do not include adequate information necessary for a complete evaluation.
    - 3.1.4.4. If requested after Contract Award directly by a subcontractor or supplier, except for special or unusual circumstances reviewed by the Contractor with CM.
  - 3.1.5. Substitute products shall not be ordered or installed without written acceptance of Architect.
  - 3.1.6. Architect will determine acceptability of proposed substitution.
- 3.2. BIDDER'S REPRESENTATION
- 3.2.1. In making formal request for substitution the Bidder represents that:
  - 3.2.2. It has investigated the proposed product and has determined it is equivalent to or superior in all respects to the product specified.
  - 3.2.3. It will provide same warranties or bonds for the proposed substitution as required for the product specified.
  - 3.2.4. It will coordinate installation of the accepted substitution into the Work, and will make such changes as may be required for the Work to be complete in all respects.
  - 3.2.5. It waives all claims for additional costs caused by or arising from the substitution which may subsequently become apparent.
  - 3.2.6. Cost data is complete and includes related costs under its Agreement, but not:
    - 3.2.6.1. Costs under separate contracts.
    - 3.2.6.2. Architect's costs for redesign or revision of Contract Documents.
  - 3.2.7. Cost data need not be submitted, if request is for inclusion in an addendum. Requests after the Agreement is awarded shall contain a complete cost comparison.
  - 3.2.8. Any modifications necessary as a result of the use of an approved substitute shall be paid by the Contractor proposing the substitution.
  - 3.2.9. Any additional engineering costs required to be performed by the Architect to approve, implement or coordinate the substitution above reasonable review services, shall be paid by the Contractor proposing the substitution.

- 3.2.10. Under no circumstances will the Architect be required to prove that a product proposed for substitution is or is not equal to the quality of the product specified.

### 3.3. ARCHITECT'S DUTIES

- 3.3.1. Review requests for substitutions with reasonable promptness.
- 3.3.2. Coordinate review/approval of "Architect Approved" substitutions with the Owner prior to notifying the CM.
- 3.3.3. Issue a written instruction of decision to accept the substitution.
- 3.3.4. Substitution requests that are not approved will be returned to the party submitting the request with an explanation for the rejection.

### 3.4. SUBSTITUTION REQUEST FORM

- 3.4.1. The form is attached to this Section.
- 3.4.2. SUBSTITUTIONS WILL BE CONSIDERED ONLY WHEN THE ATTACHED FORM IS COMPLETED AND INCLUDED WITH THE SUBMITTAL WITH ALL BACKUP DATA.

**SUBSTITUTION REQUEST FORM**

TO: Barton Malow Company

We hereby submit for your consideration the following product instead of the specified item for the above Project:

**DRAWING NO.:** \_\_\_\_\_ **DRAWING NAME:** \_\_\_\_\_

<b>SPEC. SECT.</b>	<b>SPEC. NAME</b>	<b>PARAGRAPH</b>	<b>SPECIFIED ITEM</b>
_____	_____	_____	_____

**Proposed Substitution:**

Attached complete information on changes to Drawings and/or Specifications which proposed substitution will require for its proper installation.

Submit with request all necessary samples and substantiating data to prove equal quality and performance to that which is specified. Clearly mark manufacturer's literature to indicate equality in performance.

**CERTIFICATION OF EQUAL PERFORMANCE AND ASSUMPTION OF LIABILITY FOR EQUAL PERFORMANCE**

The undersigned states that the function, appearance and quality are equivalent or superior to the specified item.

Submitted by:

\_\_\_\_\_  
Signature\_\_\_\_\_  
Title\_\_\_\_\_  
Firm\_\_\_\_\_  
Address\_\_\_\_\_  
Telephone\_\_\_\_\_  
Date

Signature shall be by person having authority to legally bind his/her firm to the above terms. Failure to provide legally binding signature will result in retraction of approval.

**For use by Architect**

☐ Accepted      ☐ Accepted as noted  
☐ Not accepted      ☐ Received too late  
☐ Insufficient data received

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

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

**For use by Owner**

☐ Accepted      ☐ Accepted as noted  
☐ Not accepted      ☐ Received too late  
☐ Insufficient data received

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

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

Fill in blanks below (attach additional sheets as required):

A. Does the Substitution affect dimensions shown on Drawings?

Yes \_\_\_\_\_ No \_\_\_\_\_ If yes, clearly indicate changes: \_\_\_\_\_

B. Will the undersigned pay for changes to the building design, including engineering and detailing costs caused by the requested substitution?

Yes \_\_\_\_\_ No \_\_\_\_\_ If no, fully explain: \_\_\_\_\_

C. What affect does substitution have on other contracts or other trades?

D. What affect does substitution have on the delivery and construction schedule? \_\_\_\_\_

E. Manufacturer's warranties of the proposed and specified items are: Same \_\_\_\_\_ Different \_\_\_\_\_

If different, explain on an attachment.

F. Reason for Request: \_\_\_\_\_

G. Itemized comparison of specified item(s) with the proposed substitution; list significant variations:

H. Accurate cost data comparing proposed substitution with product specified:

I. This substitution will amount to a credit or an extra cost to the Owner of:

\_\_\_\_\_ Dollars

(\$ \_\_\_\_\_)

END OF SECTION 01630

## **SECTION 01700 CONTRACT CLOSE-OUT**

### **1. CLOSE-OUT PROCEDURE**

- 1.1. The following procedure and forms will be used to sequentially progress through the contract close-out stage in a productive and timely manner.

#### **1.1.1. PREPARATION FOR CONTRACT CLOSE-OUT**

During the course of the Project, the Contractor will thoroughly review the Contract Documents as it relates to the requirements and obligations and gather and submit to CM the proper submittals, shop drawings, material certifications, waivers, certificates of insurance, bonds, and other contractual requirements impacting contract close-out.

#### **1.1.2. INITIATING THE FINAL CLOSE-OUT PROCESS**

When nearing 75% completion of the Work, the Contractor will review the status of the Close-Out process with CM. The Contractor's contractual responsibilities will be reviewed and outstanding close-out and other submittals identified.

#### **1.1.3. OBTAINING THE CERTIFICATE OF SUBSTANTIAL COMPLETION**

As the Contractor is nearing the completion of the Work and after concurrence with CM, it shall submit a written request for Substantial Completion, all required documentation as outlined, and a listing of all minor deficiencies yet to be completed.

The following documents are the minimum required at the time of request for Substantial Completion. Contractor shall also submit all additional documentation as required in the Contract Documents:

- 1.1.3.1. AIA G704 Certificate of Substantial Completion
- 1.1.3.2. As-built records
- 1.1.3.3. Operation and Maintenance Manuals
- 1.1.3.4. Keys, Maintenance Stock, and Spare Parts
- 1.1.3.5. Test and Start-up/Owner Training Sessions
- 1.1.3.6. Submission of Permits and Approvals (i.e. Fire Marshal, Department of Public Health Approvals, etc.)
- 1.1.3.7. Guarantee and Warranties
- 1.1.3.8. Punchlist (list of work to be completed or corrected)

Once CM has received all required documents they will be forwarded to the Architect and Owner. CM will review the Contractor's request for Substantial Completion; all above documentation, and list of deficiencies, add appropriate comments, and forward to the Architect and/or Owner for review. In conjunction with the Contractor, CM will establish a schedule for the completion of all listed items, which in no event shall exceed any time periods established in the Contract Documents for Final Completion.

When the Architect determine that the Work is substantially complete, the Certificate of Substantial Completion shall be issued to the Contractor.

#### **1.1.4. CONTRACTOR COMPLETES PUNCHLIST WORK**

Each Contractor shall submit a letter certifying all punchlist items are completed, in a manner acceptable to the Owner, CM and the Architect.

#### **1.1.5. FINAL INSPECTION NOTICE**



Each Contractor is to forward **(written notice and accompanying documentation)** to CM that Work is ready for final inspection and acceptance. CM will forward written notice to the Architect if CM is in agreement that Work is complete. The Architect will perform a final inspection and sign off on the punchlist form if Work is in fact completed. If punchlist work is not found complete, the Contractor shall take action to remedy any insufficiencies and then shall re-submit the written notice and accompanying documentation that Work is ready for **final** inspection and acceptance. If CM and/or Architect are required to perform more than 2 site visits to determine Substantial or Final Completion of Contractor's Work, the costs for such additional inspections shall be charged to Contractor.

The following documents are the minimum required to complete final payment. Contractor shall also submit all additional documentation as required in the Contract Documents:

- 1.1.5.1. Final Payment Request (on G702 & G703).
- 1.1.5.2. Guarantees/Warranties (including subs and suppliers).
- 1.1.5.3. Final Sworn Statements (including subs and suppliers).
- 1.1.5.4. Acknowledgment of Payment and Partial Unconditional Release
- 1.1.5.5. Final Release Subcontractor/Materialman
- 1.1.5.6. Certified Payroll Report (projects governed by prevailing wage laws)
- 1.1.5.7. Verification of Rate Classification and Payment (Federal projects)
- 1.1.5.8. Consent of Surety Company to Final Payment (AIA G707)
- 1.1.5.9. Consent of Surety to Reduction or Partial Release of Retainage (AIA G707A)
- 1.1.5.10. Certificate of Substantial Completion (on G704).
- 1.1.5.11. Completion and acceptance of all punchlist Work.

Items 1.1.5.2 through 1.1.5.5 must always be submitted with the final request for payment.

#### 1.1.6. REVIEW OF FINAL PAYMENT REQUEST

CM and the Architect will review the Contractor's final payment request and Close-Out file. If all administrative documents are attached or have been submitted (i.e. guarantee, warranty, waiver of lien, etc.), all Work is complete, and all other responsibilities are met, the Project Team will forward the Contractor's Application for Final Payment to the Owner and payment shall be processed according to the Owner's regular procedures.

## 2. FINAL COMPLETION

- 2.1. To attain final completion, the Contractor shall complete activities pertaining to Substantial Completion, and complete Work on punch list items. Only then shall it issue written request to CM to conduct a site visit to determine Final Completion.
- 2.2. When Contractor considers the Work is finally complete, it shall submit written certification that:
  - 2.2.5. Contract Documents have been reviewed.
  - 2.2.6. Work has been inspected for compliance with Contract Documents.
  - 2.2.7. Work has been completed in accordance with Contract Documents.
  - 2.2.8. Equipment and systems have been tested in the presence of the Owner's representative and are operational.
  - 2.2.9. Work is completed and ready for final observation.
- 2.3. CM and/or Architect will make an observation to verify the status of completion with reasonable promptness after receipt of such certification.
- 2.4. Should CM and/or Architect consider that the Work is incomplete or defective:

- 2.4.5. CM will promptly notify the Contractor in writing, listing the incomplete or defective Work.
  - 2.4.6. Contractor shall take immediate steps to remedy the stated deficiencies, and send a second written certification to the CM that the Work is complete.
  - 2.4.7. CM and/or Architect will re-inspect the Work.
  - 2.5. When CM and/or Architect determines that the Work is acceptable under the Contract Documents, it shall request the Contractor to make close-out submittals.
3. CONTRACTOR'S CLOSE-OUT SUBMITTALS
- 3.1. Evidence of compliance with requirements of governing authorities (state, local or federal):
    - 3.1.5. Certificates of Inspection:
      - 3.1.5.1. Mechanical
      - 3.1.5.2. Electrical
      - 3.1.5.3. Others as required
  - 3.2. Project Record Documents: Refer to requirements of Section 01720.
  - 3.3. Operating and Maintenance Data, Instructions to Owner's Personnel: Refer to requirements of Section 01730.
  - 3.4. Warranties and Bonds: Refer to requirements of Individual Sections and Individual Technical Specifications and Section 01740.
  - 3.5. Spare Parts and Maintenance Materials: Refer to requirements of Individual Technical Specifications.
  - 3.6. Evidence of Payment and Release of Liens: Refer to requirements of General and Supplementary Conditions and Section 01290.

END OF SECTION 01700

**SECTION 01720**  
**PROJECT RECORD DOCUMENTS**

**1 SUMMARY**

- 1.01 Each Contractor shall be responsible to maintain at the job site one copy of:
  - 1.01.1 Record Contract Drawings
  - 1.01.2 Record Project Manual
  - 1.01.3 Addenda
  - 1.01.4 Reviewed/Approved Shop Drawings
  - 1.01.5 Change Orders
  - 1.01.6 Other modifications to Contract
  - 1.01.7 Field test records
  - 1.01.8 Affidavits
- 1.02 Store documents apart from documents used for construction.
- 1.03 Maintain documents in clean, dry, legible condition.
- 1.04 Do not use project record documents for construction purposes.
- 1.05 Make documents available for inspection by the Owner, CM and the Architect.
- 1.06** Failure to maintain documents up-to-date will be cause for withholding payments to Contractor.
- 1.07 At the outset of the project, obtain from the Architect through the CM, at no charge to the Contractor, one complete set of Contract Documents including:
  - 1.07.1 Technical Specifications with all addenda.
  - 1.07.2 One complete set of prints of all Drawings.

**2 RECORDING**

- 2.01 Label each document "Project Record."
- 2.02 Keep record documents current.
- 2.03 Do not permanently conceal any work until required information has been recorded.
- 2.04 Contract Drawings:
  - 2.04.1 Contractor may at his option enter required information on a "working set" and then at completion of Project transfer the information to final submitted "Project Record" set.
  - 2.04.2 Contractor shall legibly mark to record actual construction:
    - 2.04.2.1 Depths of various elements of foundation in relation to survey data.
    - 2.04.2.2 Horizontal and vertical location of underground utilities and appurtenances referenced to permanent surface improvements.
    - 2.04.2.3 Location and depths of internal utilities and appurtenances concealed in construction referenced to visible and accessible features of structure.
    - 2.04.2.4 Field changes of dimension and detail.
    - 2.04.2.5 Changes made by PCO- Notice to Proceed.

2.04.2.6 Details not on original Contract Drawings.

2.05 Technical Specifications and Addenda:

2.05.1 Contractor shall legibly mark up each section to record:

2.05.1.1 Manufacturer, trade name, catalog number and Supplier of each product and item of equipment actually installed.

2.05.1.2 Changes made by PCO- Notice to Proceed.

2.05.1.3 Other items not originally specified.

2.06 Conversion of Schematic Layouts:

2.06.1 Arrangement of conduits, circuits, piping, ducts and similar items are in most cases shown schematically on the Drawings.

2.06.2 Contractor shall legibly mark to record actual construction:

2.06.2.1 Dimensions accurate to within 1" of the center of items shown schematically.

2.06.2.2 Identify each item, for example, "cast iron drain", "galvanized water", etc.

2.06.2.3 Identify location of each item, for example, "under slab", "in ceiling plenum", "exposed", etc.

2.06.3 The Owner, Architect or CM may waive requirements of schematic layout conversion, when in their opinion, it serves no beneficial purpose. Do not, however, rely on waivers being issued except as specifically issued by the CM in written form.

3 SUBMITTAL

3.01 At completion of Project deliver, 1 set of electronic sets of Record Documents, in a format acceptable to the Owner and the Architect, using the Final Document Submittal Form (in Section 01600 Forms), to CM prior to request for final payment.

3.02 Accompany submittal with transmittal letter, in duplicate, containing:

3.02.1 Date

3.02.2 Project title and number

3.02.3 Contractor's name and address

3.02.4 Title and number of each record document

3.02.5 Certification that each document as submitted is complete and accurate.

3.02.6 Signature of Contractor, or his authorized representative.

END OF SECTION 01720

**SECTION 01730  
OPERATIONS AND MAINTENANCE DATA**

**1. SCOPE**

- 1.1. Compile product data and related information appropriate for Owner's maintenance and operation of products furnished under Contract.
- 1.2. Prepare operating and maintenance data as specified in this Section and as referenced in other pertinent sections of the Technical Specifications.
- 1.3. Instruct Owner's personnel in maintenance of products and in operation of equipment and systems in accordance with the requirements in Section 01750 Systems Demonstration, Training and Start-up.

**2. QUALITY ASSURANCE**

- 2.1. Preparation of data shall be done by personnel:
  - 2.1.1. Trained and experienced in maintenance and operation of described products.
  - 2.1.2. Familiar with requirements of this Section.
  - 2.1.3. Skilled as technical writer to the extent required to communicate essential data.
  - 2.1.4. Skilled as draftsman competent to prepare required drawings.

**3. FORM OF SUBMITTALS**

- 3.1. Prepare data in the form of an instructional manual for use by Owner's personnel.
- 3.2. Format:
  - 3.2.1. Size: 8-1/2" x 11"
  - 3.2.2. Paper: white, for typed pages.
  - 3.2.3. Text: Manufacturer's printed data, or neatly typewritten.
  - 3.2.4. Drawings:
    - a. Provide reinforced punched binder tab, bind in with text.
    - b. Fold larger drawings to size of text pages.
  - 3.2.5. Provide fly-leaf for each separate product, or each piece of operating equipment.
    - c. Provide typed description of product, and major component parts of equipment.
    - d. Provide indexed tabs.
  - 3.2.6. Cover: Identify each volume with typed or printed title "OPERATING AND MAINTENANCE INSTRUCTIONS." list:
    - e. Title of Project
    - f. Identity of separate structures as applicable.
    - g. Identity of general subject matter covered in the manual.
- 3.3. Binders:
  - 3.3.1. Commercial quality three-ring binders with durable and cleanable plastic covers.
  - 3.3.2. Maximum ring size: 3"
  - 3.3.3. When multiple binders are used, correlate the data into related consistent groupings.

**4. CONTENT OF MANUAL**

- 4.1. Neatly typewritten table of contents for each volume, arranged in systematic order.

- 4.1.1. Contractor, name of responsible principal, address and telephone number.
- 4.1.2. A list of each product required to be included, indexed to content of the volume.
- 4.1.3. List with each product, name, address and telephone number of:
  - a. Subcontractor or installer.
  - b. Maintenance contractor, as appropriate.
  - c. Identify area of responsibility of each.
  - d. Local source of supply for parts and replacement.
- 4.1.4. Identify each product by product name and other identifying symbols as set forth in Contract Documents.
- 4.2. Product Data:
  - 4.2.1. Include only those sheets which are pertinent to the specific product.
  - 4.2.2. Annotate each sheet to:
    - e. Clearly identify specific product or part installed.
    - f. Clearly identify data applicable to installation.
    - g. Delete references to inapplicable information.
- 4.3. Drawings:
  - 4.3.1. Supplement product data with drawings as necessary to clearly illustrate:
    - b. Relations of component parts or equipment and systems.
    - c. Control and flow diagrams.
  - 4.3.2. Coordinate drawings with information in Project Record Documents to assure correct illustration of completed installation.
  - 4.3.3. Contractor may use Project Record Documents as maintenance drawings - coordinate with CM.
- 4.4. Written text, as required to supplement product data for the particular installation:
  - 4.4.1. Organize in consistent format under separate headings for different procedures.
  - 4.4.2. Provide logical sequence of instructions for each procedure.
- 4.5. Copy of each warranty, bond and service contract issued.
  - 4.5.1. Provide information sheet for Owner's personnel, give:
    - a. Proper procedures in event of failure.
    - b. Instances which might affect validity of warranties or bonds.
- 5. MANUAL REVIEW AND PREPARATION SCHEDULE
  - 5.1. Submit two copies of preliminary draft of proposed formats and outlines of contents to CM prior to start of preparation.
    - 5.1.1. Architect will review draft and return one copy with comments.
  - 5.2. Submit 1 set of electronic copy of completed data in final form to the CM at least 2 months before the end of the project, for Owner review.
    - 5.2.1. Copy will be returned after final inspection or acceptance, with comments.
  - 5.3. Submit copies of completed operation and maintenance manuals at least two (2) weeks before execution and have at hand for use in demonstrations and instructions.

- 5.4. Submit specified number of copies of approved data in final form to the CM ten (10) days after final inspection or acceptance.

## 6. PRODUCTS

### 6.1. MANUAL FOR MATERIALS AND FINISHES

- 6.1.1. Submit 1 electronic copy of complete manual in final form.
- 6.1.2. Content, for architectural products, applied materials and finishes:
  - 6.1.2.1. Manufacturer's data, giving full information on products.
    - 6.1.2.1.1. Catalog number, size, and composition.
    - 6.1.2.1.2. Color and texture designations.
    - 6.1.2.1.3. Information required for reordering special-manufactured products.
  - 6.1.2.2. Instructions for care, maintenance and preventative maintenance.
    - 6.1.2.2.1. Manufacturer's recommendation for types of cleaning agents and methods.
    - 6.1.2.2.2. Cautions against cleaning agents and methods which are detrimental to product.
    - 6.1.2.2.3. Recommended schedule for cleaning and maintenance.
- 6.1.3. Content, for moisture-protection and weather-exposed products:
  - 6.1.3.1. Manufacturer's data, giving full information on products.
    - 6.1.3.1.1. Applicable standards.
    - 6.1.3.1.2. Chemical composition.
    - 6.1.3.1.3. Details of installation.
  - 6.1.3.2. Instructions for inspection, maintenance and repair.
- 6.1.4. Additional requirements for maintenance data: Reference sections of Technical Specifications.

### 6.2. MANUAL FOR EQUIPMENT AND SYSTEMS

- 6.2.1. Submit 1 electronic copy of complete manual in final form.
- 6.2.2. Content, for each unit of equipment and system, as appropriate:
  - 6.2.2.1. Description of unit and component parts.
    - 6.2.2.1.1. Function, normal operating characteristics, and limiting conditions.
    - 6.2.2.1.2. Performance curves, engineering data and tests.
    - 6.2.2.1.3. Complete nomenclature and commercial number of replaceable parts.
  - 6.2.2.2. Operating procedures:
    - 6.2.2.2.1. Start-up, break-in, routine and normal operating instructions.
    - 6.2.2.2.2. Regulation, control, stopping, shutdown and emergency instructions.
    - 6.2.2.2.3. Summer and winter operating instructions.
    - 6.2.2.2.4. Special operating instructions.
  - 6.2.2.3. Maintenance and Preventative Maintenance Procedures:
    - 6.2.2.3.1. Routine operations.
    - 6.2.2.3.2. Guide to "trouble-shooting".

- 6.2.2.3.3. Disassembly, repair and re-assemble.
    - 6.2.2.3.4. Alignment, adjusting and checking.
  - 6.2.2.4. Servicing and lubrication schedule.
    - 6.2.2.4.1. List of lubricants required.
  - 6.2.2.5. Manufacturer's printed operating and maintenance instructions.
  - 6.2.2.6. Description of sequence of operation by control manufacturer.
  - 6.2.2.7. Original manufacturer's parts, list, illustrations, assembly drawings and diagrams required for maintenance.
    - 6.2.2.7.1. Predicted life of parts subject to wear.
    - 6.2.2.7.2. Items recommended to be stocked as spare parts.
  - 6.2.2.8. As-installed control diagrams by controls manufacturer.
  - 6.2.2.9. Each Contractor's coordination drawings.
    - 6.2.2.9.1. As-installed color coded piping diagrams.
  - 6.2.2.10. Charts of valve tag numbers, with location and function of each valve.
  - 6.2.2.11. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.
  - 6.2.2.12. Other data as required under pertinent sections of specifications.
- 6.2.3. Content, for each electric and electronic system, as appropriate:
  - 6.2.3.1. Description of system and component parts.
    - 6.2.3.1.1. Function, normal operating characteristics and limiting conditions.
    - 6.2.3.1.2. Performance curves, engineering data and tests.
    - 6.2.3.1.3. Complete nomenclature and commercial number of replaceable parts.
  - 6.2.3.2. Circuit directories of panel boards.
    - 6.2.3.2.1. Electrical service.
    - 6.2.3.2.2. Controls.
    - 6.2.3.2.3. Communications.
  - 6.2.3.3. As-installed color coded wiring diagrams.
  - 6.2.3.4. Operating procedures:
    - 6.2.3.4.1. Routine and normal operating instructions.
    - 6.2.3.4.2. Sequences required.
    - 6.2.3.4.3. Special operating instructions.
  - 6.2.3.5. Maintenance and preventative maintenance procedures:
    - 6.2.3.5.1. Routine operations.
    - 6.2.3.5.2. Guide to "trouble-shooting".
    - 6.2.3.5.3. Disassembly, repair and re-assemble.
    - 6.2.3.5.4. Adjustment and checking.
  - 6.2.3.6. Manufacturer's printed operating and maintenance instructions.



- 6.2.3.7. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.
- 6.2.3.8. Other data as required under pertinent sections of specifications.
- 6.2.4. Prepare and include additional data when the need for such data becomes apparent during instruction of Owner's personnel.
- 6.2.5. Additional requirements for operating and maintenance data: Reference sections of Technical Specifications.

END OF SECTION 01730

## **SECTION 01740 WARRANTIES AND GUARANTEES**

### **1 GENERAL**

- 1.01 Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products. Manufacturer's disclaimers and limitations on product warranties do not relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

### **2 WARRANTY REQUIREMENTS**

- 2.01 Deliver all written warranties and guarantees required by the Contract Documents with the Owner named as beneficiaries. All warranties shall include labor and materials, shall be signed by the manufacturer or subcontractor as the case may be, and countersigned by the Contractor. All written warranties shall be addressed to the Owner and delivered to CM upon completion of the Project, before or with the submission of Request for Final Payment.
- 2.02 In addition to all other warranties set forth in the Contract Documents or imposed by applicable law, Contractor warrants to Owner and CM that the Work will be free from defects and performed in strict conformity with the requirements of the Contract Documents. This warranty survives the termination of the Agreement and shall only be extinguished by limitation periods imposed by applicable law and shall not be limited by any other provisions contained in the Agreement, including any provisions or time periods related to Contractor's obligation to correct defective Work.
- 2.03 Contractor, upon signing the Agreement, shall obtain and forward to CM any and all Standard Product Warranties for products, materials and systems covered under its Agreement. The Manufacturer's warranties do NOT relieve the Contractor from its warranty obligations under the Contract Documents.
- 2.04 Special Warranties shall become effective on a date established by the Project Team. This date generally shall be the date of Final Completion of the Project or Substantial Completion of the Project or portions thereof as agreed upon by the Project Team. In the case of acceptance of a portion of the Work or Project, separate warranties shall be issued for those specific portions of the Project that were accepted, and shall be dated the date the specific portion was accepted. As additional Work is accepted, separate warranties for those specific portions of the Work shall be issued and properly dated. Issuance of warranties for a portion of the Work shall in no way become the basis for Application for Final Payment.
- 2.05 If for any reason, the Bidder cannot warrant any part of the Work using products, materials, or construction methods that have been specified or shown, it shall notify CM in writing at least ten (10) days before the bid submission date, giving reasons together with the names of products and data on substitutions it can guarantee. Should the Bidder fail to so notify CM within this time period, it will be bound to all warranties and guarantees as set forth in the Contract Documents.
- 2.06 Related Damages and Losses: In correcting Work that has been rejected as defective or otherwise failing to conform to the Contract Documents, whether before or after Substantial Completion, Contractor shall bear all related costs, including, but not necessarily limited to, the cost to correct the Work, the cost to correct all other Work that has been damaged by the defective or non-conforming Work, or that is damaged in the process of correcting the defective or nonconforming Work, and the cost of all additional testing and inspections and compensation for the Architect and/or CM's services and expenses made necessary thereby.
- 2.07 Reinstatement of Warranty: When Work covered by a warranty with a specific time period has failed and has been corrected by Contractor, the warranty shall be reinstated for a time period equal to the original warranty.
- 2.08 Express warranties are in addition to implied warranties and shall not limit the duties, obligations, rights, and remedies otherwise available to the Owner or CM under the law. Express warranty periods shall not be interpreted as limitations on the time in which Owner or CM may enforce Contractor's duties and obligation or their rights and remedies under the Agreement and applicable law.

2.08.1 Rejection of Warranties: The Owner and CM reserve the right to reject warranties and to limit selection to products with warranties not in conflict with requirements of the Contract Documents.

2.09 Where the Contract Documents require a Special Warranty, or similar commitment on the Work or part of the Work, the Owner and CM reserve the right to refuse to accept the Work, until the Contractor presents evidence that the entities required to countersign such commitments are willing to do so.

### 3 SUBMITTALS

3.01 Submit electronic copies of the warranties to the CM within fourteen (14) days of Substantial Completion using the form found in section 01600-Forms and organizing the warranty documents into an orderly sequence based on the table of contents of the Project Manual. If the project Team's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of CM.

3.02 When the Contract Documents require Contractor, or Contractor and a Subordinate Party to execute a Special Warranty, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the CM for approval prior to final execution.

3.03 Forms for warranties are included in Section 01600-Forms. Prepare a written document utilizing the appropriate form, ready for execution by Contractor and its Subordinate Party(ies). Submit a draft to CM for approval prior to final execution.

END OF SECTION 01740

**SECTION 01750**  
**SYSTEMS DEMONSTRATION, TRAINING AND START-UP**

**2 GENERAL**

- 2.01 COORDINATE Procedures for demonstration of equipment operation and instruction of Owner's personnel through CM.

**3 QUALITY ASSURANCE**

- 3.01 When specified in individual Sections, require manufacturer to provide authorized representative to demonstrate operation of equipment and systems, instruct Owner's personnel, and provide written report that demonstrations and instructions have been completed.
- 3.02 CM will provide list of personnel to receive instructions, and will coordinate their attendance at agreed-upon times.

**4 SUBMITTALS**

- 4.01 Submit preliminary schedule to CM for Architect's and Owner's approval, listing times and dates for demonstration of each item of equipment and each system, at least two (2) weeks prior to proposed dates.
- 4.02 Submit electronic copies of the reports within one week after completion of demonstrations, that demonstrations and instructions have been satisfactorily completed. Give time and date of each demonstration, and hours devoted to demonstration, with a list of persons present.

**5 PREPARATION**

- 5.01 Provide substantiating information that verifies equipment has been inspected and put into operation; testing, adjusting, and balancing has been performed; and equipment and systems are fully operational.
- 5.02 Submit copies of completed operation and maintenance manuals at least two (2) weeks before execution and have at hand for use in demonstrations and instructions.
- 5.03 CM will develop a schedule for the system demonstration, training, start-up and turn over of all systems and equipment.

**6 DEMONSTRATION AND INSTRUCTIONS**

- 6.01 Demonstrate operation and maintenance of equipment and systems to the Owner's, CM's and Architect's personnel two (2) weeks prior to date of final inspection. For equipment requiring seasonal operation, perform instructions for other seasons within six months. Contractor shall document the testing, equipment start-up and training sessions as required using the following forms in Section 01600 Forms:
- 6.01.1 Equipment/System Acceptance - This form will be completed for each piece of equipment or system for each contract that requires operational testing and/or training before acceptance. This will document the date of testing, the equipment tested, names of personnel which witnessed the testing and acceptance.
- 6.01.2 Owner Training Register - This form will be completed for each contract that requires training to be provided to the Owner's personnel. This will document the date of training, type of training, names of the personnel trained and acceptance of the training.
- 6.02 The amount of time required for instruction on each item of equipment and system is that specified in individual sections or as mutually agreed upon between Contractor and CM.
- 6.03 Demonstrate start-up, operation, control, adjustment, troubleshooting, servicing, maintenance, and shutdown of each item of equipment at agreed-upon times, at designated location.
- 6.04 Use operation and maintenance manuals as basis of instruction and review the contents of the manuals with personnel in full detail to explain all aspects of operations and maintenance.
- 6.05 Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instructions.

- 6.06 Contractor is responsible for video taping the training sessions. The videotape should be of professional quality and the Owner should be provided with three (3) copies of the videotape.

END OF SECTION 01750

PROJECT MANUAL FOR THE CONSTRUCTION OF:

PROJECT:

2013 BOND PROGRAM SERIES 1

HAMILTON ELEMENTARY SCHOOL REMODELING (13160B)  
INTERNATIONAL ACADEMY EAST REMODELING (13175C)

BID PACKAGE NO. 16

OWNER:

TROY SCHOOL DISTRICT  
4400 Livernois  
Troy, Mi. 48098

TMP PROJECT NOS.: 13160B and 13175C

DATE: December 15, 2015

ISSUED FOR BIDS

ARCHITECT

TMP ARCHITECTURE, INC.  
1191 West Square Lake Road  
Bloomfield Hills, Michigan 48302-0374

PH (248) 338-4561  
FX (248) 338-0223  
Email [info@tmp-architecture.com](mailto:info@tmp-architecture.com)

STRUCTURAL ENGINEER

DESAI/NASR CONSULTING ENGINEERS  
6765 Daly Rd.  
West Bloomfield, Michigan 48332

PH (248) 932-2010  
FX (248) 932-3088  
Email [info@desainasr.com](mailto:info@desainasr.com)

CONSTRUCTION MANAGER

BARTON MALOW COMPANY  
26500 American Drive  
Southfield, Mi. 48034

PH (248) 436-5000  
FX (248) 436-5001  
Email [info@bartonmalow.com](mailto:info@bartonmalow.com)

MECHANICAL & ELECTRICAL ENGINEER

PETER BASSO ASSOCIATES, INC  
5145 Livernois, Suite 100  
Troy, Michigan 48098

PH (248) 879-5666  
FX (248) 879-0007  
Email [info@pbanet.com](mailto:info@pbanet.com)

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A1.1A	FLOOR PLAN - ZONE 'A'
A1.1B	FLOOR PLAN - ZONE 'B'
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M8.3	TEMPERATURE CONTROLS
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**International Academy East (13175C)****GENERAL INFORMATION**

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TG.1	GENERAL INFORMATION

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ELECTRICAL

E0.1	ELECTRICAL STANDARDS AND DRAWING INDEX
E0.2	ELECTRICAL STANDARD SCHEDULES
E0.3	ELECTRICAL COMPOSITE PLAN
ED1.1A	ELECTRICAL DEMOLITION PLAN - ZONE 'A'
ED1.1B	ELECTRICAL DEMOLITION PLAN - ZONE 'B'
ED1.1C	ELECTRICAL DEMOLITION PLAN - ZONE 'C'
ED1.1D	ELECTRICAL DEMOLITION PLAN - ZONE 'D'
E2.1A	LIGHTING PLAN - ZONE 'A'
E2.1B	LIGHTING PLAN - ZONE 'B'
E2.1C	LIGHTING PLAN - ZONE 'C'
E2.1D	LIGHTING PLAN - ZONE 'D'
E3.1A	POWER AND AUXILIARY SYSTEMS PLAN - ZONE 'A'
E3.1B	POWER AND AUXILIARY SYSTEMS PLAN - ZONE 'B'
E3.1C	POWER AND AUXILIARY SYSTEMS PLAN - ZONE 'C'
E3.1D	POWER AND AUXILIARY SYSTEMS PLAN - ZONE 'D'
E5.1	DEMOLITION ONE LINE DIAGRAM
E5.2	NEW WORK ONE LINE DIAGRAM
E5.3	PANEL SCHEDULES
E7.1	ELECTRICAL DETAILS
E7.2	ELECTRICAL DETAILS

\*\*END OF SECTION\*\*

AVAILABILITY OF ELECTRONIC FILES

PART 1 – GENERAL

1.1 POLICY

- A. As a service to contractors, subcontractor, vendors, material suppliers and others needing electronic copies of drawing files, the Architect will provide CAD files electronically in accordance with the following policy:
1. By acceptance it is understood and agreed that the data and medium being supplied is to be used only for the project referenced.
  2. It is further understood and agreed that the undersigned will hold TMP Architecture harmless and indemnify TMP Architecture from all claims, liabilities, losses, etc., including attorney's fees arising out of the use or misuse of the transferred items.
  3. It is understood and agreed that the items transmitted are prepared from CAD files current at the time of preparation. All files are AutoCAD version 2009 dwg files.
  4. This information does not waive the need to verify and review current field conditions and the status of Addenda and/or Bulletin documentation.
  5. As a record of information to be transmitted, TMP Architecture will prepare a duplicate electronic back-up for its record.
  6. Compensation for providing this material will be as follows:
    - a. Base Fee of \$250 for 1 to 3 drawings.
    - b. Base Fee of \$500 for 4 to 10 drawings.
    - c. For each additional drawing after 10 the fee is \$40.00 per drawing (i.e., 11 drawings = \$540).
  7. Payment must be provided along with a signed copy of the Release Letter before files will be released.

1.2 REQUEST PROCEDURE

- A. To receive files the attached Release Letter must be completed in full and submitted to the Construction Manager to be forwarded to the Project Manager at TMP Architecture.
1. A signed copy of the Release Letter must be submitted; faxed or emailed copies will be accepted.
  2. Upon remittance of the signed Release Letter and Fee, allow five working days for processing.
  3. Transmission of documents will be provided electronically after the receipt of payment.

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

Firm Requesting Files:

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

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

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

City, State, Zip: \_\_\_\_\_

Re: Letter of Authorization for CAD File Transfers

Project Name: \_\_\_\_\_

TMP Project No. : \_\_\_\_\_ Bid Pack No. : \_\_\_\_\_

Dear Sir:

Per your request, TMP Architecture will transmit the requested CAD files in the form of CD-ROM upon receipt of an original signed copy of this letter with conditions of agreement as stated.

1. By acceptance it is understood and agreed that the data and medium being supplied is to be used only for the project referenced.
2. It is further understood and agreed that the undersigned will hold TMP Architecture harmless and indemnify TMP Architecture from all claims, liabilities, losses, etc., including attorney's fees arising out of the use or misuse of the transferred items.
3. It is understood and agreed that the items transmitted are prepared from CAD files current at the time of preparation. All files are AutoCAD 2009.
4. This information does not waive the need to verify and review current field conditions and the status of Addenda and/or Bulletin documentation.
5. As a record of information to be transmitted, we will prepare a duplicate back-up for our files, which may be electronic or hard-copy.
6. Compensation for providing this material will be as follows: Base Fee of \$250 for 1 to 3 drawings and a Base Fee of \$500 for 4 to 10 drawings; for each additional drawing after 10 the fee is \$40.00 per drawing (i.e., 11 drawings = \$540). Payment must be provided along with a signed copy of this form before files will be released. Please remit to TMP Architecture and allow five working days for processing.

Fee: \$\_\_\_\_\_ Drawings: \_\_\_\_\_

Signed: \_\_\_\_\_ Printed Name/Title: \_\_\_\_\_

Firm Requesting: \_\_\_\_\_

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

*To Be Completed By TMP Architecture, Inc.*

Released (signed by): \_\_\_\_\_ TMP Architecture, Inc.

Printed Name/Title: \_\_\_\_\_ Date: \_\_\_\_\_

**\*\*END OF SECTION\*\***



## ALTERNATES

### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

#### 1.2 DESCRIPTION OF REQUIREMENTS:

- A. Definition: An alternate is an amount proposed by Bidders and stated on the Bid Form that will be added to or deducted from Base Bid amount if the Owner decides to accept a corresponding change in either scope of work or in products, materials, equipment, systems or installation methods described in Contract Documents.
- B. Coordination: Coordinate related work and modify or adjust adjacent work as required to ensure that work affected by each accepted alternate is complete and fully integrated into the project.
- C. Notification: Immediately following award of Contract, prepare and distribute to each party involved, notification of the status of each alternate. Indicate whether alternates have been accepted, rejected or deferred for consideration at a later date. Include a complete description of negotiated modifications to alternates, if any.
- D. Schedule: A "Schedule of Alternates" is included at the end of this section. Specification sections referenced in the Schedule contain requirements for materials and methods necessary to achieve the work described under each alternate.
  - 1. Include as part of each alternate, miscellaneous devices, appurtenances and similar items incidental to or required for a complete installation whether or not mentioned as part of the alternate.

### PART 2 - PRODUCTS (not applicable)

### PART 3 - EXECUTION

#### 3.1 SCHEDULE OF ALTERNATES

- A. Alternate No.A1: International Academy - Quote add in price to: Remove and replace windows and roller shades on the north and west sides of the building as indicated in drawings and specifications
- B. Alternate No. A2: International Academy - Quote add in price to: Remove and replace windows and roller shades in the courtyard of the building as indicated in drawings and specifications
- C. Alternate No.A3: International Academy - Quote add in price to remove and replace additional casework as indicated on drawings
- D. Alternate No.A4: Hamilton Elementary – Quote add in price to demolish light cove and patch-in new ceiling grid as described on drawings A0.1B, A0.1C, A2.1B, A2.1C and A3.1

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ALTERNATES

- E. Alternate No. A5: International Academy – Quote add in price to demolish and replace ceiling in Laundry Room B113 as indicated on drawings
- F. Alternate No. M1: International Academy – Quote add in price for plumbing and mechanical work in rooms B113 and B117 as indicated in drawings and specifications.
- G. Alternate No.M2: International Academy – Quote add in price for HVAC Air Distribution System Cleaning as described in specification section 230130 and on drawings.
- H. Alternate No. E1: International Academy – Quote add in price for electrical work in rooms B113 and B117 as indicated in drawings and specifications
- I. Alternate No. E2: International Academy – Quote add in price for all work associate with adding receptacle panel RP-K1 as indicated in drawings and specifications.
- J. Alternate No. E3: International Academy – Quote add in price to provide LED light fixtures at Gymnasium A109 in lieu of specified fluorescent fixtures as indicated in drawings and specifications.
- K. Alternate No. E4: Hamilton Elementary – Quote add in price to demolish light cove and add new light fixtures in corridors around Media Center as described on drawings ED1.1B, ED1.1C, E2.1B and E2.1C.

**\*\*END OF SECTION\*\***

SCHEDULE OF REQUIRED SUBMITTALS

PART 1 - GENERAL

1.1 SUMMARY

- A. Specified Herein: General Requirements and schedule tabulating submittals required under the individual Trade Sections.
- B. Related Work: The following submittals are described under other Sections of these Specifications:
  - 1. Division 01 Section "Related Documents Submittal Procedures" for shop drawings.
  - 2. Division 01 Section "Project Record Documents" for project record documents.
  - 3. Division 01 Section "Warranties" for warranties and warranty services.

1.2 SUBMITTALS

- A. Submittals schedule is for reference only and is not necessarily complete. Specific requirements are included in the respective Trade Sections.
- B. Description of submittals and definitions of terms are included under other Sections of Division 01.
- C. Submittal of Materials for Approval:
  - 1. See Division 01 "Product Requirements" for requirements for materials submittals.
  - 2. All materials requiring Manufacturer Services or Warranty shall be submitted in the form specified under "Warranties".
  - 3. Standard materials may be submitted in tabular form. Where necessary to clarify proposed use, submit as a Shop Drawing a schedule of applications or a drawing showing proposed locations.

1.3 SCHEDULE

- A. The Contractor shall prepare a schedule relating and conforming to the Approved Construction Schedule. Said Schedule shall recognize and allow for lead-time, including lead-time required by Subcontractors and Manufacturers, and time required for Architect's review in compliance with the Contract Documents for all submittals.
- B. This Schedule shall be submitted to the Owner and the Architect for approval prior to the second Request for Payment.
- C. Exact procedures and time schedules for submittals will be determined at the time Job Progress Schedule is established. Time schedule for submittals shall be periodically revised and adjusted to coordinate with job progress.

1.4 EQUIPMENT ROOM LAYOUT DRAWINGS

- A. Each Contractor shall prepare and submit equipment room layout drawings, as called for under "Shop Drawings and Samples," for all equipment furnished under its Contract.
- B. Scale (Minimum): 1/4 inch equals 1 foot.

1.5 CERTIFICATE OF COMPLIANCE

- A. Each certificate required for demonstrating proof of compliance of materials with specification requirements, including mill certificates, shall be executed in quadruplicate. It shall be the Contractor's responsibility to review all certificates, before submittal, to ensure compliance with the Contract Documents.
- B. Each certificate shall be signed by an official authorized to certify in behalf of the manufacturing company and shall contain the name and address of the Contractor, the project name and location and the quantity and date or dates of shipment or delivery to which the certificate applies.
- C. Copies of laboratory test reports submitted with certificates shall contain the name and address of the testing laboratory and the date or dates of the tests to which the report applies. Certification shall not be construed as relieving the Contractor from furnishing satisfactory material, if after tests are performed on selected samples, the material is found not to meet the specific requirements.

1.6 SPARE PARTS DATA

- A. The Contractor shall furnish spare parts data for each different item of equipment furnished if and as called for in the Trade Sections.

1.7 SAMPLES

- A. After the award of the Contract, the Contractor shall furnish, for approval, samples required by the Specifications. The Contractor shall prepay all shipping charges on samples.
- B. Materials or equipment for which samples are required shall not be used in the work until approved in writing.

1.8 OPERATION AND MAINTENANCE MANUALS

- A. Where required by the Specifications, Operation and Maintenance Manuals shall be provided by the Contractor as specified under "Project Record Documents".
- B. Provide all manuals, parts information and similar data that the Architect may determine to be necessary for proper operation and maintenance.
- C. The manuals shall cover the operation requirements of each item specified to require operational and maintenance manuals, and shall include standard maintenance procedures and recommended schedules for routine service. The manuals shall be submitted to the Architect ten (10) days prior to final tests of mechanical and electrical system.

1.9 TEST PROCEDURES AND TEST RESULTS

- A. Where required by the Technical Specifications test procedures and test results shall be provided by the Contractor in quadruplicate. Test procedures shall cover all items required by the Technical Provisions and as specified under "Laboratory Testing and Inspection."

**\*\*END OF SECTION\*\***

ELECTRONIC SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Specified Herein: General Requirements for preparation, submittal, and distribution of Shop Drawings, Samples, Product Data, and similar information required to be furnished by the Contractors.
- B. Related Work: The following items of work are specified under other Sections of these Specifications:
  - 1. Division 01 Section "Electronic Project Record Documents" for electronic project record documents.

1.2 DEFINITIONS

- A. Samples: See General Conditions.
  - 1. Preliminary Samples: Hand made or simulated examples or proposed materials submitted to demonstrate anticipated finished appearance.
  - 2. Product Samples: Representative examples of materials proposed for use.
  - 3. Range Samples: Samples showing extremes of variations in appearance, texture or color and the limits within which the Contractor agrees to hold the materials used in the work.
  - 4. Sample Installation: Trial run or initial example provided for review and acceptance by the Architect before continuing with the work.
  - 5. Test Samples: Samples provided for purposed of physical or chemical test analysis. If samples are submitted directly to the Testing Laboratory, submit copy of letter of transmittal.
- B. Shop Drawings: See General Conditions
  - 1. Electronic File: Drawings and other data submitted electronically in PDF format only.
  - 2. Preliminary Shop Drawings: Drawings and other data submitted electronically prior to acceptance of systems and only required to show information necessary for evaluation and coordination with other work.
  - 3. Project Shop Drawings: Drawings and other data illustrating materials and assemblies proposed for the Project.
  - 4. Coordination Drawings: Original electronic drawings prepared by the Trades to investigate conflicts and coordinate locations of each with the work of the other.

- C. Identification: All shop drawings, samples and product data shall be identified by the project title, Construction Manager's name, the Architect's name and the Architect's project number or numbers.

1.3 ELECTRONIC SUBMITTAL PROCEDURES

A. Summary:

1. Shop drawing and product data submittals shall be transmitted to the Construction Manager in electronic (PDF) format using Submittal Exchange, a website service designed specifically for transmitting submittals between construction team members.
2. The intent of electronic submittals is to expedite the construction process by reducing paperwork, improving information flow, and decreasing turnaround time.
3. Physical samples (color samples, color charts, physical material samples, etc.) will be accompanied by an electronic transmittal processed through Submittal Exchange. Refer to Paragraph 1.4E for additional information.

B. Procedures:

1. Submittal Preparation –Subcontractors and Suppliers may use any or all of the following options as directed by the Construction Manager.
  - a. Subcontractors and Suppliers provide electronic (PDF) submittals to Contractor via email.
  - b. Subcontractors and Suppliers provide paper submittals to General Contractor who electronically scans and converts to PDF format and submits to the Construction Manager by uploading to Submittal Exchange.
2. Contractor shall review and apply electronic stamp certifying that the submittal complies with the requirements of the Contract Documents including verification of manufacturer / product, dimensions and coordination of information with other parts of the work.
3. Contractor shall transmit each submittal to Construction Manager using the Submittal Exchange website, [www.submittalexchange.com](http://www.submittalexchange.com).
4. Construction Manager shall transmit each submittal to the Architect using the Submittal Exchange website, [www.submittalexchange.com](http://www.submittalexchange.com).
5. Architect / Engineer review comments will be made available on the Submittal Exchange website for downloading. Construction Manager will receive email notice of completed review and send notification to the Contractor.
6. Distribution of reviewed submittals to subcontractors and suppliers is the responsibility of the Contractor.
7. Submit electronic copies of reviewed submittals at project closeout for record purposes in accordance with Section 017839 "Electronic Project Record Documents"

C. Costs:

1. Cost of data management service (Submittal Exchange) shall be paid for by the Project Owner thru the Construction Manager.
2. At Contractor's option, training is available from Submittal Exchange regarding use of website and PDF submittals. Contact Submittal Exchange at 1-800-714-0024.
3. Internet Service and Equipment Requirements:
  - a. Email address and Internet access at Contractor's main office.
  - b. Adobe Acrobat ([www.adobe.com](http://www.adobe.com)), Bluebeam PDF Revu ([www.bluebeam.com](http://www.bluebeam.com)), or other similar PDF review software for applying electronic stamps and comments.

1.4 GENERAL REQUIREMENTS FOR ELECTRONIC SUBMITTALS:

- A. Contractor shall transmit each submittal (shop drawings and product data) to the Construction Manager using the Submittal Exchange website, [www.submittalexchange.com](http://www.submittalexchange.com). Submittals are to be made in the following form.
  1. Shop drawing: Combined together into one pdf file for each assembly.
  2. Product data: Provide product data in individual pdf file.
- B. File naming shall be in the following format. Specification Section Number; consecutive number of submittal for that section; revision number for that section; school name(s) (where multiple schools are involved only); and description of file being submitted (submittal type).
  1. Example: 079200-01-00\_Watt, Wass\_Joint Sealants\_Product data.pdf.
  2. Example: 123204-07-01\_Prefabricated Casework\_Shop Drawings.pdf.
- C. Contractor shall fill out the TMP Shop Drawing and Sample Transmittal Form found at the end of this Section and include at the beginning of the file. An electronic version of Transmittal Form is available upon request from the Architect, thru the Construction Manager. Also, an electronic version of this form is part of the upload process in Submittal Exchange.
- D. Contractor shall review and apply electronic stamp certifying that the submittal complies with the requirements of the Contract Documents including verification of manufacturer / product, dimensions and coordination of information with other parts of the work prior to notifying the Construction Manager that the submittal is read for review.
- E. Physical Samples must be submitted through the Construction Manager and must be accompanied by an electronic (PDF) copy of the completed TMP Shop Drawing and Transmittal Form. Electronic Transmittal Form must be submitted to the Construction Manager using the Submittal Exchange website.

1.5 SCHEDULES

- A. Prepare Shop Drawing Submittal Schedule as required.



- B. Recognize and allow for lead-time required for manufacture, fabrication, delivery to the site, and for review.
- C. Arrange schedule in orderly sequence in compliance with Project Schedule.
- D. Request for approval of materials, systems, substitutions, or for deviations from the Contract Documents shall be submitted according to Section 016000 – “Product Requirements” and shall be Preliminary submittal with allowances for time for review prior to submittal of Product Samples or Project Shop Drawings.

1.6 SAMPLES - GENERAL

- A. Samples in general, are required for all materials that form an exposed part of the finished Project. Samples of concealed components are not required unless specifically called for.
- B. Typical Samples shall be taken from production run material and shall be representative examples of proposed quality and finish.
- C. Preliminary Samples shall, as far as possible, anticipate the quality and finish of production run material.
- D. Samples will be retained at the job site for comparison purposes. Samples of manufactured items will be returned to the Contractor for installation in the Work after approval of materials. Use in locations where directed.
- E. All materials in the completed installation shall be equal in every respect to the approved product samples and within the limits defined by the approved range samples.

1.7 SAMPLES SUBMITTALS

- A. Size and quantity, unless otherwise specified: Four (4) each; 8 inches by 12 inches, or 12 inches long, as applicable; not over one inch thick for masonry or cementitious materials.
- B. Preliminary or Range Samples shall be resubmitted as directed until an acceptable Sample or Range is established, at which time Project Samples shall be submitted.
- C. Furnish Samples to other trades where required to match color or finish.
- D. Required Samples are scheduled or are listed in the Trade Sections. Optional Samples will be accepted and reviewed by the Architect.
- E. Review will be for shape and appearance only. Physical and chemical properties shall be established by adequate documentation that shall accompany samples.
- F. In all cases where preliminary approval samples have been submitted, final production run, or in-place installation samples will be required for verification.
- G. Notify Construction Manager and Architect in advance and obtain directions for place and time to ship large, heavy or bulky samples. Ship such samples "Prepaid." If return is requested, they will be returned "Collect."

1.8 SHOP DRAWINGS AND PRODUCT DATA - GENERAL

- A. Shop Drawings shall be prepared by a qualified detailer and shall be complete including erection diagrams and shall show the fabrication and construction of all items required for complete assembly.
- B. Provide pertinent information relating to installation and connection to work of other trades, and coordinate with work of other trades as required for proper placing, anchorage and support of the work. Indicate in detail, the precise location and spacing of all embedded anchor bolts, sleeves and other features required to be placed in the concrete, structural steel or masonry or otherwise required to be built into the structure.
- C. Identify details by reference to the Contract Drawings, other Shop Drawings or other information as required to properly identify and locate the portion of the Work covered.
- D. Indicate on the Drawings and explain by covering letter all proposed deviations from the requirements of the Contract Documents.
- E. Manufacturer's Standard Documents:
  - 1. Drawings and similar documents provide in PDF version from original documents: Modify drawings to delete information which is not applicable to the Project, provide additional information where required and submit electronically.
  - 2. Brochures and other pre-printed data, clearly mark PDF information as follows:
    - a. Identify pertinent material, product, and model.
    - b. Number or otherwise reference each item to applicable Contract Document or other Shop Drawing.
    - c. Show dimensions and clearances required.
    - d. Provide all other information required for Shop Drawings including, where applicable, wiring diagrams and controls.
    - e. Delete all options, or variations from the Contract Documents, except where such items are specifically noted as proposed deviations.
- F. Where proper installation of the work requires that other work be set to special detail, held to tolerance, or dimension be established, so indicate on the Shop Drawings.
- G. Where items must fit spaces previously constructed, take measurements at the site, not from drawings.
- H. Where applicable, indicate mechanical and electrical characteristics of, or required to be provided for, the material shown on the Shop Drawings.
- I. Each shop drawing or coordination drawing shall have a blank area (5 x 8 inches), located adjacent to the title block. The title block shall display the following:
  - 1. Number and title of drawing
  - 2. Date of drawing or revision

3. Name or project building or facility
4. Name of Contractor and (if appropriate) name of Subcontractor submitting drawings.
5. Clear identity of contents and location of the work.
6. Project title and contract number.
7. Initials or party preparing drawings.
8. Signature of party responsible and, where applicable, professional engineers seal.

1.9 SHOP DRAWINGS - TYPES

A. Preliminary Shop Drawings:

1. Preliminary Shop Drawings shall be provided for portions of the Work where interpretations or variations from the Contract Documents are proposed, or otherwise required.

B. Project Shop Drawings:

1. Project Shop Drawings shall show all changes to building details to coordinate with required modifications and indicate approval by other trades for required modifications to their work.
2. Where Shop Drawings are based on the use of a particular material, such material shall be submitted for review independently of the Shop Drawing.
3. When Shop Drawings are submitted in the form of brochures indicate all current variations from the information in effect at time documents were issued for bids.

C. Coordination Drawings: Comply with all requirements of Project Manual

1.10 DELEGATED-DESIGN SUBMITTALS

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 the Architect thru the Construction Manager.

B. Shop Drawings: Submit shop drawings for each component of work identified, signed and sealed by the qualified professional engineer responsible for their preparation licensed in the State of Michigan.

- C. Engineering Analysis: Submit comprehensive engineering analysis for each component of work identified, signed and sealed by the qualified professional engineer responsible for their preparation licensed in the State of Michigan.
  - 1. 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.
- D. Product Data: Submit product data for each product and system specifically assigned to the Contractor to be designed or certified by a design professional, signed and sealed by the responsible 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 to certify the product.
- E. Submittals: Shop drawings, engineering analysis, product data and other required submittals will be digitally signed and sealed and submitted electronically. The design professional's seal, license number, and signature shall be clear and legible and shall appear on each shop drawing sheet, each product data coversheet, and engineering analysis coversheet.

#### 1.11 CONTRACTOR'S RESPONSIBILITIES

- A. The Contractor shall obtain, review, stamp with his approval and submit for review all Shop Drawings and Samples required by the Contract Documents. The Contractor shall be required to utilize the "Shop Drawing Transmittal Form attached to this section. Submittal materials for only one (1) specification section trade shall be submitted per each transmittal form. Do not combine submittals for multiple specification sections on one transmittal form. Use a separate transmittal form for each specification section.
- B. By approving and submitting Shop Drawings and Samples, the Contractor thereby represents that he has determined and verified all field measurements and field construction criteria at the site, and all materials, catalog numbers and similar data, or will do so, and that he has checked and coordinated each Shop Drawing and Sample with the requirements of the work and of the Work and of the Contract Documents.
- C. The Contractor shall not be relieved of responsibility for any deviation from the requirements of the Contract Documents by the Owner's, Construction Manager's, or the Architect's acceptance of Shop Drawings, Product Data or Samples, unless the Contractor has informed the Owner, Construction Manager and the Architect, in writing, of such deviation at the time of submission and the Architect has given written acceptance to the specific deviation. The Contractor shall not be relieved from responsibility for errors or omissions in the Shop Drawings, Product Data or Samples by the acceptance thereof.
- D. The Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, Product Data or Samples to revisions other than those requested on previous submittals.

- E. No portion of the Work requiring submission of Shop Drawings, Product Data or Sample shall be commenced until the submittal has been accepted as provided herein. All such portions of the Work shall be in accordance with accepted submittals.

1.12 ARCHITECT'S REVIEW

- A. The Architect will complete review of Shop Drawings within fifteen (15) working days, and of Samples within twenty-one (21) working days of receipt thereof except that:
  - 1. Shorter time limits will be negotiated on a basis of need for each specific case for "fast track" or critical path items.
  - 2. With respect to those areas with special architectural finishes and coordination of various material sources the parties shall agree upon a mutually satisfactory time schedule.
  - 3. Review time will be considered as starting when Drawings and Samples are substantially correct and so submitted.
  - 4. Incomplete or incorrect submittals will be returned without review, for proper submission.
- B. Shop Drawings, Samples and Product Data will be reviewed only for conformance with the design concept, compliance with the information given in the Contract Documents, arrangement and appearance. Deviations from the Contract Documents will be noted with comments and required corrections or changes will be noted on the returned submittal.
- C. Delegated Design Submittals will be reviewed only for conformance with the general design concept, compliance with performance and design criteria, and for loads transmitted to the building structure. Engineering analysis and calculations will not be reviewed and will be retained for record only. The Contractor is responsible for the design and performance of the delegated design systems and components. The review of a delegated design submittal shall not relieve the Contractor of the responsibility for proper and safe design.
- D. Contractor will be notified through the data management service when review is completed.
- E. Architect will retain electronic file of Product Data and A-E "mark-ups" or corrections of mark-ups.
- F. The Architect will **not** accept physical copies (hard copies) of shop drawings or product data submittals. Physical submittals will be accepted for Samples only. Physical Samples must be submitted through the Construction Manager and must be accompanied by an electronic (PDF) copy of the completed TMP Shop Drawing and Sample Transmittal Form.
- G. One sample from each set will be returned to the Contractor, one filed at the office of the Architect, one at the office of the Construction Manager or and one at the jobsite. If the Contractor intends that samples such as hardware or fixtures be installed on the project or returned at completion of the Project, he shall indicate at time of submittal, otherwise the Owner, Construction Manager and the Architect assume no responsibility for protection or return of such samples.

1.13 EQUIPMENT ROOM LAYOUT DRAWINGS

- A. The Contractor shall prepare and submit equipment room layout drawings as required by the technical specifications and additionally for areas where equipment proposed for use could present interface or space difficulties. Such drawings shall be prepared in the same manner as coordination drawings.

1.14 MATERIALS, EQUIPMENT AND FIXTURE LISTS

- A. Where required by the Technical Provisions, lists of materials, equipment and fixtures shall be submitted by the Contractor. The lists shall be supported by sufficient descriptive material, such as catalogs, cuts, diagrams, and other data published by the manufacturer, as well as evidence of compliance with safety and performance standards, to demonstrate conformance to the specification requirements; catalog numbers alone will not be acceptable.
- B. The data shall include the name and address of the nearest service and maintenance organization that regularly stocks repair parts. No consideration will be given to partial lists submitted from time to time.
- C. Materials, equipment and fixtures will not be approved for use at capacity ratings in excess of manufacturer's published data.
- D. Approval of materials and equipment will be tentative subject to submission of complete shop drawings indicating compliance with the Contract Documents.

\*\* END OF SECTION\*\*

# TMP SHOP DRAWING AND SAMPLE TRANSMITTAL FORM

CONTRACTOR/CONST. MANAGER:	PROJECT TITLE AND LOCATION:	DATE SUBMITTED: _____	NEW _____	SUB. NO. _____
_____	_____	CHECKER: _____	RESUB. _____	RESUB. NO. _____
_____	_____	TMP PROJECT NO. _____		
_____	_____			

SPEC SECTION NO.	NO. PRINT	NO. SEPI	NO. CAT.	NO. SAMPLES	SUBCONTRACTOR/MFR.	ITEM DESCRIPTION	*ACTION CODE	DATE CHECKED	DATE RETURNED	NO. COPIES

The undersigned certifies that the above submitted items have been reviewed in detail and are correct and in strict conformance with the contract documents except as otherwise noted. NOTE: Approval of items submitted does not relieve contractor from complying with all requirements of the contract documents.		<b>* ACTION DEFINITION</b>  R = REVIEWED – NO EXCEPTIONS NOTED RN = REVIEWED WITH CORRECTIONS NOTED RR = REVISE AND SEND RECORD COPY X = NOT APPROVED – RESUBMIT NA = NO ACTION REQ'D
CONTRACTOR'S COMMENTS:   ARCHITECT'S COMMENTS:	_____ <b>CONTRACTOR'S NAME</b>  _____ <b>SIGNATURE</b>  cc: Owner Consultant	

## REFERENCES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 DEFINITIONS

- A. General: Basic Contract definitions are included in the General Conditions.
- B. Indicated: The term "indicated" refers to graphic representations, notes, or schedules on the Drawings, other paragraphs or schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.
- C. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by the Architect," "requested by the Architect," and similar phrases.
- D. Approve: The term "approved," where used in conjunction with the Architect's action on the Contractor's submittals, applications, and requests, is limited to the Architect's duties and responsibilities as stated in General and Supplementary Conditions.
- E. Regulation: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. Furnish: The term "furnish" is used to mean "supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation, and similar operations."
- G. Install: The term "install" is used to describe operations at project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."
- H. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use."
- I. Installer: An "Installer" is the Contractor or an entity engaged by the Contractor, either as an employee, subcontractor, or sub-subcontractor, for performance of a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.
  - 1. The term "experienced" when used with the term "Installer" means having a minimum of 5 previous Projects similar in size and scope to this Project, being familiar with the precautions required, and having complied with requirements of the authority having jurisdiction.
  - 2. Trades: Use of titles such as "carpentry" is not intended to 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 tradespersons of the corresponding generic name.



3. Assignment of Specialists: Certain Sections of the Specifications require that specific construction activities shall be performed by specialists who are recognized experts in the operations to be performed. The specialists must be engaged for those activities, and assignments are requirements over which the Contractor has no choice or option. Nevertheless, the ultimate responsibility for fulfilling Contract requirements remains with the Contractor.
  - a. This requirement shall not be interpreted to conflict with enforcement of building codes and similar regulations governing the Work. It is also not intended to interfere with local trade union jurisdictional settlements and similar conventions.
- J. Project Site is the space available to the Contractor for performance of construction activities, either exclusively or in conjunction with others performing other work as part of the Project. The extent of the Project Site is shown on the Drawings and may or may not be identical with the description of the land upon which the Project is to be built.
- K. Testing Laboratories: A "testing laboratory" is an independent entity engaged to perform specific inspections or tests, either at the Project Site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.

### 1.3 SPECIFICATION FORMAT AND CONTENT EXPLANATION

- A. Specification Format: These Specifications are organized into Divisions and Sections based on the Construction Specifications Institute's MASTERFORMAT 2004 Edition (MF04) numbering system.
  1. Abbreviated Language: Language used in Specifications and other Contract Documents is the abbreviated type. Implied words and meanings will be appropriately interpreted. Singular words will be interpreted as plural and plural words interpreted as singular where applicable and the full context of the Contract Documents so indicates.
  2. Imperative and streamlined language is used generally in the Specifications. Requirements expressed in the imperative mood are to be performed by the Contractor. At certain locations in the text, for clarity, subjective language is used to describe responsibilities that must be fulfilled indirectly by the Contractor, or by others when so noted.
    - a. The words "shall be" shall be included by inference wherever a colon (:) is used within a sentence or phrase.

### 1.4 INDUSTRY STANDARDS

- A. Applicability of Standards: Except where the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Where the date of issue of a referenced standard is not specified, comply with the standard in effect as of date of Contract Documents.
- C. Conflicting Requirements: Where compliance with two or more standards is specified, and the standards establish different or conflicting requirements for minimum quantities or quality levels, refer requirements that are different, but apparently equal, and uncertainties to the Architect for a decision before proceeding.

1. 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. In complying with these requirements, indicated numeric values are minimum or maximum, as appropriate for the context of the requirements. Refer uncertainties to the Architect for a decision before proceeding.
- D. Copies of Standards: Each entity engaged in construction on the Project is required to be familiar with industry standards applicable to that entity's construction activity. Copies of applicable standards are not bound with the Contract Documents.
1. Where copies of standards are needed for performance of a required construction activity, the Contractor shall obtain copies directly from the publication source.
  2. Although copies of standards needed for enforcement of requirements may be included as part of required submittals, the Architect reserves the right to require the Contractor to submit additional copies as necessary for enforcement of requirements.
- E. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. Where such acronyms or abbreviations are used in the Specifications or other Contract Documents, they mean the recognized name of the trade association, standards generating organization, authority having jurisdiction, or other entity applicable to the context of the text provision. Refer to the "Encyclopedia of Associations," published by Gale Research Co., available in most libraries.
- F. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. The following acronyms or abbreviations as referenced in Contract Documents are defined to mean the associated names. Names and addresses are subject to change and are believed to be but are not assured to be accurate and up to date as of date of Contract Documents.

AA	Aluminum Association 900 19th St., NW, Suite 300 Washington, DC 20006 www.aluminum.org	(202)862-5100
AABC	Associated Air Balance Council 1518 K St., NW, Suite 503 Washington, DC 20005 www.aabchq.com	(202)737-0202
AAMA	American Architectural Manufacturers Association 1827 Walden Office Sq., Suite 104 Schaumburg, IL 60173-4268 www.aamanet.org	(847)303-5664
AAN	American Association of Nurserymen (See ANLA)	
AASHTO	American Association of State Highway and Transportation Officials 444 North Capitol St., NW, Suite 249 Washington, DC 20001 www.aashto.org	(202)624-5800

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REFERENCES

AATCC	American Association of Textile Chemists and Colorists P.O. Box 12215 One Davis Dr. Research Triangle Park, NC 27709-2215 www.aatcc.org	(919)549-8141
ABMA	American Bearing Manufacturers Association (Formerly: Anti-Friction Bearing Manufacturers Association) 1200 19th St., NW, Suite 300 Washington, DC 20036-2401 www.abma-dc.org	(202)429-5155
ABMA	American Boiler Manufacturers Association 950 North Glebe Rd., Suite 160 Arlington, VA 22203-1824 www.abma.com	(703)522-7350
ACI	American Concrete Institute P.O. Box 9094 Farmington Hills, MI 48333-9094 www.aci-int.org	(248)848-3700
ACIL	ACIL: The Association of Independent Scientific, Engineering, and Testing Firms 1629 K St., NW, Suite 400 Washington, DC 20006 www.acil.org	(202)887-5872
ACPA	American Concrete Pipe Association 222 West Las Colinas Blvd., Suite 641 Irving, TX 75039-5423 www.concrete-pipe.org	972) 506-7216
ADC	Air Diffusion Council 104 South Michigan Ave., Suite 1500 Chicago, IL 60603	(312) 201-0101
AEIC	Association of Edison Illuminating Companies 600 N. 18th St. P.O. Box 2641 Birmingham, AL 35291-0992 www.aeic.org	(205) 250-2530
AFBMA	Anti-Friction Bearing Manufacturers Association (See ABMA)	
AFPA	American Forest and Paper Association (Formerly: National Forest Products Association) 1111 19th St., NW, Suite 800 Washington, DC 20036 www.afandpa.org	(800) 878-8878 (202) 463-2700

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REFERENCES

AGA	American Gas Association 1515 Wilson Blvd. Arlington, VA 22209 www.aga.com	(703) 841-8400
AHA	American Hardboard Association 1210 W. Northwest Hwy Palatine, IL 60067-1897	(847) 934-8800
AHAM	Association of Home Appliance Manufacturers 20 N. Wacker Dr., Suite 1231 Chicago, IL 60606 www.aham.org	(312) 984-5800
AI	Asphalt Institute P.O. Box 14052 Lexington, KY 40512-4052 www.asphaltinstitute.org	(606) 288-4960
AIA	The American Institute of Architects 1735 New York Ave., NW Washington, DC 20006-5292 www.aia.org	(202) 626-7300
AIA	American Insurance Association 1130 Connecticut Ave., NW, Suite 1000 Washington, DC 20036	(202) 828-7100
AIHA	American Industrial Hygiene Association 2700 Prosperity Ave., Suite 250 Fairfax, VA 22031 www.aiha.org	(703) 849-8888
AISC	American Institute of Steel Construction One East Wacker Dr., Suite 3100 Chicago, IL 60601-2001 www.aisc.web.com	(800) 644-2400 (312) 670-2400
AISI	American Iron and Steel Institute 1101 17th St., NW, Suite 1300 Washington, DC 20036-4700 www.steel.org	(202) 452-7100
AITC	American Institute of Timber Construction 7012 S. Revere Pkwy, Suite 140 Englewood, CO 80112 www.aitc-glulam.org	(303) 792-9559
ALA	American Laminators Association (See LMA)	

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REFERENCES

ALCA	Associated Landscape Contractors of America 150 Elden St., Suite 270 Herndon, VA 20170-4831 www.alca.org	(800) 395-2522 (703) 736-9666
ALI	Associated Laboratories, Inc. P.O. Box 152837 Dallas, TX 75315 www.assoc-labs.com	(214) 565-0593
ALSC	American Lumber Standards Committee P.O. Box 210 Germantown, MD 20875	(301) 972-1700
AMCA	Air Movement and Control Association International, Inc. 30 W. University Dr. Arlington Heights, IL 60004-1893 www.amca.org	(847) 394-0150
ANLA	American Nursery and Landscape Association (Formerly: American Association of Nurserymen) 1250 Eye St., NW, Suite 500 Washington, DC 20005 www.anla.org	(202) 789-2900
ANSI	American National Standards Institute 11 West 42nd St., 13th Floor New York, NY 10036-8002 www.ansi.org	(888) 267-4783 (212) 642-4900
AOAC	AOAC International 481 N. Frederick Ave., Suite 500 Gaithersburg, MD 20877 www.aoac.org	(301) 924-7077
AOSA	Association of Official Seed Analysts P.O. Box 81152 Lincoln, NE 68501-1152 www.zianet.com/AOSA	(402) 476-3852
APA	APA-The Engineered Wood Association (Formerly: American Plywood Association) P.O. Box 11700 Tacoma, WA 98411-0700 www.apawood.org	(253) 565-6600
APA	Architectural Precast Association P.O. Box 08669 Fort Myers, FL 33908-0669 www.archprecast.org	(941) 454-6989

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REFERENCES

API	American Petroleum Institute 1220 L St., NW, Suite 900 Washington, DC 20005-8029 www.api.org	(202) 682-8000
ARI	Air-Conditioning and Refrigeration Institute 4301 Fairfax Dr., Suite 425 Arlington, VA 22203 www.ari.org	(703) 524-8800
ARMA	Asphalt Roofing Manufacturers Association Center Park 4041 Powder Mill Rd., Suite 404 Calverton, MD 20705 www.asphaltroofing.org	(301) 348-2002
ASA	Acoustical Society of America 500 Sunnyside Blvd. Woodbury, NY 11797 //asa.aip.org	(516) 576-2360
ASC	Adhesive and Sealant Council 1627 K St., NW, Suite 1000 Washington, DC 20006-1707 www.ascouncil.org	(202) 452-1500
ASCA	Architectural Spray Coaters Association 895 Doncaster Dr. West Deptford, NJ 08066	(609) 848-6120
ASCE	American Society of Civil Engineers World Headquarters 1801 Alexander Graham Bell Dr. Reston, VA 20191-4400 www.asce.org	(800) 548-2723 (703) 295-6000
ASHES	American Society for Healthcare Environmental Services Division of the American Hospital Association One North Franklin, Suite 2700 Chicago, IL 60606	(312) 422-3860
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers 1791 Tullie Circle, NE Atlanta, GA 30329-2305 www.ashrae.org	(800) 527-4723 (404) 636-8400
ASLA	American Society of Landscape Architects 636 Eye St., NW Washington, DC 20001-3736 www.asla.org	(202) 898-2444

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REFERENCES

ASME	American Society of Mechanical Engineers 345 East 47th St. New York, NY 10017-2392 www.asme.org	(800) 843-2763 (212) 705-7722
ASPA	American Sod Producers Association (See TPI)	
ASPE	American Society of Plumbing Engineers 3617 Thousand Oaks Blvd., Suite 210 Westlake Village, CA 91362-3649	(805) 495-7120
ASQ	American Society for Quality 611 East Wisconsin Ave. Milwaukee, WI 53201-3005 www.asq.org	(800) 248-1946 (414) 272-8575
ASSE	American Society of Sanitary Engineering 28901 Clemens Rd. Westlake, OH 44145 www.asse-plumbing.org	(440) 835-3040
ASTM	American Society for Testing and Materials 100 Barr Harbor Dr. West Conshohocken, PA 19428-2959 www.astm.org	(610) 832-9500
ATIS	Alliance for Telecommunications Industry Solutions (Formerly: Exchange Carriers Standards Association) 1200 G St., NW, Suite 500 Washington, DC 20005 www.atis.org	(202) 628-6380
AWCI	Association of the Wall and Ceiling Industries--International 803 West Broad St., Suite 600 Falls Church, VA 22046 www.awci.org	(703) 534-8300
AWCMA	American Window Covering Manufacturers Association (See WCMA)	
AWI	Architectural Woodwork Institute 1952 Isaac Newton Sq. West Reston, VA 20190 www.awinet.org	(800) 449-8811 (703) 733-0600
AWPA	American Wood-Preservers' Association P.O. Box 5690 Granbury, TX 76049 www.awpa.com	(817) 326-6300

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REFERENCES

AWPB	American Wood Preservers' Bureau (This organization is now defunct.)	
AWS	American Welding Society 550 NW LeJeune Rd. Miami, FL 33126 www.amweld.org	(800) 443-9353 (305) 443-9353
AWWA	American Water Works Association 6666 W. Quincy Ave. Denver, CO 80235 www.awwa.org	(800) 926-7337 (303) 794-7711
BAC	Brick Association of the Carolinas (Formerly: Brick Association of North Carolina) P.O. Box 13290 Greensboro, NC 27415-3290 www.gobrick.com	(800) 622-7425 (336) 273-5566
BHMA	Builders Hardware Manufacturers Association 355 Lexington Ave., 17th Floor New York, NY 10017-6603	(212) 661-4261
BIA	Brick Industry Association 11490 Commerce Park Dr. Reston, VA 22091-1525 www.bia.org	(703) 620-0010
BIFMA	The Business and Institutional Furniture Manufacturer's Association International 2680 Horizon Dr., SE, Suite A1 Grand Rapids, MI 49546-7500 www.bifma.com	(616) 285-3963
CAGI	Compressed Air and Gas Institute c/o Thomas Associates, Inc. 1300 Sumner Ave. Cleveland, OH 44115-2851 www.taol.com/cagi	(216) 241-7333
CAUS	Color Association of the United States 409 W. 44th St. New York, NY 10036-4402	(212) 582-6884
CBMA	Certified Ballast Manufacturers Association 355 Lexington Ave., 17th Floor New York, NY 10017 www.certbal.org	(212) 661-4261
CCC	Carpet Cushion Council P.O. Box 546 Riverside, CT 06878-0546	(203) 637-1312



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REFERENCES

CDA	Copper Development Association Inc. 260 Madison Ave., 16th Floor New York, NY 10016-2401 www.copper.org	(800) 232-3282 (212) 251-7200
CFFA	Chemical Fabrics & Film Association, Inc. c/o Thomas Associates, Inc. 1300 Sumner Ave. Cleveland, OH 44115-2851 www.taol.com/cffa	(216) 241-7333
CGA	Compressed Gas Association 1725 Jefferson Davis Hwy, Suite 1004 Arlington, VA 22202-4102 www.cganet.com	(703) 412-0900
CGSB	Canadian General Standards Board Place du Portage Phase III, 6B1 11 Laurier St. Hull, Quebec K1A 0S5 CANADA www.pwgsc.gc.ca/cgsb Mailing Address: Canadian General Standards Board Sales Centre Ottawa K1A 1G6 CANADA	(819) 956-3500          (819) 956-0425
CISCA	Ceilings and Interior Systems Construction Association 1500 Lincoln Hwy, Suite 202 St. Charles, IL 60174 www.cisca.org	(630) 584-1919
CISPI	Cast Iron Soil Pipe Institute 5959 Shallowford Rd., Suite 419 Chattanooga, TN 37421 www.cispi.org	(423) 892-0137
CLFMI	Chain Link Fence Manufacturers Institute 9891 Broken Land Pkwy, Suite 300 Columbia, MD 21046 www.baileadership.com	(301) 596-2584
CPA	Composite Panel Association (Formerly: National Particleboard Association) 18928 Premiere Ct. Gaithersburg, MD 20879-1569 www.pbmdf.com	(301) 670-0604
CPPA	Corrugated Polyethylene Pipe Association 3621 Secor Rd., Suite 320 Toledo, OH 436046 www.cppa-info.org	(800) 510-2772 (419) 241-2221

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REFERENCES

CRI	Carpet and Rug Institute 310 S. Holiday Ave. Dalton, GA 30722-2048 www.carpet-rug.com	(800) 882-8846 (706) 278-3176
CRSI	Concrete Reinforcing Steel Institute 933 N. Plum Grove Rd. Schaumburg, IL 60173-4758 www.crsi.org	(847) 517-1200
CSSB	Cedar Shake and Shingle Bureau 515 116th Ave., NE, Suite 275 Bellevue, WA 98004-5294 www.cedarbureau.org	(206) 453-1323
CTI	Ceramic Tile Institute of America 12061 West Jefferson Blvd. Culver City, CA 90230-6219	(310) 574-7800
CTI	Cooling Tower Institute P.O. Box 73383 Houston, TX 77273 www.cti.org	(281) 583-4087
DASMA	Door and Access Systems Manufacturers Association, International (Formerly: National Association of Garage Door Manufacturers) c/o Thomas Associates, Inc. 1300 Sumner Ave. Cleveland, OH 44115-2851 www.taol.com/dasma	(216) 241-7333
DHI	Door and Hardware Institute (Formerly: National Builders Hardware Association) 14170 Newbrook Dr. Chantilly, VA 20151-2223 www.dhi.org	(703) 222-2010
DIPRA	Ductile Iron Pipe Research Association 245 Riverchase Pkwy East, Suite O Birmingham, AL 35244 www.dipra.org	(205) 402-8702
DLPA	Decorative Laminate Products Association (Dissolved in 1995 - Now part of KCMA.)	
ECSA	Exchange Carriers Standards Association (See ATIS)	
EIA	Electronic Industries Association 2500 Wilson Blvd. Arlington, VA 22201 www.eia.org	(703) 907-7500

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REFERENCES

EIMA	EIFS Industry Members Association 3000 Corporate Center Dr., Suite 270 Morrow, GA 30260-4116 www.eifsfacts.com	(800) 294-3462 (770) 968-7945
EJMA	Expansion Joint Manufacturers Association 25 N. Broadway Tarrytown, NY 10591-3201 www.ejma.org	(914) 332-0040
ETL	ETL Testing Laboratories, Inc. (Now part of ITS)	
FCI	Fluid Controls Institute c/o Thomas Associates, Inc 1300 Sumner Ave. Cleveland, OH 44115-2851 www.taol.com/fci	(216) 241-7333
FCICA	Floor Covering Installation Contractors Association P.O. Box 948 Dalton, GA 30722-0948	(706) 226-5488
FGMA	Flat Glass Marketing Association (See GANA)	
FM	Factory Mutual System 1151 Boston-Providence Tnpk. P.O. Box 9102 Norwood, MA 02062-9102 www.factorymutual.com	(781) 762-4300
GA	Gypsum Association 810 First St., NE, Suite 510 Washington, DC 20002 www.usg.com	(202) 289-5440
GANNA	Glass Association of North America (Formerly: Flat Glass Marketing Association) 2945 Southwest Wanamaker Dr., Suite A Topeka, KS 66614 www.glasswebsite.com/gana	(913) 266-7013
GRI	Geosynthetic Research Institute 475 Kedron Ave. Folsom, PA 19033 www.drexel.edu/gri	(610) 522-8440
HEI	Heat Exchange Institute c/o Thomas Associates, Inc. 1300 Sumner Ave. Cleveland, OH 44115-2851 www.taol.com/hei	(216) 241-7333

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REFERENCES

HI	Hydraulic Institute 9 Sylvan Way Parsippany, NJ 07054-3802	(888) 786-7744 (973) 267-9700
HI	Hydronics Institute Division of Gas Appliance Manufacturers Association P.O. Box 218 35 Russo Pl. Berkeley Heights, NJ 07922 www.gamanet.org	(908) 464-8200
HMA	Hardwood Manufacturers Association (Formerly: Southern Hardwood Lumber Manufacturers Association) 400 Penn Center Blvd., Suite 530 Pittsburgh, PA 15235-5605 www.hardwood.org	(412) 829-0770
HPVA	Hardwood Plywood and Veneer Association 1825 Michael Farraday Dr. P.O. Box 2789 Reston, VA 22195-0789 www.hpva.org	(703) 435-2900
IAS	International Approval Services Division of Canadian Standards Association 8501 East Pleasant Valley Rd. Cleveland, OH 44131 www.iasapprovals.org	(216) 524-4990
IBD	Institute of Business Designers (Now part of IIDA)	
ICC	International Code Council 5203 Leesburg Pike #708 Falls Church, VA 22041 www.intlcode.org	(703) 931-4533
ICEA	Insulated Cable Engineers Association P.O. Box 440 South Yarmouth, MA 02664 www.icea.net	(508) 394-4424
IEC	International Electrotechnical Commission (Available from ANSI) 11 West 42nd St., 13th Floor New York, NY 10036-8002 www.ansi.org	(888) 267-4783 (212) 642-4900
IEEE	Institute of Electrical and Electronics Engineers 345 E. 47th St. New York, NY 10017-2394 www.ieee.org	(800) 678-4333 (212) 705-7900

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IESNA	Illuminating Engineering Society of North America 120 Wall St., 17th Floor New York, NY 10005-4001 <a href="http://www.iesna.org">www.iesna.org</a>	(212) 248-5000
IGCC	Insulating Glass Certification Council P.O. Box 9 Henderson Harbor, NY 13651	(315) 938-7444
IIDA	International Interior Design Association 341 Merchandise Mart Chicago, IL 60654-1104 <a href="http://www.iida.com">www.iida.com</a>	(800) 888-4432 (312) 467-1950
ILI	Indiana Limestone Institute of America Stone City Bank Building, Suite 400 Bedford, IN 47421 <a href="http://www.iliai.com">www.iliai.com</a>	(812) 275-4426
IMSA	International Municipal Signal Association P.O. Box 539 165 E. Union St. Newark, NY 14513 <a href="http://www.imsasafety.org">www.imsasafety.org</a>	(800) 723-4672 (315) 331-2182
INCE	Institute of Noise Control Engineering P.O. Box 3206, Arlington Branch Poughkeepsie, NY 12603 <a href="http://www.ince.org">www.ince.org</a>	(914) 462-4006
IRI	HSB Industrial Risk Insurers P.O. Box 5010 85 Woodland St. Hartford, CT 06102-5010 <a href="http://www.industrialrisk.com">www.industrialrisk.com</a>	(800) 520-7300 (860) 520-7300
ISA	ISA - International Society for Measurement and Control P.O. Box 12277 67 Alexander Dr. Research Triangle Park, NC 27709 <a href="http://www.isa.org">www.isa.org</a>	(919) 549-8411
ISEA	Industrial Safety Equipment Association 1901 N. Moore St., Suite 808 Arlington, VA 22209 <a href="http://www.safetycentral.org/isea">www.safetycentral.org/isea</a>	(703) 525-1695
ISS	Iron and Steel Society 410 Commonwealth Dr. Warrendale, PA 15086-7512 <a href="http://www.issource.org">www.issource.org</a>	(412) 776-1535

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ITS	Intertek Testing Services (Formerly: Inchcape Testing Services) P.O. Box 2040 3933 US Route 11 Cortland, NY 13045-7902 www.itsglobal.com	(800) 345-3851 (607) 753-6711
KCMA	Kitchen Cabinet Manufacturers Association (Formerly: National Kitchen Cabinet Association) 1899 Preston White Dr. Reston, VA 22191 www.kema.org	(703) 264-1690
LGSi	Light Gage Structural Institute P.O. Box 560746 The Colony, TX 75056	(972) 625-4560
LIA	Lead Industries Association, Inc. 295 Madison Ave., Suite 808 New York, NY 10017 www.leadinfo.com	(800) 422-5323 (212) 578-4750
LMA	Laminating Materials Association (Formerly: American Laminators Association) 116 Lawrence St. Hillsdale, NJ 07642-2730 www.lma.org	(201) 664-2700
LPI	Lightning Protection Institute 3335 N. Arlington Heights Rd., Suite E Arlington Heights, IL 60004-7700 www.lightning.org	(800) 488-6864 (847) 577-7200
MBMA	Metal Building Manufacturers Association c/o Thomas Associates, Inc. 1300 Sumner Ave. Cleveland, OH 44115-2851 www.taol.com/mbma	(216) 241-7333
MCAA	Mechanical Contractors Association of America 1385 Piccard Dr. Rockville, MD 20850-4329 www.mcaa.org	(301) 869-5800
MFMA	Maple Flooring Manufacturers Association (Formerly: Wood and Synthetic Flooring Institute) 60 Revere Dr., Suite 500 Northbrook, IL 60062 www.maplefloor.com	(847) 480-9138
MFMA	Metal Framing Manufacturers Association 401 N. Michigan Ave. Chicago, IL 60611	(312) 644-6610

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MHIA	Material Handling Industry Association 8720 Red Oak Blvd., Suite 201 Charlotte, NC 28217-3957 www.mhia.org	(800) 345-1815 (704) 676-1190
MIA	Marble Institute of America 30 Eden Alley, Suite 301 Columbus, OH 43215 www.marble-institute.com	(614) 228-6194
MIA	Masonry Institute of America 2550 Beverly Blvd. Los Angeles, CA 90057 www.masonryinstitute.org	(213) 388-0472
ML/SFA	Metal Lath/Steel Framing Association 8 South Michigan Ave., Suite 1000 Chicago, IL 60603	(312) 456-5590
MRCA	Midwest Roofing Contractors Association 4840 W. 15th St., Suite 1000 Lawrence, KS 66049 www.mrca.org	(913) 843-4888
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry 127 Park St., NE Vienna, VA 22180-4602 www.mss-hq.com	(703) 281-6613
NAA	National Arborist Association P.O. Box 1094 Amherst, NH 03031-1094 www.natlarb.com	(800) 733-2622 (603) 673-3311
NAAMM	National Association of Architectural Metal Manufacturers 8 South Michigan Ave., Suite 1000 Chicago, IL 60603 www.gss.net/naamm	(312) 322-0405
NAAMM	North American Association of Mirror Manufacturers (See GANA) 2945 Southwest Wanamaker Dr., Suite A Topeka, KS 66614 www.glasswebsite.com/naamm	(913) 266-7013
NACE	NACE International (Formerly: National Association of Corrosion Engineers) P.O. Box 218340 Houston, TX 77218-8340	(281) 492-0535 (281) 492-8254
NAGDM	National Association of Garage Door Manufacturers (See DASMA)	

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NAIMA	North American Insulation Manufacturers Association (Formerly: Thermal Insulation Manufacturers Association) 44 Canal Center Plaza, Suite 310 Alexandria, VA 22314 www.naima.org	(703) 684-0084
NAMI	National Accreditation & Management Institute, Inc. P.O. Box 366 207 S. Washington St. Berkeley Springs, WV 25411	(304) 258-5100
NAPA	National Asphalt Pavement Association NAPA Building 5100 Forbes Blvd. Lanham, MD 20706-4413 www.hotmix.org	(888) 468-6499 (301) 731-4748
NBHA	National Builders Hardware Association (See DHI)	
NBGQA	National Building Granite Quarries Association, Inc. 1220 L. St., NW, Suite 100-167 Washington, DC 20005	(800) 557-2848
NCAC	National Council of Acoustical Consultants 66 Morris Ave., Suite 1A Springfield, NJ 07081 www.ncac.com	(973) 564-5859
NCCA	National Coil Coaters Association 401 N. Michigan Ave. Chicago, IL 60611 www.coilcoaters.org	(312) 321-6894
NCMA	National Concrete Masonry Association 2302 Horse Pen Rd. Herndon, VA 20171-3499 www.ncma.org	(703) 713-1900
NCPI	National Clay Pipe Institute P.O. Box 759 253-80 Center St. Lake Geneva, WI 53147 www.ncpi.org	(414) 248-9094
NCRPM	National Council on Radiation Protection and Measurements 7910 Woodmont Ave., Suite 800 Bethesda, MD 20814-3095 www.ncrp.com	(800) 229-2652 (301) 657-2652



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NCSPA	National Corrugated Steel Pipe Association 1255 23rd St., NW, Suite 850 Washington, DC 20037 www.ncspa.org	(202) 452-1700
NEBB	Natural Environmental Balancing Bureau 8575 Grovemont Circle Gaithersburg, MD 20877-4121 www.mcaa.org/nebb.htm www.nebb.org	(301) 977-3698
NECA	National Electrical Contractors Association 3 Bethesda Metro Center, Suite 1100 Bethesda, MD 20814-3299 www.necanet.org	(301) 657-3110
NEI	National Elevator Industry 185 Bridge Plaza North, Suite 310 Fort Lee, NJ 07024	(201) 944-3211
NELMA	Northeastern Lumber Manufacturers Association 272 Tuttle Rd. P.O. Box 87A Cumberland Center, ME 04021 www.nelma.org	(207) 829-6901
NEMA	National Electrical Manufacturers Association 1300 N 17th St., Suite 1847 Rosslyn, VA 22209 www.nema.org	(703) 841-3200
NETA	InterNational Electrical Testing Association P.O. Box 687 106 Stone St. Morrison, CO 80465-1526 www.electricnet.com/neta	(303) 697-8441
NFPA	National Fire Protection Association One Batterymarch Park P.O. Box 9101 Quincy, MA 02269-9101 www.nfpa.org	(800) 344-3555 (617) 770-3000
NFPA	National Forest Products Association (See AFPA)	
NFRC	National Fenestration Rating Council Incorporated 1300 Spring St., Suite 500 Silver Spring, MD 20910 www.nfrc.org	(301) 589-6372

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NGA	National Glass Association 8200 Greensboro Drive, 3rd Floor McLean, VA 22102-3881	(703) 442-4890
NHLA	National Hardwood Lumber Association P.O. Box 34518 Memphis, TN 38184-0518 www.natlhardwood.org	(901) 377-1818
NIA	National Insulation Association (Formerly: National Insulation and Abatement Contractors Association) 99 Canal Center Plaza, Suite 222 Alexandria, VA 22314 www.insulation.org	(703) 683-6422
NIAC	National Insulation and Abatement Contractors Association (See NIA)	
NKCA	National Kitchen Cabinet Association (See KCMA)	
NLGA	National Lumber Grades Authority #406-First Capital Pl. 960 Quayside Dr. New Westminster, BC V3M 6G2 CANADA	(604) 524-2393
NOFMA	National Oak Flooring Manufacturers Association P.O. Box 3009 Memphis, TN 38173-0009 www.nofma.org	(901) 526-5016
NPA	National Parking Association 1112 16th Street, NW, Suite 300 Washington, DC 20036	(202) 296-4336 (800) 647-7275
NPCA	National Paint and Coatings Association 1500 Rhode Island Ave., NW Washington, DC 20005-5597 www.paint.org	(202) 462-6272
NRCA	National Roofing Contractors Association O'Hare International Center 10255 W. Higgins Rd., Suite 600 Rosemont, IL 60018-5607 www.roofonline.org	(800) 323-9545 (847) 299-9070
NRMCA	National Ready Mixed Concrete Association 900 Spring St. Silver Spring, MD 20910 www.nrmca.org	(301) 587-1400

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NSA	National Stone Association 1415 Elliot Pl., NW Washington, DC 20007 www.aggregates.org	(800) 342-1415 (202) 342-1100
NSF	NSF International (Formerly: National Sanitation Foundation) 3475 Plymouth Rd. Ann Arbor, MI 48105 www.nsf.org	(734) 769-8010
NSSEA	National School Supply and Equipment Association 8300 Colesville Rd., Suite 250 Silver Spring, MD 20910 www.nssea.org	(800) 395-5550 (301) 495-0240
NTMA	National Terrazzo and Mosaic Association 110 E. Market St., Suite 200-A Leesburg, VA 20176-3122 www.ntma.com	(800) 323-9736 (703) 779-1022
NUSIG	National Uniform Seismic Installation Guidelines P.O. Box 0933 Alamo, CA 94507	(925) 555-6331
NWMA	National Woodwork Manufacturers Association (See NWWDA)	
NWWDA	National Wood Window and Door Association (Formerly: National Woodwork Manufacturers Association) 1400 E. Touhy Ave. Des Plaines, IL 60018 www.nwwda.org	(800) 223-2301 (847) 299-5200
PATMI	Powder Actuated Tool Manufacturers' Institute 1603 Boonslick Rd. St. Charles, MO 63301-2244	(314) 947-6610
PCA	Portland Cement Association 5420 Old Orchard Rd. Skokie, IL 60077-1083 www.portcement.org	(847) 966-6200
PCI	Precast/Prestressed Concrete Institute 175 W. Jackson Blvd. Chicago, IL 60604 www.pci.org	(312) 786-0300
PDCA	Painting and Decorating Contractors of America 3913 Old Lee Hwy, Suite 33-B Fairfax, VA 22030 www.pdca.com	(800) 332-7322 (703) 359-0826

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PDI	Plumbing and Drainage Institute 45 Bristol Dr., Suite 101 South Easton, MA 02375 <a href="http://pdi-online.org">//pdi-online.org</a>	(800) 589-8956 (508) 230-3516
PEI	Porcelain Enamel Institute 4004 Hillsboro Pike, Suite 224-B Nashville, TN 37215 <a href="http://www.porcelainenamel.com">www.porcelainenamel.com</a>	(615) 385-5357
PGI	PVC Geomembrane Institute/Technology Program University of Illinois-Urbana Champaign 205 N. Mathews Ave. 2215 Newmark Civil Engineering Lab Urbana, IL 61801 <a href="http://pgi-tp.ce.vivc.edu">//pgi-tp.ce.vivc.edu</a>	(217) 333-3929
PIMA	Photographic and Imaging Manufacturers Association 550 Mamaroneck Ave., Suite 307 Harrison, NY 10528 <a href="http://www.pima.net">www.pima.net</a>	(914) 698-7603
PPFA	Plastic Pipe and Fittings Association 800 Roosevelt Rd., Building C, Suite 20 Glen Ellyn, IL 60137-5833	(888) 314-6774 (630) 858-6540
PPI	Plastics Pipe Institute (The Society of the Plastics Industry, Inc.) 1801 K St., NW, Suite 600K Washington, DC 20006 <a href="http://www.plasticpipe.org">www.plasticpipe.org</a>	(202) 974-5306
RCMA	Roof Coatings Manufacturers Association Center Park 4041 Powder Mill Rd., Suite 404 Calverton, MD 20705 <a href="http://www.roofcoatings.org">www.roofcoatings.org</a>	(301) 348-2003
RCSC	Research Council on Structural Connections Sargent & Lundy 55 E. Monroe St. Chicago, IL 60603	(312) 269-2424
RFCI	Resilient Floor Covering Institute 966 Hungerford Dr., Suite 12-B Rockville, MD 20850-1714	(301) 340-8580
RMA	Rubber Manufacturers Association 1400 K St., NW, Suite 900 Washington, DC 20005 <a href="http://www.rma.org">www.rma.org</a>	(800) 220-7620 (202) 682-4800

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SAE	SAE International 400 Commonwealth Dr. Warrendale, PA 15096-0001 For publications: Call (724) 776-4970 www.sae.org	(724) 776-4841
SDI	Steel Deck Institute P.O. Box 25 Fox River Grove, IL 60021 www.sdi.org	(847) 462-1930
SDI	Steel Door Institute 30200 Detroit Rd. Cleveland, OH 44145-1967 www.steeldoor.org	(440) 899-0010
SEFA	Scientific Equipment and Furniture Association 7 Wildbird Lane Hilton Head Island, SC 29926 www.sefalabfurn.com	(843) 689-6878
SEGD	Society for Environmental Graphic Design 401 F St., NW, Suite 333 Washington, DC 20001-2728	(202) 638-5555
SGCC	Safety Glazing Certification Council P.O. Box 9 Henderson Harbor, NY 13651	(315) 938-7444
SHLMA	Southern Hardwood Lumber Manufacturers Association (See HMA)	
SIGMA	Sealed Insulating Glass Manufacturers Association 401 N. Michigan Ave. Chicago, IL 60611-4267 www.sigmaonline.org/sigma	(312) 644-6610 x3279
SJI	Steel Joist Institute 3127 10th Ave., North Ext. Myrtle Beach, SC 29577-6760	(803) 626-1995
SMA	Screen Manufacturers Association 2850 S. Ocean Blvd., Suite 114 Palm Beach, FL 33480-5535	(561) 533-0991
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association 4201 Lafayette Center Dr. P.O. Box 221230 Chantilly, VA 20151-1209 www.smacna.org	(703) 803-2980

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SPI	The Society of the Plastics Industry, Inc. Spray Polyurethane Division 1801 K St., NW, Suite 600K Washington, DC 20006 www.socplas.org	(800) 951-2001 (202) 974-5200
SPIB	Southern Pine Inspection Bureau 4709 Scenic Hwy Pensacola, FL 32504-9094 www.spib.org	(850) 434-2611
SPRI	SPRI (Formerly: Single Ply Roofing Institute) 200 Reservoir St., Suite 309A Needham, MA 02494-3034 www.spri.org	(781) 444-0242
SSINA	Specialty Steel Industry of North America c/o Collier, Shannon Rill & Scott 3050 K St., NW, Suite 400 Washington, DC 20007 www.ssina.com	(800) 982-0355 (202) 342-8630
SSPC	SSPC: The Society for Protective Coatings 40 24th St., 6th Floor Pittsburgh, PA 15222-4656 www.sspc.org	(800) 837-8303 (412) 281-2331
SSPMA	Sump and Sewage Pump Manufacturers Association P.O. Box 647 Northbrook, IL 60065-0647	(847) 559-9233
STI	Steel Tank Institute 570 Oakwood Rd. Lake Zurich, IL 60047-1559 www.steeltank.com	(847) 438-8265
SWI	Steel Window Institute c/o Thomas Associates, Inc. 1300 Sumner Ave. Cleveland, OH 44115-2851 www.taol.com/swi	(216) 241-7333
SWPA	Submersible Wastewater Pump Association 1806 Johns Dr. Glenview, IL 60025-1657	(847) 729-7972
SWRI	Sealant, Waterproofing and Restoration Institute 2841 Main St. Kansas City, MO 64108 www.swrionline.org	(816) 472-7974

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TCA	Tile Council of America P.O. Box 1787 Clemson, SC 29633 www.tileusa.com	(864) 646-8453
TIMA	Thermal Insulation Manufacturers Association (See NAIMA)	
TPI	Truss Plate Institute 583 D'Onofrio Dr., Suite 200 Madison, WI 53719	(608) 833-5900
TPI	Turfgrass Producers International (Formerly: American Sod Producers Association) 1855-A Hicks Rd. Rolling Meadows, IL 60008 www.turfgrassod.org	(800) 405-8873 (847) 705-9898
UFAC	Upholstered Furniture Action Council P.O. Box 2436 High Point, NC 27261	(910) 885-6085
UL	Underwriters Laboratories Inc. 333 Pfingsten Rd. Northbrook, IL 60062 www.ul.com	(800) 704-4050 (847) 272-8800
UNI	Uni-Bell PVC Pipe Association 2655 Villa Creek Dr., Suite 155 Dallas, TX 75234 members.aol.com/unibell	(972) 243-3902
USITT	USITT: The American Association of Design and Production Professionals in the Performing Arts 6443 Ridings Rd. Syracuse, NY 13206-1111 www.culturenet.ca/usitt	(800) 938-7488 (315) 463-6463
USP	U.S. Pharmacopeia (Formerly: U.S. Pharmacopoeial Convention) 12601 Twinbrook Pkwy Rockville, MD 20852-1790 www.usp.org	(800) 227-8772 (301) 881-0666
WA	Wallcoverings Association 401 N. Michigan Ave. Chicago, IL 60611-4267	(312) 644-6610

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WASTEC	Waste Equipment Technology Association 4301 Connecticut Ave. NW, Suite 300 Washington, DC 20008	(202) 244-4700
WCLIB	West Coast Lumber Inspection Bureau P.O. Box 23145 Portland, OR 97281-3145	(800) 283-1486 (503) 639-0651
WCMA	Window Covering Manufacturers Association (Formerly: American Window Covering Manufacturers Association) 355 Lexington Ave., 17th Floor New York, NY 10017-6603	(212) 661-4261
WEF	Water Environment Federation (Formerly: Water Pollution Control Federation) 601 Wythe St. Alexandria, VA 22314-1994 <a href="http://www.wef.org">www.wef.org</a>	(800) 666-0206 (703) 684-2400
WIC	Woodwork Institute of California P.O. Box 980247 West Sacramento, CA 95798-0247 <a href="http://www.wicnet.org">www.wicnet.org</a>	(916) 372-9943
WMMPA	Wood Moulding & Millwork Producers Association 507 First St. Woodland, CA 95695 <a href="http://www.wmmpa.com">www.wmmpa.com</a>	(800) 550-7889 (530) 661-9591
WPCF	Water Pollution Control Federation (See WEF)	
WRI	Wire Reinforcement Institute 301 E. Sandusky St. Findlay, OH 45840 <a href="http://www.bright.net/~rreiter">www.bright.net/~rreiter</a>	(419) 425-9473
WSC	Water Systems Council Building C, Suite 20 800 Roosevelt Rd. Glen Ellyn, IL 60137	(630) 545-1762
WSFI	Wood and Synthetic Flooring Institute (See MFMA)	
WWPA	Western Wood Products Association Yeon Building 522 SW 5th Ave. Portland, OR 97204-2122 <a href="http://www.wwpa.org">www.wwpa.org</a>	(503) 224-3930



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- G. Federal Government Agencies: Names and titles of Federal Government standards- or specification-developing agencies are often abbreviated. The following abbreviations and acronyms referenced in the Contract Documents indicate names of standards- or specification-developing agencies of the Federal Government. Names and addresses are subject to change and are believed, but are not assured, to be accurate and up-to-date as of the date of the Contract Documents.

CE	Corps of Engineers (U.S. Department of the Army) 20 Massachusetts Ave., NW Washington, DC 20314 <a href="http://www.usace.army.mil">www.usace.army.mil</a> CRD standards are available from: U.S. Army Corps of Engineers Waterways Experiment Station Technical Report Distribution Section Services Branch, TIC 3909 Halls Ferry Rd. Vicksburg, MS 39180-6199	(202) 761-0660          (601) 634-2696
CFR	Code of Federal Regulations (Available from the Government Printing Office) Washington, DC 20401 (Material is usually published first in the "Federal Register.") <a href="http://www.access.gpo.gov">www.access.gpo.gov</a>	(202) 512-1800
CPSC	Consumer Product Safety Commission East West Towers 4330 East-West Hwy Bethesda, MD 20814 <a href="http://www.cpsc.gov">www.cpsc.gov</a>	(800) 638-2772 (301) 504-0990
CS	Commercial Standard (U.S. Department of Commerce) Government Printing Office Washington, DC 20402 For commercial standards, contact: Ms. Brenda Umberger CS & PS Specialist c/o NIST Gaithersburg, MD 20899 <a href="http://www.nist.gov">www.nist.gov</a>	(202) 512-1800       (301) 975-4036
DOC	Department of Commerce 14th St. and Constitution Ave., NW Washington, DC 20230 <a href="http://www.doc.gov">www.doc.gov</a>	(202) 482-2000
DOT	Department of Transportation 400 Seventh St., SW Washington, DC 20590 <a href="http://www.dot.gov">www.dot.gov</a>	(202) 366-4000

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EPA	Environmental Protection Agency 401 M St., SW Washington, DC 20460 <a href="http://www.epa.gov">www.epa.gov</a>	(202) 260-2090
FAA	Federal Aviation Administration (U.S. Department of Transportation) 800 Independence Ave., SW Washington, DC 20591 <a href="http://www.faa.gov">www.faa.gov</a>	(202) 366-4000
FCC	Federal Communications Commission 1919 M St., NW Washington, DC 20554 <a href="http://www.fcc.gov">www.fcc.gov</a>	(202) 418-0126
FDA	Food and Drug Administration 5600 Fishers Lane Rockville, MD 20857 <a href="http://www.fda.gov">www.fda.gov</a>	(301) 443-1544
FHA	Federal Housing Administration (U.S. Department of Housing and Urban Development) 451 Seventh St., SW Washington, DC 20410 <a href="http://www.hud.gov">www.hud.gov</a>	(202) 401-0388
FS	Federal Specification Unit (Available from GSA) 470 East L'Enfant Plaza, SW, Suite 8100 Washington, DC 20407 <a href="http://www.gsa.gov">www.gsa.gov</a>	(202) 619-8925
GSA	General Services Administration F St. and 18th St., NW Washington, DC 20405 <a href="http://www.gsa.gov">www.gsa.gov</a>	(202) 708-5082
MIL	Military Standardization Documents (U.S. Department of Defense) Defense Automated Printing Service 700 Robbins Ave., Building 4D Philadelphia, PA 19111 <a href="http://www.dodssp.daps.mil">www.dodssp.daps.mil</a>	(215) 697-2179
NIST	National Institute of Standards and Technology (U.S. Department of Commerce) Building 101, #A1134, Rte. I-270 and Quince Orchard Rd. Gaithersburg, MD 20899 <a href="http://www.nist.gov">www.nist.gov</a>	(301) 975-2000

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OSHA	Occupational Safety and Health Administration (U.S. Department of Labor) 200 Constitution Ave., NW Washington, DC 20210 www.osha.gov	(202) 219-8148
PS	Product Standard of NBS (U.S. Department of Commerce) Government Printing Office Washington, DC 20402 For product standards, contact: Ms. Brenda Umberger CS & PS Specialist c/o NIST Gaithersburg, MD 20899 www.nist.gov	(202) 512-1800     (301) 975-4036
RUS	Rural Utilities Service (Formerly: Rural Electrification Administration) (U.S. Department of Agriculture) 14th St. and Independence Ave., SW Washington, DC 20250	(202) 692-0187
TRB	Transportation Research Board, National Research Council 2101 Constitution Ave., NW Washington, DC 20418 www.nas.edu/trb	(202) 334-2934
USDA	U.S. Department of Agriculture 14th St. and Independence Ave., SW Washington, DC 20250 www.usda.gov	(202) 720-8732
USPS	U.S. Postal Service 475 L'Enfant Plaza, SW Washington, DC 20260-0010 www.usps.gov	(202) 268-2000

1.5 GOVERNING REGULATIONS/AUTHORITIES

- A. The Architect has contacted authorities having jurisdiction where necessary to obtain information necessary for preparation of Contract Documents; that information may or may not be of significance to the Contractor. Contact authorities having jurisdiction directly for information and decisions having a bearing on the Work.
- B. Copies of Regulations: Obtain copies of the following regulations and retain at the Project Site, available for reference by parties who have a reasonable need for such reference.

1.6 SUBMITTALS

- A. Permits, Licenses, and Certificates: For the Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, and similar documents, correspondence, and records

established in conjunction with compliance with standards and regulations bearing upon performance of the Work.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

**\*\*END OF SECTION\*\***

## ABBREVIATIONS

## PART 1 - GENERAL

1.1 The following is a list of abbreviations utilized throughout the Contract Documents.

A		B		C	
ABV.	Above	B/B	Back-to-Back	CAB.	Cabinet
A.F.F.	Above Finish Floor	B.F.P.	Back Flow Preventer	C.U.H.	Cabinet Unit Heater
ABR.	Abrasive	B.D.D.	Back Draft Damper	CAP.	Capacity
ABS.	Absorbing	B.F.	Barrier Free	CPT.	Carpet
ACC.	Access	B.B.R.	Base Board	CSMT.	Casement
A.C.C.	Air Cooled		Radiation	CSWRK.	Casework
	Condenser	B.PL.	Base Plate	CSG.	Casing
ACC.PNL.	Access Panel	BSMT.	Basement	C.I.	Cast Iron
A.V.	Acid Vent	B.	Bath Room	C.I.F.	Cast Iron Frame
A.W.	Acid Waste	BM.	Beam	C.I.P.	Cast Iron Pipe
AC.	Acoustic/Acoustical	BRG	Bearing	CSTG.	Casting
AC.T.	Acoustic Tile	BR.	Bedroom	CAT.NO.	Catalog Number
AC.INSUL.	Acoustical Insulation	B.M.	Bench Mark	C.B.	Catch Basin
A.D.A.	Americans with Disability Act.	BT.	Bent	CLG.	Ceiling
	Addendum	BETW.	Between	C.D.	Ceiling Diffuser
ADD.	Addendum	BEV.	Bevel	CLG.HT.	Ceiling Height
ADDN.	Addition	BIT.	Bituminous	CEM.	Cement
ADDNL.	Additional	B.I.	Black-iron	CEM.PLAS.	Cement Plaster
ADH.	Adhesive	BLK.	Block	CTR.	Center
ADJ.	Adjacent/ Adjustable	BD.	Board	C.L.	Center Line
AGGR.	Aggregate	BLR.	Boiler	C/C	Center-to-Center
A.C.B.	Air Circuit Breaker	BLR.F.	Boiler Feed	CER.	Ceramic
A/C	Air Conditioning	BLR.H.	Boiler House	CER.T.	Ceramic Tile
A.C.	Air Conditioner	B.S.	Both Side	CBD.	Chalkboard
A.C.C.	Air Conditioning	B.W.	Both Ways	CHAM.	Chamfer
	Compressor	BOT.	Bottom	CHG.	Change
A.C.U.	Air Conditioning Unit	B.O.D.	Bottom of Duct	C/CHAN.	Channel
A.H.U.	Air Handling Unit	B.O.P.	Bottom of Pipe	CHKD. PL.	Checkered Plate
ALT.	Alternate	BOT.EL.	Bottom Elevation	CH.W.R.	Chilled Water Return
ALUM./AL.	Aluminum	BLVD.	Boulevard	CH.W.S.	Chilled Water Supply
AMT.	Amount	BDRY.	Boundry	CHD.	Chord
AMP.	Amphere	BRKT.	Bracket	CIRCUM.	Circumference
AMPL.	Amplifier	B.HP.	Brake Horsepower	CIR.	Circle/Circular
ANCH.	Anchor/Anchorage	BR.	Brass	CIRC.	Circuit
A.B.	Anchor Bolt	BRKR.	Breaker	CIRC.	Circulation
&	And	BRK.	Brick	C.BR.	Circuit Breaker
L/AN.	Angleg	B.T.U.	British Thermal Unit	C-	Civil Drawing
ANOD.	Anodized	BRZ.	Bronze		Number
APT.	Apartment	BLDG.	Building	CL.	Class
APR.	Approved	B.L.	Building Line	CLRM.	Classroom
APPR.	Approximate	B.M.S.	Building	C.O.	Clean Out
ARCH.	Architect		Management System	CLR.	Clear
	Architectural	B.U.R.	Built-up Roofing	CLR. GL.	Clear Glass
A-	Architectural Drawing	BN.	Bullnose	CLR. W.GL.	Clear Wire Glass
	Number	BLKHD.	Bulkhead	COEF.	Coefficient
A.T.	Ash Tray	BULL.	Bulletin	C.W.	Cold Water
ASPH.	Asphalt	B.A.	Burglar Alarm	COL.	Column
ASSY.	Assembly	BUZZ.	Buzzer	CO.	Company
@	At			COMPT.	Compartment
AUTO.	Automatic			COMPO.	Composition
A.S.R.	Automatic Sprinkler			C.A.	Compressed Air
	Riser			COMPR.	Compressor
AUX.	Auxiliary			CONC.	Concrete
AVG.	Average			C.M.U.	Concrete Masonry Unit

SECTION 014213  
ABBREVIATIONS

C.W.R. Condensing Water Return  
C.W.S. Condensing Water Supply  
COND. Condensate  
COND. Conduit  
CONF. Conference  
CONN. Connect  
C.A.V. Constant Air Volume  
CONST. Construction  
C.J. Control Joint  
CONT. Continue/Continuous  
CONTR. Contractor  
C.P. Control Panel  
CONV. Convector  
CNVYR. Conveyor  
COR. Corner  
C.G. Corner Guard  
CORR. Corridor/Corrugated  
CPR. Copper  
CNTR. Counter  
CTSK. Countersink/Countersunk  
  
CRS. Course  
COV. Cover  
COV.PL. Cover Plate  
C.C.T. Cubical Curtain Track  
CU.FT. Cubic Feet/Cubic Foot

C.F.M. Cubic Feet Per Minute  
C.Y. Cubic Yard  
CULV. Culvert  
C.D. Cup Dispenser  
CYL. Cylinder  
CYC. Cycles

D

DMPR. Damper  
DMPFG. Dampproofing  
D.L. Dead Load  
DB. Decibel  
D. Deep  
DEG. Degree  
DMT. Demountable  
PARTN. Partition  
DEPT. Department  
DEPR. Depressed  
DES. Design  
DET. Detail  
D.E.CO. Detroit Edison Co.  
DIAG. Diagonal  
DGM. Diagram  
DIA. Diameter  
DIFF. Diffuser  
DIM. Dimension  
D.R. Dining Room  
DIR. Directory  
D.D.C. Direct Digital Control  
DISC. Disconnect

DISCONT. Discontinuous  
DW. Dishwasher  
DISP. Dispenser  
DIST. Distance  
D.P. Distribution Panel  
DO. Ditto  
DIV. Divider/Division  
DR. Door  
D.O. Door Opening  
DR.OP. Door Operator  
DBL. Double  
D.A. Double Acting  
D.H. Double Hung  
DWL. Dowel  
DN. Down  
D.S. Downspout  
D.S.B. Downspout Boot  
DRN. Drain  
D.T. Drain Tile  
D.T.C. Drain Tile Connector  
DWR. Drawer  
DWG. Drawing  
D.F. Drinking Fountain  
D.B. Dry Bulb  
D.S.P. Dry Stand Pipe  
DBWTR. Dumbwaiter  
DUP. Duplicate  
D.DR. Dutch Door

E

EA. Each  
E.F. Each Face  
E.W. Each Way  
E. East  
ELAST. Elastomeric  
FLASH. Flashing  
ELAST W.P. Elastomeric Waterproofing  
E.S.R. Elastomeric Sheet Roofing  
E.D.H. Electric Duct Heater  
ELEC. Electric/Electrical  
ELEC. CL. Electric Closet  
ELEC.CAB. Electrical Cabinet  
E.C. Electrical Contractor  
E- Electrical Drawing Number  
E.P. Electrical Panel  
E.R.P. Electric Radiant Panel  
E.U.H. Electric Unit Heater  
EWC Electric Water Cooler  
E.W.H. Electric Water Heater  
ELEC.OPER. Electrically Operated  
EL. Elevation  
ELEV. Elevator  
EMERG. Emergency  
ENCL. Enclosure  
ENGR. Engineer

E/E End-to-End  
E.A.T. Entering Air Temperature  
ENTR. Entrance/Entry  
EP. Epoxy  
EQ. Equal  
EQUIP. Equipment  
EQUIV. Equivalent  
ESC. Escalator  
EST. Estimate  
EXC. Excavated  
EXH. Exhaust  
E.D. Exhaust Duct  
E.F. Exhaust Fan  
E.G. Exhaust Grille  
E.R. Exhaust Register  
EXIST. Existing  
EXP. Expansion  
EXP.B. Expansion Bolt  
E.J. Expansion Joint  
EXPL.P. Explosion Proof  
EXP'D. Exposed  
EXT'N. Extension  
EXT. Exterior  
E.H. Extra Heavy  
EXTR. Extruded  
E.S.P. External Static Pressure

F

FAB. Fabricated/Fabric  
F/F Face-to-face  
F. FIN. Factory Finish  
F.C.U. Fan Coil Unit  
F.S. Far Side  
FAS. Fastener  
FDR. Feeder  
FT. Feet/Foot  
F.P.M. Feet Per Minute  
FN. Fence  
FBD. Fiberboard  
FIG. Figure  
FIN. Finish/Finished  
FIN.FLR/ Finish Floor  
F.F.  
F.T.R. Finned Tube Radiation  
F.A. Fire Alarm  
F.A.C.P. Fire Alarm Control Panel  
F. BRK. Fire Brick  
F.D. Fire Damper  
F.E. Fire Extinguisher  
F.E.C. Fire Extinguisher Cabinet  
F.H.C. Fire Hose Cabinet  
F.H. Fire Hydrant  
F.L. Fire Line  
F.R. Fire Retardant/Fire Rated

SECTION 014213  
ABBREVIATIONS

F.V.C. Fire Valve Cabinet  
FP. Fireplace  
FPRFG. Fireproofing  
FIXT. Fixture  
FLG. Flange  
FLASH. Flashing  
F.H.M.S. Flat Head Machine  
Screw  
F.H.W.S. Flat Head Wood  
Screw  
F.C. Flexible Connection  
FLR. Floor  
F.CO. Floor Cleanout  
F.D. Floor Drain  
FLR.FIN. Floor Finish  
FLUOR. Fluorescent  
FLDG. Folding  
FTG. Footing  
FMBD. Formboard  
FDN. Foundation  
FR. Frame  
FRMG. Framing  
F.A.I. Fresh Air Intake  
FRZR. Freezer  
F.L.A. Full Load Amperes  
F.S. Full Size  
FURN. Furnish/ Furnished

G

GA. Gauge  
GAL. Gallon  
G.P.H. Gallons Per Hour  
G.P.M. Gallons Per Minute  
GALV. Galvanized  
GALV.I. Galvanized Iron  
G. Gas  
GKT. Gasket  
G.V. & B. Gate Valve And Box  
GA. Gauge  
GEN'L. General  
GL. Glass  
GLZ. Glazing  
G.H.T. Glazed Hollow Tile  
G.B. Grab Bar  
GR. Grade/Grille  
GB. Grade Beam  
GRAT. Grating  
G.L. Grid Line  
GRN. Granite  
G.S. Grease Separator  
G.T. Grease Trap  
GND. Ground  
G.F. Ground Fault  
GT. Grout  
GYP. Gypsum  
GYP.BD. Gypsum Board

H

HNDCP. Handicapped

H.R. Handrail  
H.BD. Hardboard  
HDWE. Hardware  
HDWD. Hardwood  
HD. Head  
HDR. Header  
H.O.A. Hands-Off-Auto  
HD. Head  
H.A.GL. Heat Absorbing  
Glass  
H.R.U. Heat Recovery Unit  
HTR. Heater  
HTG. Heating  
H/V. Heating And  
Ventilating  
H.V.A.C. Heating, Ventilating,  
and Air Conditioning  
H.H.W.R. Heating Hot Water  
Return  
H.H.W.S. Heating Hot Water  
Supply  
HGT. Height  
HEX. Hexagon  
H. High  
H.I.D. High Intensity  
Discharge  
H.P. High Point  
H.PR. High Pressure  
H.S. High Strength  
H.S.B. High Strength Bolt  
H.V. High Voltage  
HWY. Highway  
HSTWY. Hoistway  
H.C. Hollow Core  
H.M. Hollow Metal  
HK. Hook  
HORIZ. Horizontal/  
Horizontally  
HP. Horsepower  
H.B. Hose Bibb  
H.S.P. Hose Stand Pipe  
H.V.C. Hose Valve Cabinet  
HOSP. Hospital  
H.W. Hot Water  
H.W.R. Hot Water Return  
H.W.S. Hot Water Supply  
HR. Hour  
H.O. Hub Outlet  
HYD. Hydrant/Hydraulic  
H. Hydrogen

I

I.D. Identification  
INCAND. Incandescent  
IN. or " Inch/ Inches  
INCIN. Incinerator  
INCL. Include/ Including  
I.W. Indirect Waste  
INFO. Information  
I.D. Inside Diameter

I.F. Inside Face  
INST'L. Install/ Installation  
INSUL. Insulate/ Insulation  
I.H. Intake Hood  
INT. Interior  
INTER. Intermediate  
INV. Invert  
I.E. Invert Elevation

J

J.C. Janitor Closet  
JT. Joint  
JST. Joist  
J.B. Junction Box  
JR. Junior

K

K.P. Kick Plate  
KV. Kilovolt  
KV.A. Kilovolt Ampere  
KW. Kilowatt  
K. Kip (1000#)  
KIT. Kitchen  
K.D. Knock Down  
K.O.P. Knock-Out Panel

L

LBL. Label  
LAB. Laboratory  
LAD. Ladder  
L.B. Lag Bolt  
LAM. Laminate/ Laminated  
LDG. Landing  
L- Landscape Drawing  
Number  
LGE. Large  
LDRY. Laundry  
LAV. Lavatory  
L.A.T. Leaving Air  
Temperature  
L.H. Left Hand  
L.H.R.B. Left Hand Reverse  
Bevel  
LGTH. Length  
LEV. Level  
LIB. Library  
LT. Light  
LPRF. Lightproof  
LTG. Lighting  
L.P. Lighting Panel  
L.R.P. Lighting Receptacle  
Panel  
LTWT. Lightweight

SECTION 014213  
ABBREVIATIONS

LTWT. Lightweight Concrete  
CONC.  
LMS. Limestone  
LTL. Lintel  
L.D. Linear Diffuser  
L.C.D. Linear Ceiling  
Diffuser  
L.F. Linear Feet/Foot  
LIQ. Liquid  
L.L. Live Load  
L.R. Living Room  
LOC. Location  
LKR. Locker  
LG. Long  
L.L.H. Long Leg Horizontal  
L.L.V. Long Leg Vertical  
LVR. Louver  
L.O. Louver Opening  
L.P. Low Point  
L.PR. Low Pressure  
LBR. Lumber  
LBS. Pounds

M

MACH. Machine  
M.B. Machine Bolt  
MACH.RM. Machine Room  
M.U.A. Make-Up Air  
M.A.U. Make-up Air Unit  
M.D.P. Main Distribution  
Panel  
M.S.B. Main Switch Board  
MAINT. Maintenance  
MH. Manhole  
M.V.D. Manual Volume  
Damper  
MFR. Manufacturer  
MAR. Marble  
MK. Mark  
MAS. Masonry  
M.O. Masonry Opening  
MATL. Material  
MAX. Maximum  
MECH. Mechanical  
M- Mechanical Drawing  
Number  
M.C. Medicine Cabinet  
MED. Medium  
MEMB. Membrane  
MET. Metal/ Metallic  
M.C.S. Metal Carpet Strip  
M.D.S. Metal Divider Strip  
M.E.S. Metal Edge Strip  
M.L. Metal Lath  
M.L.& Metal Lath And  
PLAS. Plaster  
MET.W.P. Metallic  
Waterproofing  
MEZZ. Mezzanine

M.D.O.T. Michigan Department  
of Transportation  
MWK. Millwork  
MIN. Minimum  
MIR. Mirror  
M. & S. Mirror And Shelf  
MISC. Miscellaneous  
M.I. Miscellaneous Iron  
MOD. Model  
MON. Monument  
M.S. & S. Mop Strip And Shelf  
M.O. Motor Operated  
M.O.D. Motor Operated  
Damper  
MLDG. Molding  
MTD. Mounted  
MTG. Meeting/Mounting  
MTD. Mounted  
MOV. Moveable  
MOV. Moveable Partition  
PARTN.  
MULL. Mullion  
M Thousand  
MBH 1000BTU/Hour

N

NAT. Natural  
N.S. Near Side  
NK. Neck  
NEUT. Neutral  
N.R.C. Noise Reduction  
Coefficient  
NOM. Nominal  
N.C. Non-Corrosive  
NOR. Normal  
N.C. Normally Closed  
N.O. Normally Open  
N North  
NOS. Nosing  
N.I.C. Not In Contract  
N.T.S. Not To Scale  
NO. or # Number

O

OBS. Obscure  
OBS.GL. Obscure Glass  
OFF. Office  
O.C. On Center  
OPQ. Opaque  
OPG. Opening  
OPER. Operator  
O.B.V.D. Opposed Blade  
Volume Damper  
OPP. Opposite  
OPP.HD Opposite Hand  
ORIG. Original  
ORN. Ornamental

OZ. Ounce  
O/O Out-to-Out  
O.A. Outside Air  
O.D. Outside Diameter  
O.F. Outside Face  
O.H.S. Oval Head Screw  
OA. Overall  
OHD. Overhead  
OHD.DR. Overhead Door  
OXY. Oxygen

P

PRD. Painted  
PR. Pair  
PNL. Panel  
P.T.D. Paper Towel  
Dispenser  
P.T.W.R. Paper Towel Waste  
Receptacle  
PARA. Paragraph  
PRL. Parallel  
PGK. Parking  
P.BD. Particle Board  
PRTN. Partition  
PASS. Passage  
PAT. Patent  
PVM.T. Pavement  
PVG. Paving  
PED. Pedestal  
PERF. Perforated  
PERIM. Perimeter  
PERM. Permanent  
PERP. Perpendicular  
PHOTO. Photograph  
P.H. Physically  
Handicapped  
PC. Piece  
PCS. Pieces  
PLAS. Plaster  
PL.LAM. Plastic Laminate  
PL. Plate  
PL.GL. Plate Glass  
PLAT. Platform  
PLBG. Plumbing  
PLYWD. Plywood  
PT. Point  
P.T. Point of Tangency  
P.C. Point of Curvature  
POL. Polish/ Polished  
PVC. Polyvinylchloride  
PORC. Porcelain  
PORC. Porcelain Enamel  
ENAM.  
POR. Porous  
PORT. Portable  
POS. Position  
P.I.V. Post Indicator Valve  
LBS. or # Pounds  
P.L.F. Pounds Per Linear  
Foot



SECTION 014213  
ABBREVIATIONS

P.S.F. Pounds Per Square Foot  
P.S.I. Pounds Per Square Inch  
P.C.F. Pounds Per Cubic Foot  
P.P. Power Panel  
P/C Precast  
P.T.C. Precast Terrazzo Receptor  
PREFAB. Prefabricated  
PFN. Prefinished  
P.C.T./C.M. Pressure Control Terminal/Control Module  
P.G. Pressure Gauge  
P.R.G. Pressure Relief Grille  
P.R.V. Pressure Reducing Valve  
PRIM. Primary  
PROJ. Project/ Projection  
PROP. Property/ Proposed  
P.L. Property Line  
P.A. Public Address  
P.S. Purse Shelf  
P.B. Push Button

Q

QTY. Quantity  
Q.T. Quarry Tile  
QTR. Quarter  
QTR.RD. Quarter Round

R

RBT. Rabbet  
R.C.P. Radiant Ceiling Panel  
RAD. or R. Radius  
R.W.C. Rain Water Conductor  
R.R. Railroad  
RECV. Receive/ Receiving  
RECPT. Receptacle  
R.P. Receptacle Panel  
REC. Recess  
RECIRC. Recirculation  
RECT. Rectangle / Rectangular  
RED. Reducer  
RWD. Redwood  
REF. Refer/Reference  
REFL. Reflected/Reflective  
REFRIG. Refrigerant  
REFR. Refrigerator  
REG. Register  
RH.C. Reheat Coil  
REINF. Reinforce/Reinforcing Reinforcement

R.H. Relief Hood  
REM. Remove/ Removable  
REP. Repair  
REQ'D. Required  
RESIL. Resilient  
RET. Return  
R.A. Return Air  
R.A.D. Return Air Duct  
R.A.F. Return Air Fan  
REV. Revised/Revision  
R.P.M. Revolutions Per Minute  
R. Riser  
R.H. Right Hand  
R.H.R.B. Right Hand Reverse Bevel  
R.O.W. Right Of Way  
RVT. Rivet  
RD. Road  
R.S.C. Rolling Steel Curtain  
RF. Roof  
R.C. Roof Conductor  
R.D. Roof Drain  
RF.H. Roof Hatch  
R.T.U. Roof Top Unit  
R.S. Roof Sump  
R.V. Roof Ventilator  
RFG. Roofing  
R.W.C. Rain Water Conductor

RM. Room  
R.O. Rough Opening  
RND. or O Round  
R.H.M.S. Round Head Machine Screw  
R.H.W.S. Round Head Wood Screw  
R.T. Rubber Tile

S

SAN. Sanitary  
S.N.D. Sanitary Napkin Dispenser  
S.N.R. Sanitary Napkin Receptacle  
SCHED. Schedule  
SCN. Screen  
STG. Seating  
SECT. Section  
SERV. Service  
S.S. Service Sink  
SHTHG. Sheathing  
SHT. Sheet  
SHT.MET. Sheet Metal  
SH. & P. Shelf And Pole  
SHWR. Shower  
S.C.R. Shower Curtain Rod  
S.DR. Shower Door  
SW. Sidewalk  
SIM. Similar

SGL. Single  
SK. Sink  
S.D. Soap Dispenser  
S.C. Solid Core  
S.T.C. Sound Transmission Class  
S South  
SP. Space  
SPR. Spare  
SPKR. Speaker  
SPEC. Specifications  
S.D. Splitter Damper  
SPRYD. Sprayed  
SPKLR. Sprinkler  
SQ. Square  
S.F. Square Feet/ Square Foot

STAG. Staggered  
ST.STL Stainless Steel  
STD. Standard  
SP. Standpipe  
S.P. Static Pressure  
STA. Station  
STM. Steam  
STL. Steel  
STL.PL. Steel Plate  
STIFF. Stiffener  
STO.FR. Storefront  
STOR. Storage  
ST. Storm  
STR. Straight  
ST. Street  
STRUCT. Structural Drawing Number

S.G.F.T. Structural Glazed Facing Tile  
S.STL. Structural Steel  
SS.D. Subsoil Drain  
SS.D.C. Subsoil Drain Connection  
SUB. Substation  
S.A.G. Supply Air Grille  
S.D. Supply Diffuser/ Duct  
SUBST. Substitute  
S.A.R. Supply Air Register  
S.F. Supply Fan  
S.A. Supply Air  
S.A.D. Supply Air Diffuser  
SUPP. Support  
SURF. Surface/Surfacing  
SUSP. Suspend/Suspension  
SW. Switch  
SWBD. Switchboard  
SWGR. Switchgear  
SYM. Symbol/Symmetrical  
SYS. System

T

T.BD. Tackboard  
TAN. Tangent  
TECH. Technical

SECTION 014213  
ABBREVIATIONS

TEL.	Telephone	U.O.N.	Unless Otherwise	W	West
TEL.CAB.	Telephone Cabinet		Noted	W.B.	Wet Bulb
TV	Television	U.S.A.	Untempered Supply	W.	Wide/Width
TV.M.	Television Monitor		Air	W-x-	Wide Flange Section
TEMP.	Temperature	UR.	Urinal	WT	Wide Flange Tee
TEMP.GL.	Tempered Glass				Section
T.W.	Tempered Water			W.O.	Window Opening
T.U.	Terminal Unit		V	W.GL.	Wire Glass
TERR.	Terrazzo			W.M.	Wire Mesh
T.B.	Test Boring			W/	With
T.	Thermostat	VAC.	Vacuum	W/O	Without
THK.	Thick/Thickness	V.B.	Vacuum Breaker	WD.	Wood
T.S.	Thickened Slab	V.C.O.	Vacuum Cleaner	W.L.	Working Line
M (1000)	Thousand		Outlet	W.PT.	Working Point
K (KIP)	Thousand Pounds	V.BARR.	Vapor Barrier	W.I.	Wrought Iron
THD.	Thread/Threaded	VAR.	Variable		
THRESH.	Threshold	V.A.V.	Variable Air Volume		Y
THRU.	Through	VARN.	Varnish		
T.	Tile	VNR	Veneer		
T./TOIL.	Toilet	V. PLAS.	Veneer Plaster		
T.P.D.	Toilet Paper	V.	Vent	YD.	Yard
	Dispenser	V.T.R	Vent Thru Roof	Y.P.	Yield Point
T.P.H.	Toilet Paper Holder	VENT.	Ventilate/ Ventilation	Y.S.	Yield Strength
T & G	Tongue And Groove	V.I.F.	Verify In Field	YR.	Year
T & B	Top & Bottom	VS.	Versus		
T/C	Top Of Cover/Curb	VERT.	Vertical/Vertically		Z
T/EL.	Top Elevation	VERT.C.	Vertical Curve		
T/F	Top Of Footing	VEST.	Vestibule		
T/M	Top Of Masonry	V.I.	Vibration Isolator		
T/P	To Of Pavement	VNY.	Vinyl		
T/R	Top of Rail	V.C.T.	Vinyl Composition	Z.C.	Zinc-Coated
T/R	Top of Rim		Tile		
T/S	Top of Steel	VIN.FAB.	Vinyl Fabric		
T/W	Top of Wall	V.R.S.	Vinyl Reducer Strip		
T.B.	Towel Bar	VIT.	Vitreous		
T.D.	Towel Dispenser	V.C.P.	Vitrified Clay Pipe		
T.D. & W.R.	Towel Dispenser &	VOL.	Volume		
	Waste Receptacle	V.D.	Volume Damper		
T.G.	Transfer Grille	V	Volts		
TRFR.	Transformer				
TRAN.	Transom				
T	Tread		W		
T.D.	Trench Drain				
T.S.	Tube Section				
T.V.	Turning Vane	WAINS.	Wainscot		
T.T.	Twin Tee	W.CAB.	Wall Cabinet		
TYP.	Typical	W.CO.	Wall Cleanout		
		W.H.	Wall Hydrant		
		W/W	Wall-to-wall		
		W.V.	Wall Vent		
	U	WHSE.	Warehouse		
		W.F.	Wash Fountain		
U.C.	Undercut	W.	Waste/Watts		
U.G.	Underground	W & V	Waste And Vent		
U.L.	Underwriters'	W.R.	Waste Receptacle		
	Laboratories, Inc.	W.C.	Water Closet		
ULT.	Ultimate	W.G.	Water Gauge		
UNFIN.	Unfinished	W.H.	Water Heater		
U.H.	Unit Heater	WP.	Waterproofing		
U.SUB.	Unit Substation	W.P.	Weatherproof		
U.V.	Unit Ventilator	W.STPG.	Weatherstripping		
U.S.G.S.	United States	WT.	Weight		
	Geological Survey	W.W.F	Welded Wire Fabric		

PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. DRAWINGS AND GENERAL PROVISIONS of Contract, including General and Supplementary Conditions and other Division 01 Specification sections, apply to work of this section.

1.2 SUBMITTALS

- A. Substitution Request Submittal: Requests for substitution will be considered if presented to the Construction Manager at least 10 days in advance of bid due date.
  - 1. Identify the product, or the fabrication to be replaced in each request. Include related Specification Section and Drawing numbers. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
    - a. Product Data, including Drawings and descriptions of products, fabrication and installation procedures.
    - b. Samples, where applicable or requested.
    - c. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements such as size, weight, durability, performance and visual effect.
    - d. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate Contractors that will become necessary to accommodate the proposed substitution.
    - e. A Statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
    - f. Cost information, including all related costs under this Contract and excluding Architect's redesign costs, net change, if any, in the Contract Sum, and waiving all claims for additional costs related to the substitution which subsequently became apparent.
    - g. Certification by the Contractor that the substitution proposed is appropriate in every significant respect to that required by the Contract Documents, and that it will perform adequately in the application indicated. Include the Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the substitution to perform adequately.
- B. Product Presentation: Conduct a presentation at the Architect's office if required by the Architect to prove appropriateness to the specified product.
- C. Architect's Action: Within one (1) week of receipt of Bids, the Architect may request additional information or documentation necessary for evaluation of the request. Within two (2) weeks of receipt of the request, or one (1) week of receipt of the additional information or documentation, whichever is later, the Architect will notify the Contractor of acceptance or rejection of the proposed substitution. If a decision on use of a proposed substitute is not made or obtained within the time allocated, use the product specified by name. If acceptance is made prior to award, it will be included in the Contract Amount. If acceptance is made after Award, it will be in the form of a Change Order.

1.3 GENERAL REQUIREMENTS FOR SUBSTITUTIONS

A. Substitutions During Bidding:

1. Substitutions shall be included in the proposal under the following conditions only and shall follow all requirements of "Acceptance of Substitutions."
  - a. When the Contractor is unable to obtain competitive prices from more than one of the specified manufacturers.
  - b. When the Contractor knows of another product of equal or better quality and performance.
  - c. When the Contractor has had unsatisfactory experience with one or more of the specified products or has reason to believe that the specified Manufacturer will not provide the necessary guarantees or assume responsibility for performance.

B. Substitutions After Contract:

1. Substitutions proposed after Award of the contract will only be considered for the following reasons.
2. A substantial advantage is offered the Owner, in terms of cost, time, energy conservation or other considerations of merit, after deducting offsetting responsibilities the Owner may be required to bear. Additional responsibilities for the Owner may include additional compensation to the Architect for redesign and evaluation services, increased cost of other construction by the Owner or separate Contractors, and similar considerations.

C. Acceptance of Substitutions:

1. Substitutions will be considered for any manufacturer except those followed by the words "No Substitutions" in the Specifications.
2. In all cases where substitutions are proposed by the Contractor, it shall be the sole responsibility of the Contractor to provide adequate data and samples as required by the Architect to evaluate the substitution.
3. The Architect shall not be obliged to justify his reason for rejecting a proposed substitution.
4. In the event that a substitution is accepted conditionally on the Contractor's agreement to assume full responsibility for equality and performance, the Contract shall provide a full value warranty and agree to make good all damages resulting from the failure of the substitute product.

1.4 ACCEPTANCE OF MATERIALS AND MANUFACTURERS

A. Standard Materials:

1. Architect's acceptance applies to the Manufacturer only and shall not act to permit any deviation from other requirements of the Specifications.
2. Acceptance will be based on the Manufacturer's specifications at time of issuance of Bidding Documents. Deviations from such specifications shall be considered as a substitution.

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3. Requests for acceptance shall be in tabular form stating Specification paragraph and material selected, except as otherwise provided.
  4. Shop Drawings shall not indicate any material for which acceptance has not been received, unless accompanied by a separate request for approval. In no case shall Architect's review and return of Shop Drawings constitute and acceptance of either specified or substitute manufacturers or materials.
- B. Materials Involving Supplementary Warranty of Maintenance Contract:
1. These materials shall be submitted as a request for acceptance over the signature of a qualified technical representative in the direct employ of the Manufacturer of such other person as the manufacturer may authorize in writing. Request for acceptance shall contain the following information.
    - a. Name of project.
    - b. Name of Contractor, Subcontractor or other party to whom material is furnished.
    - c. Reference to Specification Section and Article where material is specified and other Contract Documents necessary for identification.
    - d. Statement of acceptance of documents, conditions, and performance requirements:
      - 1) Statement that documents as issued are in accordance with manufacturer's recommendations for use of specified materials, or
      - 2) Recommended modification of detail, use, application or for substitution of different product by same manufacturer as being more suitable for the performance requirements of the warranty.
    - e. Statement that detailed installation instructions will be provided.
    - f. Extent of job site technical services, consultants or instructors proposed, if any.
    - g. Statement that warranty will be provided.
    - h. Special provisions required to keep warranty in force.
  2. Requests for acceptance may be in the form of a letter including the above items and addressed to the subcontractor responsible for installation of the material, or may be according to a sample form of Material Proposal, provided by the Architect.
  3. Upon receipt of the manufacturer's proposal, the subcontractor shall add his own statement agreeing to comply with the manufacturer's requirements and warranting his own workmanship.
  4. The Contractor shall submit letter of endorsement of copies of all documents, including letters of comment, to the Architect for approval. In the event that the request for approval recommends a change in the work, modification of detail, or substitution of material, the Contractor shall indicate his concurrence with the change as being within the scope of the Contract or indicate the change in the Contract Sum for making such change, or state his objections to the change.

**\*\*END OF SECTION\*\***

## EXECUTION REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Specified Herein: General Requirements for standards of construction operations and procedures of a repetitive or general nature.

#### 1.2 MANUFACTURER'S REVIEW

- A. Manufacturer's review of documents and conditions of use is a statement by the manufacturer or a representative or agent thereof that it has reviewed the documents pertaining to the work and verified the proposed use of the material including details and instructions for applications or installation, is suitable for the intended purpose, and under similar conditions of use.
- B. Obtain and submit a statement from the manufacturer indicating that they have no objection to the proposed details or method of installation, and that instructions for applications or installation are in conformance with manufacturer's recommendations. Statement shall include any additional precautions or protective measures that should be taken.
- C. Manufacturer's review shall recognize adjacent materials and state if there is, in its opinion, a serious question of compatibility including possibility of damage to other materials, or damage to the material or assembly by other materials. Such conditions shall be reconsidered and adjustments made, previous approvals notwithstanding.

#### 1.3 APPROVED APPLICATOR

- A. An approved applicator or installer is one whom the manufacturer has reason to believe is experienced and qualified in the work and is familiar with the product and with the manufacturer's recommendations for use and installation.
- B. Obtain and submit a statement from the manufacturer that the proposed applicator or installer is approved and indicate whether or not this approval is subject to review and observation of the work by the manufacturer's representative.
- C. Manufacturer shall not approve an installer or applicator if, because of past history of performance or other reasons, there is a reasonable doubt that it can be relied upon to perform in accordance with the Contract Documents.
- D. Upon completion of the work, manufacturer shall certify that approved material in the proper quantities have been delivered to the approved applicator for use on the Project.
- E. In the event that manufacturer declines to approve proposed applicator, submit a statement as to whether or not on-site instruction or manufacturer's supervision is recommended.

#### 1.4 MATERIAL HANDLING, STORAGE AND DELIVERY

- A. Where applicable, deliver all packaged materials to the site in manufacturer's original unopened containers.

- B. Properly pack all materials in appropriate containers for shipment. Identify contents with piece marks referenced to shop drawings and as far as possible in some sequence as erection. Provide packing, wrapping and other protection as required to insure satisfactory condition of materials and finishes at time of erection.
- C. Inspection and acceptance will be made on the basis of materials as delivered to the job site.
- D. Provide adequate quantities to allow for damage and breakage during shipment and delivery and for replacement of all materials damaged prior to final acceptance. All such replacement of damaged materials shall be at no additional cost to the Owner.
- E. Store materials and equipment that are subject to degradation by outside exposure in a weathertight enclosure.

1.5 MIXING, THINNING AND STORAGE

- A. Store and mix paints only in areas designated, and provide proper protection for walls and floors.
- B. Mix and thin paints in strict accordance with recommendations of the manufacturer.
- C. Deliver and store paints and flammable materials in the manufacturer's original unopened containers, as far as practicable. Keep partially used materials in tightly closed containers.
- D. Do not store oil or paint soaked rags inside the building. Do not store materials in any room containing a direct-fired heating unit.

1.6 ON SITE INSTRUCTION

- A. On-site instruction shall consist of inspection and instruction performed by a qualified representative of the manufacturer.
- B. Obtain and submit a statement from the manufacturer that its authorized representative will provide the specified inspection and instruction and submit a record of the date on which specified services were provided.
- C. Service shall consist of:
  - 1. Preliminary inspection of substrates and all other conditions that would affect the performance of the work.
  - 2. Give notice of all unacceptable conditions and recommend remedial action.
  - 3. Recommend proper procedures for conditions as encountered at the site.
  - 4. Verify that workers are qualified and have received proper instructions.

1.7 MANUFACTURER'S SUPERVISION

- A. Manufacturer's supervision, in addition to all services specified for on- site instruction, consists of continuing inspection and verification that the work has been performed in accordance with the Contract.
- B. Obtain and submit a statement from the manufacturer that complete supervision will be provided.

- C. Where supervision is specified, all costs shall be included in the Base Bid. Where supervision is recommended as a modification, submit a proposal indicating the extent and additional cost, if any, of such service.
- D. Upon completion submit a report giving dates of inspections and include pertinent information as applicable to the particular trade such as procedures, coats, coverages, tests as necessary to verify conformance and certify that the proper types and quantities of materials were installed.

1.8 WORKMANSHIP

- A. Employ skilled mechanics and fabricate all work in the best and most workman-like manner and in strict accordance with the detail drawings, by fabricating contractors regularly engaged in the particular type or work.
- B. Conform to the acceptable fabrication and erection standards of the manufacturer and to the applicable rulings of Code Authorities.

1.9 FABRICATION

- A. Fabricate and install all items plumb, true, straight, square, level and in proper elevations, plane, locations and alignment with other work. Design all work for adjustment to field connection, fitted with proper joints and intersections, adequately anchored in place. Complete work in every detail.
- B. Design and anchor work so that work will not be distorted not fasteners overstressed from expansion and contraction due to temperature change.
- C. All fasteners for exposed surface where not otherwise indicated shall be concealed.
- D. Fabricated Items:
  - 1. Model numbers of Manufacturers as listed herein are intended to indicate design and detail for each item. Variations affecting function or appearance will not be accepted.
  - 2. Identifying Markings: Where the manufacturer's name, patent number, model number or similar identifying marks are required, locate such markings in as inconspicuous as possible location. In no case will such marks be acceptable as part of the basic design.
  - 3. Hardware for all Units: Concealed fasteners and hardware. Butt hinges are not acceptable as a substitute where item scheduled in Specification is manufactured with concealed pivots or piano hinges.

1.10 INSTALLATION

- A. Accurately locate, carefully plumb and level, and securely attach all accessories.
- B. Provide concealed grounds and backing or other anchorages devices, properly located, as required for fastening.
- C. Use manufacturer's standard mounting devices as best suited to installation conditions and as accepted by the Architect. Make all attachments by positive mechanical fastening devices, except where other installation methods are indicated.



- D. Where so recommended by the manufacturer, install the work under direct supervision of the authorized representative of the manufacturer. Employ workers experienced and qualified in the trade.
- E. Install units true and plumb in the opening maintaining proper contact with frames or adjacent materials and fitting closely to detail at intersection with other materials to provide for proper operation.
- F. Connect and properly adjust all operating devices and equipment to operate smoothly and perfectly.
- G. Upon completion or when directed, conduct careful inspection and correct defective work. Perform necessary adjustments as required to leave the completed installation in efficiently operable condition.

1.11 PREPARATION OF SURFACES FOR COATINGS AND COVERINGS

- A. Inspect all surfaces and verify that all required cants and chamfers are provided, and that all surfaces are free from irregularities of projections that would interfere with proper application.
- B. Thoroughly clean surfaces; remove all loose materials, grease, oil and foreign matter.
- C. Allow surfaces to completely dry before applying materials.
- D. Report all unsatisfactory surfaces to contractor for correction before proceeding. Otherwise proceeding will constitute acceptance of surface by Contractor.
- E. Note: Interior application of solvent type adhesives and systems require special ventilation or special solvents if ventilation is not possible.

1.12 BUILDING-IN, ANCHORS, INSERTS

- A. Unless otherwise stipulated, each trade generally shall promptly furnish anchorage and insert devices, together with adequate setting information, where necessary for building into the work by other trades.
- B. Verify the accuracy of all built-in anchors and inserts.
- C. Delays and errors shall be corrected by the trade responsible therefor.
- D. Power driven anchors of equivalent capacity and function may be accepted, subject to written acceptance, where approved by local jurisdictional authorities.
- E. Do not endanger or alter the work of any other trade without obtaining prior written consent.
- F. Furnish all supports necessary for proper installation of equipment.

**\*\*END OF SECTION\*\***

## CUTTING AND PATCHING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes procedural requirements for cutting and patching.
- B. Related Sections include the following:
  - 1. Division 02 Section "Selective Demolition" for demolition of selected portions of the building for alterations.
  - 2. Divisions 02 through 35 Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.
    - a. Requirements in this Section apply to mechanical and electrical installations. Refer to Divisions 15 and 16 Sections for other requirements and limitations applicable to cutting and patching mechanical and electrical installations.

#### 1.3 DEFINITIONS

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

#### 1.4 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 Existing 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. Utilities: List utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out of service. Indicate how long service 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. Architect'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.

1.5 QUALITY ASSURANCE

- A. Roofing: When modifying an existing roof and adding new penetrations comply with the following requirements:
  1. Notify original roof manufacturer prior to beginning any work and comply with all manufacturer guidelines and requirements.
  2. Provide original roof manufacturer with a brief description of the proposed work, including any required submittals.
  3. Work shall not begin until written approval is received from original roof manufacturer.
  4. Work must be done by an approved roofing manufacturer's contractor.
  5. Original roof manufacturer shall inspect all modifications to the original roof system.
- B. Structural Elements: Do not cut and patch the following structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.
  1. Obtain approval of the cutting and patching proposal before cutting and patching the following structural elements:
    - a. Foundation construction.
    - b. Bearing and retaining walls.
    - c. Structural concrete.
    - d. Structural steel.
    - e. Lintels.
    - f. Timber and primary wood framing.
    - g. Structural decking.
    - h. Stair systems.
    - i. Miscellaneous structural metals.
    - j. Shoring, bracing and sheeting.
    - k. Structural systems of special construction in Division 13 Sections.
- C. Operational Elements: Do not cut and patch the following 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. Obtain approval of the cutting and patching proposal before cutting and patching the following operating elements or safety related elements:
    - a. Primary operational systems and equipment.
    - b. Air or smoke barriers.
    - c. Fire-protection systems.
    - d. Control systems.
    - e. Communication systems.
    - f. Conveying systems.
    - g. Electrical wiring systems.

- h. Operating systems of special construction in Division 13 Sections.
- D. Miscellaneous Elements: Do not cut and patch the following 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.
- 1. Water, moisture, or vapor barriers.
  - 2. Membranes and flashings.
  - 3. Exterior curtain-wall construction.
  - 4. Equipment supports.
  - 5. Piping, ductwork, vessels, and equipment.
  - 6. Noise- and vibration-control elements and systems.
- E. 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 Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- 1. If possible, retain original Installer or fabricator to cut and patch exposed Work listed below. If it is impossible to engage original Installer or fabricator, engage another recognized, experienced, and specialized firm.
    - a. Processed concrete finishes.
    - b. Stonework and stone masonry.
    - c. Ornamental metal.
    - d. Matched-veneer woodwork.
    - e. Preformed metal panels.
    - f. Roofing.
    - g. Firestopping.
    - h. Window wall system.
    - i. Stucco and ornamental plaster.
    - j. Terrazzo.
    - k. Finished wood flooring.
    - l. Fluid-applied flooring.
    - m. Aggregate wall coating.
    - n. Wall covering.
    - o. Swimming pool finishes.
    - p. HVAC enclosures, cabinets, or covers.
    - q. Acoustical Ceilings
    - r. Carpeting
- F. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.6 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.
  - 1. Existing Roof: The existing roof is a roof system which is still under warranty. Comply with the requirements stated in the "Quality Assurance" paragraph above.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections of these Specifications.
- B. Existing Materials: Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing 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 existing 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 existing 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 existing 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 Services: Where existing services are required to be removed, relocated, or abandoned, bypass such services before cutting to avoid interruption of services 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 existing 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.

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- B. Cutting: Cut existing 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. Existing Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
  3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
  4. Excavating and Backfilling: Comply with requirements in applicable Division 2 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 of these Specifications.
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 existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
    - a. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
  4. Ceilings: Patch, repair, or rehang existing 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.

**\*\*END OF SECTION\*\***

## CLOSEOUT PROCEDURES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Specified Herein: General Requirements for Completion of Work prerequisites for Project close-out.

#### 1.2 SUBSTANTIAL COMPLETION

- A. Each Contractor shall submit written certification to the Owner that project or designated portion of project is substantially complete.
- B. The Owner and the Architect will make an inspection within seven days after receipt of certification.
- C. Should the Owner and the Architect consider that work is substantially complete:
  - 1. Contractor shall prepare, and submit to the Architect, a list of items to be corrected, as determined by the inspection.
  - 2. The Architect will prepare and issue a Certificate of Substantial Completion, AIA Document G704, complete with signatures of Owner and Contractor, accompanied by Contractor's list to items to be completed or corrected as verified and amended by the Architect.
  - 3. Owner occupancy of project or designated portion of project:
    - a. Contractor shall:
      - 1) Apply for Certification of Occupancy
      - 2) Direct final cleaning
    - b. Owner will occupy Project, under provisions stated in Certificate of Substantial Completion.
    - c. Contractor: Complete work listed for completion or correction, within designated time.
    - d. Should the Architect consider that work is not substantially complete:
      - 1) The Architect shall immediately notify the Contractor, in writing, stating reasons.
      - 2) The Contractor shall complete work, and submit written notice, certifying that the project of designated portion of the project, is substantially complete.
      - 3) The Architect will reinspect work.

#### 1.3 FINAL INSPECTION

- A. The Contractor shall submit written certification that:
  - 1. The Contract Documents have been reviewed.

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2. The Work has been completed and inspected in accordance with the Contract Documents.
3. Equipment and systems have been tested in presence of the Contractor and are operational.
4. The Project is completed, and ready for final inspection.
5. The Architect will make final inspection after receipt of certification.
6. Should the Architect consider that work is finally complete in accordance with requirements of Contract Documents they shall request project closeout submittals from the Contractor.
7. Should they consider that work is not finally complete:
  - a. They shall notify Contractor, in writing, stating reasons.
  - b. The Contractor shall take immediate steps to remedy the stated deficiencies, and send second written notice certifying that work is complete.
  - c. The Architect will reinspect work.

1.4 SUBMITTALS

- A. Operation and Maintenance Manuals: As specified in respective sections.
- B. Test Reports: As specified in respective sections.
- C. Guarantees: Written guarantees where specified.

**\*\*END OF SECTION\*\***



## ELECTRONIC PROJECT RECORD DOCUMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Specified Herein: General Requirements for preparation and submittal of Project Record Documents.

#### 1.2 DEFINITIONS

- A. Record Documents: Copies of the Contract Documents, Shop Drawings, Product Data and Samples maintained at the site for purpose of recording changes and other project information.
- B. Maintenance and Parts Manuals: Annotated PDF file format Brochures, instructions, parts lists and similar documents, published by manufacturers and suppliers of materials and equipment for purpose of providing information necessary to maintenance, repair and replacement.
- C. "As-Built" Drawings: Except for "as-built" corrections to the Shop Drawings the only record of architectural as-built conditions required will be clean copy of the Contractor's notations on the Record Drawings in Annotated PDF file format, unless otherwise specified.
- D. "As-Built" drawings for Mechanical, Electrical and Life Safety or Security Systems shall be fully dimensioned and detailed drawings, in Annotated PDF file format, showing all systems as they exist at the completion of Work.

#### 1.3 SCHEDULES

- A. Prepare schedule listing required Record Drawings and Maintenance Manual submittals in accordance with "Submittals" Section of this Division 01.
- B. Keep schedule up to date listing record drawings and other documents as they are received from Manufacturers, Suppliers and Subcontractors.
- C. Hold all such material until completion of the project and submit when directed.

#### 1.4 DRAWINGS AND SPECIFICATIONS AT THE SITE

- A. Each Contractor shall maintain at the site and available for reference by the Owner and the Architect one copy of all Drawings, Specifications, Addenda, approved Shop Drawings, Change Orders and other Modifications applicable to their portion of the Work, in good order and marked to record all changes made during construction.
- B. The Drawings, marked to record all changes made during construction, shall be delivered to the Owner upon completion of the Work in Annotated PDF file format.
- C. Record Documents: At the date of Final Completion and as condition precedent to Final Payment, each Contractor shall furnish the following documents to the Owner:

1. Record Drawings in PDF file format showing the field changes affecting the general construction, mechanical, electrical, and all other Work, and indicating the Work as actually installed in the building.
  - a. These shall consist of carefully drawn markings on a set of black and white prints of the Construction Documents obtained especially for the purpose unless otherwise specified. The prints can be scanned into a PDF file when project is completed or the contractor can keep a Annotated PDF file on site.
  - b. The Contractor shall maintain at the job site one set of Construction Documents and indicate thereon each field change as it occurs.
2. A neatly arranged searchable PDF file containing the wiring and control diagrams, operating and maintenance instructions, cuts of all mechanical and electrical equipment and fixtures, as installed including catalogues or parts lists from the prime manufacturer. Said lists shall not be based on local dealer stock number systems.

#### 1.5 RECORD DRAWINGS

- A. Record Drawings are required to establish the location of concealed work deviations from details or dimensions indicated on the construction drawings. Where location or dimensions of portions of the work is indicated by note or line drawings or otherwise indicated to be at the option of the Contractor, the final determination of such options shall be indicated in the Record Drawings.
- B. Record Drawings are required for information only but are intended to provide complete information for as-built drawings.
- C. Final PDF file record copy of all Shop Drawings shall be submitted showing all corrections made and also indicating all field changes or other variations from the details as originally reviewed by the Contractor and the Architect.

#### 1.6 OPERATING AND MAINTENANCE MANUALS

- A. Prior to completion of work in this Contract, each Contractor shall submit for review by the Architect searchable PDF file of manufacturer's catalog data covering all fixtures, equipment and finish materials incorporated into the project. Manufacturer's catalog data shall include full identification of the equipment or fixture capacities, current characteristics, dimensions, and identification of all replacement parts. Operating instructions for all installed equipment, including supplier's names and telephone numbers shall be placed on or lettered on the front page of each catalog or manual.
- B. Maintenance procedure descriptions shall be submitted for all materials requiring special treatments or continued maintenance work and for all assemblies, which may require parts replacement during the life of the installation. Manuals shall indicate recommended schedule for routine service and shall provide complete instructions for performing such service.
- C. Manuals and catalogs shall be searchable PDF format. Each item shall be tab and shall have an index. All material shall be grouped together by specification number.
- D. Contractor shall arrange and provide for the services of factory representatives or other authorized qualified specialists to provide operating and maintenance instruction sessions

directly with Owner's related operating and maintenance personnel for the systems, equipment and materials involved.

- E. These requirements are in addition to other similar requirements stated elsewhere in the Contract Documents including those of "Warranties" Section of Division 01.
- F. Equipment Operation manuals and operating instructions for each item of mechanical and electrical equipment:
  - 1. Operation and Maintenance Charts: Searchable PDF and one (1) hard copy of an operating and maintenance instruction chart which will incorporate applicable comprehensive descriptive instructions, lay-outs, diagrams or any other information that will necessary and/or of value to the operating and maintenance personnel. Hard copy of the charts shall be framed and glazed and mounted at a designated location, and the other three sets shall be included in the operation and maintenance manuals.
  - 2. Operation and Maintenance Manuals: Searchable PDF file of an operation and maintenance manual which shall contain complete instructions for overall operation and maintenance of the facility and its component parts. The manual shall also contain the operating and maintenance instruction charts as specified.

**\*\*END OF SECTION\*\***

## SELECTIVE DEMOLITION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Demolition and removal of selected portions of a building or structure.
  - 2. Demolition and removal of selected site elements.
  - 3. Repair procedures for selective demolition operations.
- B. Related Sections include the following:
  - 1. Division 01 Section "Cutting and Patching" for cutting and patching procedures for selective demolition operations.
  - 2. Division 23 Sections for demolishing, cutting, patching, or relocating mechanical items.
  - 3. Division 26 Sections for demolishing, cutting, patching, or relocating electrical items.

#### 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: Detach items from existing construction and deliver them to Owner.
- C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
- D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

#### 1.4 MATERIALS OWNERSHIP

- A. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, demolished materials shall become Contractor's property and shall be removed from Project site.
- B. Historic items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to Owner that may be encountered during selective demolition remain Owner's property. Carefully remove and salvage each item or object in a manner to prevent damage and deliver promptly to Owner.

1.5 SUBMITTALS

- A. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- B. Proposed Dust-Control and Noise-Control Measures: Submit statement or drawing that indicates the measures proposed for use, proposed locations, and proposed time frame for their operation. Identify options if proposed measures are later determined to be inadequate.
- 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.
  - 3. Coordination for shutoff, capping, and continuation of utility services.
  - 4. Use of elevator and stairs.
  - 5. Locations of temporary partitions and means of egress.
  - 6. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- D. Inventory: After selective demolition is complete, submit a list of items that have been removed and salvaged.
- E. Predemolition Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by selective demolition operations. Submit before Work begins.
- F. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.
- G. 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.

1.6 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.
- B. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.
- C. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- D. Standards: Comply with ANSI A10.6 and NFPA 241.

- E. Predemolition Conference: Conduct conference at Project site to comply with requirements in Division 01. Review methods and procedures related to selective demolition including, but not limited to, the following:
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.

1.7 PROJECT 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. Provide not less than 72 hours' notice to Owner of activities that will affect Owner's operations.
- B. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.
1. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from authorities having jurisdiction.
- C. Owner assumes no responsibility for condition of areas to be selectively demolished.
1. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- 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 materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
- E. Storage or sale of removed items or materials on-site will not be permitted.
- F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
1. Maintain fire-protection facilities in service during selective demolition operations.

1.8 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.
1. If possible, retain original Installer or fabricator to patch the exposed Work listed below that is damaged during selective demolition. If it is impossible to engage original

Installer or fabricator, engage another recognized experienced and specialized firm.

- a. Matched-veneer woodwork.
- b. Preformed metal panels.
- c. Roofing.
- d. Window wall system.
- e. Terrazzo.
- f. HVAC enclosures, cabinets, or covers.

## PART 2 - PRODUCTS

### 2.1 REPAIR MATERIALS

- A. Use repair materials identical to existing materials.
  - 1. If identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
  - 2. Use materials whose installed performance equals or surpasses that of existing materials.
- B. Comply with material and installation requirements specified in individual Specification Sections.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped.
- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.
- D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.
- E. Engage a professional engineer to survey 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 demolition operations.
- F. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

### 3.2 UTILITY SERVICES

- A. Existing Utilities: Maintain services indicated to remain and protect them against damage during selective demolition operations.
- B. Do not interrupt existing utilities serving occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to authorities having jurisdiction.

1. Provide at least 72 hours' notice to Owner if shutdown of service is required during changeover.
- C. Utility Requirements: Locate, identify, disconnect, and seal or cap off indicated utilities serving areas to be selectively demolished.
1. Owner will arrange to shut off indicated utilities when requested by Contractor.
  2. Arrange to shut off indicated utilities with utility companies.
  3. If utility services are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary utilities that bypass area of selective demolition and that maintain continuity of service to other parts of building.
  4. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.
  5. Refer to Divisions 15 and 16 for other applicable requirements and limitations.

### 3.3 PREPARATION

- A. Dangerous Materials: Drain, purge, or otherwise remove, collect, and dispose of chemicals, gases, explosives, acids, flammables, or other dangerous materials before proceeding with selective demolition operations.
- B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
  2. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction.
  3. Protect existing site improvements, appurtenances, and landscaping to remain.
  4. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
- C. 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.
- D. Temporary Enclosures: Provide temporary enclosures for protection of existing building and construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
  1. Where heating or cooling is needed and permanent enclosure is not complete, provide insulated temporary enclosures. Coordinate enclosure with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.
- E. Temporary Partitions: Erect and maintain dustproof partitions and temporary enclosures to limit dust and dirt migration and to separate areas from fumes and noise.
- F. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent movement, settlement, or collapse of construction 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 POLLUTION CONTROLS

- A. Dust Control: Use water mist, temporary enclosures, and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations.
  1. Do not use water when it may damage existing construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
  2. Wet mop floors to eliminate trackable dirt and wipe down walls and doors of demolition enclosure. Vacuum carpeted areas.
- B. Disposal: Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
  1. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
- C. Cleaning: 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.

### 3.5 SELECTIVE DEMOLITION

- 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.
    - a. Remove debris from elevated portions by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

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 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.
  10. Return elements of construction and surfaces that are to remain to condition existing before selective demolition operations began.
  11. Explosives: Use of explosives is not permitted.
- B. Existing Facilities: Comply with building manager's requirements for using and protecting elevators, stairs, walkways, loading docks, building entries, and other building facilities during selective demolition operations.
- C. Removed and Salvaged Items: Comply with the following:
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 on-site .
  5. Protect items from damage during transport and storage.
- D. Removed and Reinstalled Items: Comply with the following:
1. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
  2. Pack or crate items after cleaning and repairing. Identify contents of containers.

3. Protect items from damage during transport and storage.
  4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.
- F. Concrete: Demolish in small sections. Cut concrete to a depth of at least 3/4 inch (19 mm) at junctures with construction to remain, using power-driven saw. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete indicated for selective demolition. Neatly trim openings to dimensions indicated.
- G. Structural Steel: Dismantle field connections without bending or damaging steel members. Do not use flame-cutting torches unless otherwise authorized by Architect.
1. Transport steel trusses and joists as whole units without dismantling them further.
- H. Below-Grade Construction: Demolish in sections. Remove below-grade construction, including basements, foundation walls and footings, completely to at least 12 inches below grade unless otherwise indicated on Drawings.
- I. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.
- J. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.
- K. Building Components: Remove metal gratings, metal ladders, doors, windows, door hardware, cabinets, mirrors, chalkboards and marker boards, tackboards, toilet accessories, plumbing fixtures, and light fixtures, as whole units, intact and undamaged.
- L. Elevators: Remove as whole units as much as practical.
- M. Equipment: Disconnect equipment at nearest fitting connection to services, complete with service valves. Remove as whole units, complete with controls.
- N. Air-Conditioning Equipment: Remove equipment without releasing refrigerants.
- O. Carpet and Pad: Remove in large pieces and roll tightly after removing demolition debris, trash, adhesive, and tack strips.
- P. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI-WP and its Addendum.
1. Remove residual adhesive and prepare substrate for new floor coverings by one of the methods recommended by RFCI.
- Q. Roofing: Remove no more existing roofing than can be covered in one day by new roofing. Refer to applicable Division 7 Section for new roofing requirements.

R. Existing Utilities: Unless otherwise indicated on Drawings, demolish existing utilities and below-grade utility structures that are within 5 feet (1.5 m) outside of footprint indicated for new construction. Abandon utilities outside this area.

1. Fill abandoned utility structures with satisfactory soil materials according to backfill requirements in Division 2 Section "Earthwork."
2. Piping: Disconnect piping at unions, flanges, valves, or fittings.
3. Wiring Ducts: Disassemble into unit lengths and remove plug-in and disconnecting devices.

### 3.6 PATCHING AND REPAIRS

- A. General: Promptly repair damage to adjacent construction caused by selective demolition operations.
- B. Patching: Comply with Division 01 Section "Cutting and Patching."

### 3.7 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.
- B. Burning: Do not burn demolished materials.
- C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

### 3.8 SELECTIVE DEMOLITION SCHEDULE

- A. Existing Items and Construction to Be Removed: As indicated on Drawings.
- B. Existing Items to Be Removed and Salvaged: As indicated on Drawings.
- C. Existing Items to Be Removed and Reinstalled: As indicated on Drawings.
- D. Existing Items to Remain: As indicated on Drawings.

**\*\*END OF SECTION\*\***

CAST-IN-PLACE CONCRETE

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 specifies cast-in place concrete, including formwork, reinforcing, mix design, placement procedures, and finishes.
- B. Cast-in-place concrete includes the following:
  - 1. Foundations and footings.
  - 2. Slabs-on-grade.
  - 3. Fill for steel deck.
- C. Related Sections: The following Sections contain requirements that relate to this Section:
  - 1. Division 2 Section "Cement Concrete Pavement" for concrete walks.
  - 2. Division 5 Section "Steel Deck" for steel deck construction.

1.3 SUBMITTALS

- A. General: Submit the following according to Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for proprietary materials and items, including reinforcement and admixtures, and others if requested by Architect.
- C. Shop drawings for reinforcement detailing fabricating, bending, and placing concrete reinforcement. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup spacing, bent bar diagrams, and arrangement of concrete reinforcement. Include special reinforcing required for openings through concrete structures.
- D. Laboratory test reports for concrete materials and mix design test.

1.4 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:
  - 1. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings."
  - 2. ACI 318, "Building Code Requirements for Reinforced Concrete."

3. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice."
  4. ACI 302, "Guide for Concrete Floor and Slab Construction".
  5. ACI 117, "Standard Specifications for Tolerances for Concrete Construction and Materials".
- B. Materials and installed work may require testing and retesting at any time during progress of Work. Tests, including retesting of rejected materials for installed Work, shall be done at Contractor's expense.
- C. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 1 and the following:
1. At least 35 days prior to submitting design mixes, conduct a meeting to review detailed requirements for preparing concrete design mixes and to determine procedures for satisfactory concrete operations. Review requirements for submittals, status of coordinating work, and availability of materials. Establish preliminary work progress schedule and procedures for materials inspection, testing, and certifications. Require representatives of each entity directly concerned with cast-in-place concrete to attend conference, including, but not limited to, the following:
    - a. Contractor's superintendent.
    - b. Agency responsible for concrete design mixes.
    - c. Agency responsible for field quality control.
    - d. Ready-mix concrete producer.
    - e. Concrete subcontractor.
    - f. Primary admixture manufacturers.

## PART 2 - PRODUCTS

### 2.1 FORM MATERIALS

- A. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings.
- B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or another acceptable material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Form Release Agent: Provide commercial formulation form release agent with a maximum of 350 mg/l volatile organic compounds (VOCs) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- D. Form Ties: Factory-fabricated, adjustable-length, removable or snap-off metal form ties designed to prevent form deflection and to prevent spalling of concrete upon removal. Provide units that will leave no metal closer than 1-1/2 inches to the plane of the exposed concrete surface.
1. Provide ties that, when removed, will leave holes not larger than 1 inch in diameter in the concrete surface.

## 2.2 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Welded Wire Fabric: ASTM A 185, welded steel wire fabric.
- C. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bar-type supports complying with CRSI specifications.
  - 1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.

## 2.3 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I.
  - 1. Use one brand of cement throughout Project unless otherwise acceptable to Architect.
- B. Fly Ash: ASTM C 618, Type C.
- C. Normal-Weight Aggregates: ASTM C 33 and as specified. Provide aggregates from a single source for exposed concrete.
  - 1. For exposed exterior surfaces, do not use fine or coarse aggregates that contain substances that cause spalling.
- D. Water: Potable.
- E. Admixtures, General: Provide concrete admixtures that contain not more than 0.1 percent chloride ions.
- F. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Air-Mix or Perma-Air, Euclid Chemical Co.
    - b. Darex AEA or Daravair, W.R. Grace & Co.
    - c. MB-VR or Micro-Air, Master Builders, Inc.
    - d. Sealtight AEA, W.R. Meadows, Inc.
- G. Water-Reducing Admixture: ASTM C 494, Type A.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Eucon WR-91, Euclid Chemical Co.
    - b. Daracem-55 W.R. Grace & Co.
    - c. Pozzolith Normal or Polyheed, Master Builders, Inc.
- H. High-Range Water-Reducing Admixture: ASTM C 494, Type F or Type G.
  - 1. Products: Subject to compliance with requirements, provide one of the following:

- a. Eucon MR, Euclid Chemical Co.
  - b. WRDA 19 or Daracem, W.R. Grace & Co.
  - c. Rheobuild or Polyheed, Master Builders, Inc.
- I. Water-Reducing, Accelerating Admixture: ASTM C 494, Type E.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Accelguard 80, Euclid Chemical Co.
    - b. Daraset, W.R. Grace & Co.
    - c. Pozzutec 20, Master Builders, Inc.
- J. Water-Reducing, Retarding Admixture: ASTM C 494, Type D.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Eucon Retarder 75, Euclid Chemical Co.
    - b. Daratard-17, W.R. Grace & Co.
    - c. Pozzolith R, Master Builders, Inc.

## 2.4 RELATED MATERIALS

- A. Vapor Retarder: Provide vapor retarder that is resistant to deterioration when tested according to ASTM E 154, as follows:
  - 1. Polyethylene sheet not less than 8 mils thick.
- B. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.
  - 1. Waterproof paper.
  - 2. Polyethylene film.
  - 3. Polyethylene-coated burlap.
- C. Concrete Sealer: Sealer for interior exposed concrete slabs. Prior to application of sealer, cure concrete according to manufacturer's recommendations.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Day-Chem Sure Hard (J17), Dayton Superior.
    - b. Intraseal, Conspec Marketing and Mfg. Co.
- D. Bonding Agent: Polyvinyl acetate or acrylic base.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Polyvinyl Acetate (Interior Only):
      - 1) Superior Concrete Bonder, (J-41) Dayton Superior Corp.
      - 2) Euco Weld, Euclid Chemical Co.
      - 3) Everweld, L&M Construction Chemicals, Inc.
    - b. Acrylic or Styrene Butadiene:
      - 1) Day-Chem Ad Bond, Dayton Superior Corp.



- 2) SBR Latex, Euclid Chemical Co.
  - 3) Daraweld C, W.R. Grace & Co.
  - 4) Everbond, L&M Construction Chemicals, Inc.
  - 5) Acryl-Set, Master Builders Inc.
- E. Epoxy Adhesive: ASTM C 881, two-component material suitable for use on dry or damp surfaces. Provide material type, grade, and class to suit Project requirements.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Resi-Bond (J-58), Dayton Superior.
    - b. Euco Epoxy System #452 or #620, Euclid Chemical Co.
    - c. Epabond, L&M Construction Chemicals, Inc.
    - d. Concesive Standard Liquid, Master Builders, Inc.
    - e. Rezi-Weld 1000, W.R. Meadows, Inc.
- F. Underlayment Compound: Free-flowing, self-leveling, pumpable, cement-based compound for applications from 1 inch thick to feathered edges.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. K-15, Ardex, Inc.
    - b. Levelayer I L&M Construction Chemicals, Inc.
    - c. Underlayment 110, Master Builders, Inc.
- G. Waterstops: Provide a flexible butyl rubber and swellable clay waterproofing compound at all construction joints in concrete walls below grade.
1. Manufacturers: Subject to compliance with requirements, provide one of the following:
    - a. Waterstop RX-101; Cetco.
    - b. Swellstop Waterstop; Greenstreak.

## 2.5 PROPORTIONING AND DESIGNING MIXES

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. For the trial batch method, use an independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.
1. Do not use the same testing agency for field quality control testing.
  2. Limit use of fly ash to not exceed 20 percent of cement content by weight.
- B. Submit written reports to Architect of each proposed mix for each class of concrete at least 15 days prior to start of Work. Do not begin concrete production until proposed mix designs have been reviewed by Architect.
- C. Design mixes to provide normal weight concrete with the following properties as indicated on drawings and schedules:
1. 4000-psi, 28-day compressive strength; water-cement ratio, 0.44 (air-entrained).
  2. 3000-psi, 28-day compressive strength; water-cement ratio, 0.58 maximum (non-air-entrained).

- D. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:
1. Ramps, slabs, and sloping surfaces: Not more than 3 inches.
  2. Reinforced foundation systems: Not less than 2 inches and not more than 4 inches.
  3. Concrete containing high-range water-reducing admixture (superplasticizer): Not more than 8 inches after adding admixture to site-verified 2-to-4-inch slump concrete.
  4. Other concrete: Not more than 4 inches.
- E. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by Architect. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Architect before using in Work.

## 2.6 ADMIXTURES

- A. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.
- B. Use air-entraining admixture in exterior exposed concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus or minus 1-1/2 percent within the following limits:
1. Concrete structures and slabs exposed to freezing and thawing, deicer chemicals, or hydraulic pressure:
    - a. 5.5 percent for 1-1/2-inch maximum aggregate.
    - b. 6.0 percent for 1-inch maximum aggregate.
    - c. 6.0 percent for 3/4-inch maximum aggregate.
    - d. 7.0 percent for 1/2-inch maximum aggregate.
  2. Other concrete not exposed to freezing, thawing, or hydraulic pressure, or to receive a surface hardener: 2 to 4 percent air.
- C. Use admixtures for water reduction and set accelerating or retarding in strict compliance with manufacturer's directions.

## 2.7 CONCRETE MIXING

- A. Ready-Mixed Concrete: Comply with requirements of ASTM C 94, and as specified.
1. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3- EXECUTION

3.1 GENERAL

- A. Coordinate the installation of joint materials, vapor retarder/barrier, and other related materials with placement of forms and reinforcing steel.

3.2 FORMS

- A. General: Design, erect, support, brace, and maintain formwork to support vertical, lateral, static, and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances and surface irregularities complying with the following ACI 347 limits:
  - 1. Provide Class A tolerances for concrete surfaces exposed to view.
  - 2. Provide Class C tolerances for other concrete surfaces.
- B. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in the Work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent cement paste from leaking.
- C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like for easy removal.
- D. Provide temporary openings for clean-outs and inspections where interior area of formwork is inaccessible before and during concrete placement. Securely brace temporary openings and set tightly to forms to prevent losing concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- E. Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
- F. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.
- G. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before placing concrete. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

3.3 VAPOR RETARDER/BARRIER INSTALLATION

- A. General: Place vapor retarder/barrier sheeting in position with longest dimension parallel with direction of pour.

- B. Lap joints 6 inches and seal with manufacturer's recommended mastic or pressure-sensitive tape.

### 3.4 PLACING REINFORCEMENT

- A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports and as specified.
  - 1. Avoiding cutting or puncturing vapor retarder/barrier during reinforcement placement and concreting operations. Repair damages before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by Architect.
- D. Place reinforcement to maintain minimum coverages as indicated for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

### 3.5 JOINTS

- A. Construction Joints: Locate and install construction joints so they do not impair strength or appearance of the structure, as acceptable to Architect.
- B. Provide keyways at least 1-1/2 inches deep in construction joints slabs, Bulkheads designed and accepted for this purpose may be used for slabs.
- C. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.

### 3.6 INSTALLING EMBEDDED ITEMS

- A. General: Set and build into formwork anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached.
- B. Forms for Slabs: Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type screeds.

### 3.7 PREPARING FORM SURFACES

- A. General: Coat contact surfaces of forms with an approved, nonresidual, low-VOC, form-coating compound before placing reinforcement.

- B. Do not allow excess form-coating material to accumulate in forms or come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply according to manufacturer's instructions.
  - 1. Coat steel forms with a nonstaining, rust-preventative material. Rust-stained steel formwork is not acceptable.

### 3.8 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- B. General: Comply with ACI 304, "Guide for Measuring, Mixing, Transporting, and Placing Concrete," and as specified.
- C. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened sufficiently to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation at its final location.
- D. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
  - 1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete complying with ACI 309.
  - 2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix to segregate.
- E. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until completing placement of a panel or section.
  - 1. Consolidate concrete during placement operations so that concrete is thoroughly worked around reinforcement, other embedded items and into corners.
  - 2. Bring slab surfaces to correct level with a straightedge and strike off. Use bull floats or darbies to smooth surface free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
  - 3. Maintain reinforcing in proper position on chairs during concrete placement.
- F. Cold-Weather Placement: Comply with provisions of ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
- G. When air temperature has fallen to or is expected to fall below 40°F (4°C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50°F (10°C) and not more than 80°F (27°C) at point of placement.

1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
  2. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.
- H. Hot-Weather Placement: When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305 and as specified.
1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90°F (32°C). Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
  3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas.
  4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Architect.

### 3.9 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: Provide a rough-formed finish on formed concrete surfaces not exposed to view in the finished Work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding 1/4 inch in height rubbed down or chipped off.
- B. Smooth-Formed Finish: Provide a smooth-formed finish on formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or another similar system. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.
- C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

### 3.10 MONOLITHIC SLAB FINISHES

- A. Scratch Finish: Apply scratch finish to monolithic slab surfaces to receive concrete floor topping or mortar setting beds for tile, Portland cement terrazzo, and other bonded applied cementitious finish flooring material, and where indicated.
  1. After placing slabs, finish surface to tolerances of F(F) 15 (floor flatness) and F(L) 13 (floor levelness) measured according to ASTM E 1155. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set with stiff brushes, brooms, or rakes.

- B. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as specified; slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo; and where indicated.
1. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, when surface water has disappeared, or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units. Finish surfaces to the following tolerances of F(F) (floor flatness) and F(L) (floor levelness) measured according to ASTM E 1155. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.
    - a. F (F) 20, local F (F) 15
    - b. F (L) 15, local F (L) 10
- C. Trowel Finish: Apply a trowel finish to monolithic slab surfaces exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or another thin film-finish coating system.
1. After floating, begin first trowel-finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and finish surfaces to the following tolerances of F(F) (floor flatness) and F(L) (floor levelness) measured according to ASTM E 1155. Grind smooth any surface defects that would telegraph through applied floor covering system.
    - a. Floor slabs to receive wood flooring:
      - 1) F (F) 50, local F (F) 25.
      - 2) F (L) 30, local F (L) 15.
    - b. Typical Floor Slabs:
      - 1) F (F) 30, local F (F) 15.
      - 2) F (L) 20, local F (L) 10.
- D. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, apply a trowel finish as specified, then immediately follow by slightly scarifying the surface with a fine broom.
- E. Nonslip Broom Finish: Apply a nonslip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
1. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

### 3.11 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as specified to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete Work.

- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

### 3.12 CONCRETE CURING AND PROTECTION

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before power floating and troweling.
- B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.
- C. Curing Methods: Cure concrete by moist curing, by moisture-retaining cover curing, or by combining these methods, as specified.
- D. Provide moisture curing by the following methods:
  - 1. Keep concrete surface continuously wet by covering with water.
  - 2. Use continuous water-fog spray.
  - 3. Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with a 4-inch lap over adjacent absorptive covers.
- E. Provide moisture-retaining cover curing as follows:
  - 1. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
- F. Curing Formed Surfaces: Cure formed concrete surfaces, by moist curing with forms in place for the full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.
- G. Curing Unformed Surfaces: Cure unformed surfaces, including slabs, floor topping, and other flat surfaces, by applying the appropriate curing method.
  - 1. Final cure concrete surfaces to receive finish flooring with a moisture-retaining cover, unless otherwise directed.

### 3.13 REMOVING FORMS

- A. General: Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50°F (10°C) for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form-removal operations, and provided curing and protection operations are maintained.



3.14 REUSING FORMS

- A. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.
- B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use patched forms for exposed concrete surfaces except as acceptable to Architect.

3.15 CONCRETE SURFACE REPAIRS

- A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removing forms, when acceptable to Architect.
- B. Mix dry-pack mortar, consisting of one part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing.
  - 1. Cut out honeycombs, rock pockets, voids over 1/4 inch in any dimension, and holes left by tie rods and bolts down to solid concrete but in no case to a depth less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with bonding agent. Place patching mortar before bonding agent has dried.
  - 2. For surfaces exposed to view, blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Provide test areas at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.
- C. Repairing Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Architect. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes and fill with dry-pack mortar or precast cement cone plugs secured in place with bonding agent.
  - 1. Repair concealed formed surfaces, where possible, containing defects that affect the concrete's durability. If defects cannot be repaired, remove and replace the concrete.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface tolerances specified for each surface and finish. Correct low and high areas as specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having the required slope.
  - 1. Repair finished unformed surfaces containing defects that affect the concrete's durability. Surface defects include crazing and cracks in excess of 0.01 inch wide or that penetrate to the reinforcement or completely through nonreinforced sections regardless of width, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.
  - 2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.

3. Correct low areas in unformed surfaces during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when acceptable to Architect.
  4. Repair defective areas, except random cracks and single holes not exceeding 1 inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
- E. Repair isolated random cracks and single holes 1 inch or less in diameter by dry-pack method. Groove top of cracks and cut out holes to sound concrete and clean of dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Place dry-pack before bonding agent has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- F. Perform structural repairs with prior approval of Architect for method and procedure, using specified epoxy adhesive and mortar.
- G. Repair methods not specified above may be used, subject to acceptance of Architect.

3.16 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. General: The Owner will employ a testing agency to perform tests and to submit test reports.
- B. Measure floor finish tolerances in accordance with ASTM E1155 Standard Test Method for determining floor flatness and levelness using the F-number system.
- C. Sampling and testing for quality control during concrete placement may include the following, as directed by Architect.
1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
    - a. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
    - b. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231, pressure method for normal weight concrete; one for each day's pour of each type of air-entrained concrete.
    - c. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4 deg C) and below, when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.
    - d. Compression Test Specimen: ASTM C 31; one set of four standard cylinders for each compressive-strength test, unless otherwise directed. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.
    - e. Compressive-Strength Tests: ASTM C 39; one set for each day's pour exceeding 5 cu. yd. plus additional sets for each 50 cu. yd. more than the first 25 cu. yd. of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.

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CAST-IN-PLACE  
CONCRETE

2. When frequency of testing will provide fewer than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.
  3. When total quantity of a given class of concrete is less than 50 cu. yd., Architect may waive strength testing if adequate evidence of satisfactory strength is provided.
  4. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
  5. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi.
- D. Test results will be reported in writing to Architect, Structural Engineer, ready-mix producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.
- F. Additional Tests: The testing agency will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Architect. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

**\*\*END OF SECTION\*\***

UNIT MASONRY ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.
- B. The provisions and guidelines indicated in ACI 530.1/ASCE 6/TMS 602 Specification for Masonry Structures (referred to hereinafter as the MSJC Code), current at the time of project bidding shall constitute the masonry standard and shall apply to this Section.

1.2 DESCRIPTION OF WORK

- A. Extent of each type of masonry work is indicated on drawings and schedule.
- B. Types of masonry work required include:
  - 1. Concrete Unit Masonry.
  - 2. Reinforced masonry
  - 3. Structural clay facing tile
- C. Products installed but not furnished under this Section include the following:
  - 1. Division 05 Section "Metal Fabrication" for steel lintels in unit masonry.
  - 2. Division 06 Section "Rough Carpentry" for wood nailers and blocking built into unit masonry.
  - 3. Division 07 Section "Fluid Applied Membrane Air & Vapor Barriers"
  - 4. Division 07 Section "Sheet Metal Flashing and Trim" for reglets in masonry joints for metal flashing.
  - 5. Division 07 Section "Firestop Joint Systems" for head-of-wall joints.
  - 6. Division 08 Section "Standard Steel Doors and Frames" for hollow metal frames in unit masonry openings.

1.3 QUALITY ASSURANCE

- A. Testing Agency Services
  - 1. The Construction Manager/Owner will secure and pay for the services of a qualified, independent materials engineer to perform quality assurance testing of mortar and grout materials, to confirm re-bar and anchorage placement, to verify compliance of materials with specified requirements, to observe and document compliance with hot and cold weather construction methods, and to perform required field and laboratory testing. Testing Agency shall be acceptable to the architect and the owner and shall be licensed to practice in the state in which the project is located.

B. Masonry Inspection Requirements:

1. Testing Frequency for Non-Essential Facilities - Level B Quality Assurance:
  - a. Assurance level to be in accordance with Table 4 of the MSJC Specification for Masonry Structures.
  - b. Frequency level for Category I, II or III buildings to be in accordance with Table 1704.5.1 Level 1 Special Inspections of the Michigan Building Code.
2. For this project, the testing and inspecting agency will be hired by the Owner or the Owner's representative.
3. Contractor may retain a qualified consultant to review procedures and construction methods to comply with this specification, industry standards and construction codes.

C. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

D. Masonry Standard: Comply with **the MSJC Code** unless modified by requirements in the Contract Documents.

E. Single source responsibility for Masonry Units: Obtain exposed masonry units of uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from one manufacturer for each different product required for each continuous surface or visually related surfaces.

F. Single source responsibility for Mortar Materials: Obtain mortar ingredients of uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source and producer for each aggregate.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide structural unit masonry that develops indicated net-area compressive strengths (f'm) at 28 days.
- B. Determine net-area compressive strength (f'm) of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in Section 1.4 of the MSJC Code. Provide f'm for concrete masonry construction according to the following:

Use	Compressive Strength, f'm (psi)	Unit Strength (psi)	Grout Strength (psi)	Mortar Type
Typical, unless noted otherwise	20000 min.	2800 min.	2000 min.	M or S

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's product data for each type of masonry unit, accessory, and other manufactured products, including certifications that each type complies with specified requirements.

- B. Shop Drawings: Show fabrication and installation details for the following:
1. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement."
- C. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:
1. Each type of masonry unit required.
    - a. Include size-variation data for brick, verifying that actual range of sizes falls within specified tolerances.
    - b. Include test data, measurements, and calculations establishing net-area compressive strength of masonry units.
  2. Each cement product required for mortar and grout, including name of manufacturer, brand, type, and weight slips at time of delivery.
  3. For each combination of masonry unit type and mortar type, include a written statement identifying the following:
    - a. Net-area compressive strength of masonry units.
    - b. Mortar type.
    - c. Net-area compressive strength of the completed masonry system determined according to Tables 1 and 2 in Section 1.4 of the MSJC Code.
  4. Each combination of masonry unit type and mortar type specified to be manufactured with integral water repellant.
  5. Each material and grade indicated for reinforcing bars.
  6. Each type and size of joint reinforcement.
  7. Each type and size of anchor, tie, and metal accessory.
- D. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
1. Include test reports from past projects which were performed in accordance with ASTM C 780, for mortar mixes intended for this project required to comply with property specification.
  2. Include test reports from past projects which were performed in accordance with ASTM C 1019, for grout mixes intended for this project required to comply with compressive strength requirement.
- E. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in Section 1.4 of **the MSJC Code**.
- F. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.
1. Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with hot-weather requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver masonry materials to project in undamaged condition.
- B. Store and handle masonry units to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion or other causes.
  - 1. Limit moisture absorption of concrete masonry units during delivery and until time of installation to the maximum percentage specified for Type I units for the average annual relative humidity as reported by the U.S. Weather Bureau Station nearest project site.
- C. Store cementitious materials off the ground, under cover and in dry location.
- D. Store aggregates where grading and other required characteristics can be maintained.
- E. Store masonry accessories including metal items to prevent deterioration by corrosion and accumulation of dirt.

1.7 PROJECT CONDITIONS

- A. Protection of work: During erection, cover top of walls with waterproof sheeting at end of each day's work. Cover partially completed structures when work is not in progress.
- B. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
- C. Do not apply uniform floor or roof loading for at least 3 days after building masonry walls or columns.
- D. Staining: Prevent grout or mortar or soil from staining the face of masonry to be left exposed or painted. Remove immediately grout or mortar in contact with such masonry.
- E. Protect base of walls from rain-splashed mud and mortar splatter by means of covering spread on ground and over wall surfaces.
- F. Protect sills, ledges and projections from droppings of mortar.

1.8 COLD WEATHER PROTECTION

- A. Do not lay masonry units which are wet or frozen.
- B. Remove any ice or snow formed on masonry bed by carefully applying heat until top surface is dry to the touch.
- C. Remove masonry damaged by freezing conditions.
- D. For clay masonry units with initial rates of absorption (suction) which require them to be wetted before laying, comply with the following requirements.
  - 1. For units with surface temperatures above 32°F (0°C), wet with water heated to above 70°F (21°C).
  - 2. For units with surface temperatures below 32°F (0°C), wet with water heated to above 130°F (54°C).
- E. Perform the following construction procedures while masonry work is progressing. Temperature ranges indicated below apply to air temperatures existing at time of installation except for grout.

- F. For grout, temperature ranges apply to anticipated minimum night temperatures. In heating mortar and grout materials, maintain mixing temperature selected with 10°F (6°C).
1. 40°F (4°C) to 32°F (0°C):
    - a. Mortar: Heat mixing water to produce mortar temperature between 40°F (4°C) and 120°F (49°C).
    - b. Grout: Follow normal masonry procedures.
  2. 32°F (0°C) to 25°F (-4°C):
    - a. Mortar: Heat mixing water and sand to produce mortar temperatures between 40°F (4°C) and 120°F (49°C); maintain temperature of mortar on boards above freezing.
    - b. Grout: Heat grout materials to 90°F (32°C) to produce in-place grout temperature of 70°F (21°C) at end of work day.
  3. 25°F (-4°C) to 20°F (-7°C):
    - a. Mortar: Heat mixing water and sand to produce mortar temperatures between 40°F (4°C) and 120°F (49°C); maintain temperature of mortar on boards above freezing.
    - b. Grout: Heat grout materials to 90°F (32°C) to produce in-place grout temperature of 70°F (21°C) at end of work day.
    - c. Heat both sides of walls under construction using salamanders or other heat sources.
    - d. Use windbreaks or enclosures when wind is in excess of 15 mph.
  4. 20°F (-7°C) and below:
    - a. Mortar: Heat mixing water and sand to produce mortar temperatures between 40°F (4°C) and 120°F (49°C).
    - b. Grout: Heat grout materials to 90°F (32°C) to produce in-place grout temperature of 70°F (21°C) at end of work day.
    - c. Masonry Units: Heat masonry units so that they are above 20°F (-7°C) at time of laying.
    - d. Provide enclosure and auxiliary heat to maintain an air temperature of at least 40°F (4°C) for 24 hours after laying units.
  5. Do not heat water for mortar and grout to above 160°F (71°C).
- G. Protect completed masonry and masonry not being worked on in the following manner. Temperature ranges indicated apply to mean daily air temperatures except for grouted masonry. For grouted masonry, temperature ranges apply to anticipated minimum night temperatures.
1. 40°F (4°C) to 32°F (0°C):
    - a. Protect masonry from rain or snow for at least 24 hours by covering with weather-resistive membrane.
  2. 32°F (0°C) to 25°F (-4°C):
    - a. Completely cover masonry with weather-resistive membrane for at least 24 hours.



3. 25°F (-4°C) to 20°F (-7°C):
  - a. Completely cover masonry with weather-resistive insulating blankets or similar protection for at least 24 hours, 48 hours for grouted masonry.
4. 20°F (-7°C) and below:
  - a. Except as otherwise indicated, maintain masonry temperature above 32°F (0°C) for 24 hours using enclosures and supplementary heat, electric heating blankets, infrared lamps or other methods proven to be satisfactory. For grouted masonry maintain heated enclosure to 40°F (4°C) for 48 hours.

## PART 2 - PRODUCTS

### 2.1 CONCRETE MASONRY UNITS

- A. General: Comply with referenced standards and other requirements indicated below applicable to each form of concrete masonry unit required.
  1. Provide special shapes where required for lintels, corners, jambs, sash, control joints, headers, bonding and other special conditions.
    - a. Provide bullnose units for outside corners unless otherwise indicated.
    - b. Provide CMU Bond Beam units where indicated.
    - c. Supply standard open-end units and open-end bond beam units to facilitate placement of vertical reinforcement. Units shall comply with the material specification of adjacent construction.
  2. Water-Repellent Admixture: All concrete masonry exposed to the exterior shall be manufactured with a liquid water-repellent block admixture intended for use with concrete masonry.
    - a. Products: Dry-Block Block Admixture as manufactured by Grace Construction Products, a unit of W. R. Grace & Co. or approved equal.
- B. Concrete block: Provide units complying with characteristics indicated below for Grade, Type, face size, exposed face and, under each form of block included, for weight classification.
  1. Exposed Faces: Manufacturer's standard color and texture, unless otherwise indicated.
    - a. Regular (Standard) Concrete Masonry Units using standard aggregate:
      - 1) Manufacturers: Subject to compliance with requirements provide products from one of the following:
        - a) Best Block Company
        - b) Fendt Builder's Supply, Inc.
        - c) National Block Company
        - d) Grand Blanc Cement Products
  2. Grade N.
    - a. Grade N except Grade S may be used above grade in exterior walls with weather protective coatings and in walls not exposed to weather.

SECTION 042000  
UNIT MASONRY  
ASSEMBLIES

3. Size: Manufacturer's standard units with nominal face dimensions of 16" long x 8" high (15-5/8" x 7-5/8" actual) x thicknesses indicated.
  - a. Provide special shape concrete blocks as indicated on drawings.
4. Hollow Load bearing or Non-load bearing Block: ASTM C 90 and as follows:
  - a. Unit Compressive Strength: Provide units with minimum average net-area compressive strength specified under the Performance Requirements of Article 1.4.B above.
  - b. Exterior Walls: Normal or Medium weight – Cavity/Veneer Walls Only
  - c. Exterior Walls: Normal weight – Singly Wythe Walls
  - d. Interior Load or Non-Load Bearing Walls: Lightweight or Medium weight.
5. Solid Load bearing or Non-load bearing Block: ASTM C 145 and as follows:
  - a. Unit Compressive Strength: Provide units with minimum average net-area compressive strength specified under the Performance Requirements of Article 1.4.B above.
  - b. Exterior Walls: Normal or Medium weight – Cavity/Veneer Walls Only
  - c. Exterior Walls: Normal weight – Singly Wythe Walls
  - d. Interior Load or Non-Load Bearing Walls: Lightweight or Medium weight.

## 2.2 EXTERIOR NON-LOAD BEARING REINFORCED MASONRY WALL SCHEDULE

- A. The following table shall apply to all exterior non-load bearing concrete block masonry unit walls as a minimum requirement unless exceeded by drawing requirements.
- B. All exterior load bearing concrete masonry walls will contain steel reinforcing. See structural drawings or contact the architect for additional information.

*WALL HEIGHT	CMU WALL WIDTH	VERTICAL REINFORCEMENT (FULL WALL HEIGHT)	As = IN <sup>2</sup> /L.FT	MAXIMUM HORIZONTAL LOAD	REMARKS
9'-6"	8"	NO REINFORCEMENT	-	15 PSF	
12'-0"	8"	#4 @ 48" O.C.	0.05	20 PSF	
13'-4"	8"	#4 @ 48" O.C.	0.06	24 PSF	
16'-0"	8"	#5 @ 48" O.C.	0.0775	25 PSF	
18'-0"	8"	#5 @ 24" O.C.	0.155	30 PSF	
16'-0"	12"	#5 @ 48" O.C.	0.0775	25 PSF	
18'-0"	12"	#4 @ 32" O.C. OR #5 @ 48" O.C.	0.075 0.0775	32 PSF 32 PSF	
20'-0"	12"	#5 @ 40" O.C.	0.093	30 PSF	
24'-0"	12"	#5 @ 24" O.C.	0.155	32 PSF	
28'-0"	12"	#6 @ 24" O.C.	0.22	28 PSF	
30'-0"	12"	#6 @ 16" O.C.	0.33	27 PSF	
32'-0"	12"	#7 @ 16" O.C. OR 2 #6 @ 32" O.C.**	0.45 0.33	26 PSF 25 PSF	**EACH FACE
34'-0"	12"	#7 @ 8" O.C. OR 2 #7 @ 32" O.C.**	0.90 0.45	29 PSF 29 PSF	**EACH FACE

- NOTE: 1. Assume Design Value  $f'_m$  = 1,500 psi,  $F_s$  = 24,000 psi, M or S Mortar, Medium Weight CMU
2. \*CMU Wall supported height start from foundation (dowels with scheduled reinforcement) and brace at each floor and/or roof level.
3. Grout cells solid at vertical reinforcements full height.
4. Vertical reinforcement to be placed in center of CMU wall U.N.O.
5. Increase wall reinforcement at the corner of all wall up to 10'-0" horizontally by 50% of scheduled reinforcement.
6. Place two (2) vertical bars of scheduled reinforcement at each side of each masonry opening (i.e. door, window, etc.).

## 2.3 INTERIOR NON-LOAD BEARING REINFORCED MASONRY WALL SCHEDULE

- A. The following table shall apply to all internal non-load bearing concrete block masonry unit walls as a minimum requirement unless exceeded by drawing requirements.
- B. All interior load bearing concrete masonry walls will contain steel reinforcing. See structural drawings or contact the architect for additional information.

*WALL HEIGHT	CMU WALL WIDTH H	VERTICAL REINFORCEMENT (FULL WALL HEIGHT)	As = IN <sup>2</sup> /L.FT	REMARKS
10'-0"	6"	NO REINFORCEMENT	-	
10'-0" TO 18'-0"	6"	* #3 @ 32" O.C.	0.0412	* REINFORCEMENT CAN BE ELIMINATED IF WALL SUPPORTED 10'-0" HORIZONTALLY
16'-0"	8"	NO REINFORCEMENT	-	
20'-0"	8"	#3 @ 48" O.C.	0.0275	
24'-0"	8"	#3 @ 48" O.C.	0.0275	
20'-0"	10"	NO REINFORCEMENT	-	
24'-0"	10"	#3 @ 48" O.C.	0.0275	
28'-0"	10"	#4 @ 56" O.C.	0.0433	
30'-0"	10"	#4 @ 48" O.C.	0.05	
22'-8"	12"	NO REINFORCEMENT	-	
32'-0"	12"	#4 @ 72" O.C.	0.0333	
36'-0"	12"	#4 @ 64" O.C.	0.0375	

- NOTE: 1. Assume Design Value  $f'_m$  = 1,500 psi,  $F_s$  = 24,000 psi, N Mortar, Light Weight CMU.  
2. All masonry wall design for lateral load = 5 PSF (Wind Load).  
3. \*CMU wall supported height start from foundation (dowels with scheduled reinforcement) and brace at floor or roof level with minimum 1" space.  
4. Grout cells solid at vertical reinforcements full height.  
5. Vertical reinforcement to be placed in center of CMU wall U.N.O.  
6. Place one (1) vertical bar of scheduled reinforcement at each side of each masonry opening (i.e.door)

## 2.4 STRUCTURAL CLAY FACING TILE

- A. General:
1. Provide solid, multicored, or hollow units, with shape and direction of cores optional unless otherwise indicated.

2. Where reinforced masonry is indicated, provide multicolored units designed for use in reinforced, grouted masonry, either with vertical cores and with webs notched to receive horizontal reinforcement, or with horizontal cores and with holes in bed shells for placement of grout and to receive vertical reinforcement.
3. Where indicated for exterior applications, provide units recommended by manufacturer for exterior use in Project's location.
4. Provide special shapes where required for corners, jambs, coved bases, sills, and other special conditions indicated, including applications that cannot be produced by sawing standard units.
  - a. Provide bullnose units for outside corners unless otherwise indicated.
  - b. Provide coved internal corners
  - c. Provide recessed, coved base units.
5. Where direct application of plaster is indicated or where bonded to backup masonry, provide units with rough, combed, or scored faces.

B. Glazed Structural Clay Facing Tile: ASTM C 126,

1. Sizes: 6T Series with actual face dimensions of 5 inches (127 mm) high by 11-11/16 inches (297 mm) long by widths indicated.
2. Width: Manufactured to dimensions 5/16 inch (8 mm) less than nominal dimensions.
3. Provide Type I (single-faced units) where only one finished face is exposed when units are installed, and Type II (double-faced units) where two opposite finished faces are exposed when units are installed.
4. Provide special units glazed on ends and tops, as well as faces for corners, jambs, sills, pilasters, columns, and other applications indicated, where glazed units are exposed on other surfaces and faces.
5. Provide glazed structural clay tile matching color range, texture, and size of existing adjacent glazed structural clay tile.
6. SCFT: Elgin | Butler  
Series: 6T  
Length: 11-11/16"  
Height: 5 inches  
Finish: Glazed  
Color: #6000 Palomino Cream  
  
Cove Base  
Series: 6T  
Length: 11-11/16"  
Height: 5 inches  
Finish: Glazed  
Color: #6000 Palomino Cream
7. Provide all necessary inside and outside corner pieces to complete installation.

2.5 CONCRETE AND MASONRY LINTELS

- A. General: Provide either concrete or masonry lintels, at Contractor's option, complying with requirements below.

- B. Concrete Lintels: Formed-in-place concrete lintels complying with requirements in Division 03 Section "Cast-in-Place Concrete" with the same reinforcing as scheduled Masonry Lintels. Use in hidden or un-exposed conditions only. Temporarily support built-in-place lintels until cured.
- C. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam concrete masonry units with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

## 2.6 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, Type I, except Type III may be used for cold weather construction. Provide natural color or white cement as required to produce required mortar color.
- B. Masonry Cement: ASTM C 91.
- C. Hydrated Lime: ASTM C 207, Type S.
- D. Aggregate for Mortar: ASTM C 144, except for joints less than 1/4" use aggregate graded with 100% passing the No. 16 sieve.
- E. Aggregate for Grout: ASTM C 404.
- F. Water: Clean and potable.
- G. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete masonry units.
  - 1. Products: Dry-Block Mortar Admixture as manufactured by Grace Construction Products, a unit of W. R. Grace & Co. or approved equal.

## 2.7 JOINT REINFORCEMENT, TIES AND ANCHORING DEVICES

- A. Materials: Comply with requirements indicated below for basic materials and with requirements indicated under each form of joint reinforcement, tie and anchor for size and other characteristics:
  - 1. Hot-Dip Galvanized Steel Wire: ASTM A 82 for uncoated wire and with ASTM A 153, Class B-2 (1.5 oz. per sq. ft. of wire surface) for zinc coating applied after prefabrication into units.
- B. Joint Reinforcement: Provide welded-wire units prefabricated with deformed continuous side rods and plain cross rods into straight lengths of not less than 10', with prefabricated corner and tee units, and complying with requirements indicated below:
  - 1. Width: Fabricate joint reinforcement in units with widths of approximately 2" less than nominal width of walls and partitions as required to provide mortar coverage of not less than 5/8" on joint faces exposed to exterior and 1/2" elsewhere.
  - 2. Wire Size for Side Rods: 0.1483" diameter.
  - 3. Wire Size for Cross Rods: 0.1483" diameter.
  - 4. For single-wythe masonry provide type as follows with single pair of side rods:
    - a. Ladder design with perpendicular cross rods spaced not more than 16" o.c.

5. For multi-wythe masonry provide type as follows:
  - a. Ladder design with perpendicular cross spaced not more than 16" o.c. and number of side rods as follows: One side rod for each face shell of concrete masonry back-up and one rod for brick wythe.
  - b. Number of side rods for Composite Construction: One side rod for each face shell of concrete masonry back-up and one rod for brick wythe.
  - c. Use units with adjustable 2-piece rectangular ties where horizontal joints of facing wythe do not align with those of back-up.
    - 1) Products: Subject to compliance with requirements, provide the following:
      - a) "Series 800 Hook and Eye"; Wire Bond.
      - b) "AA525" Adjustable Econo-Eye-Lok", AA Wire Products.
      - c) "Ladur-Eye"; Dur-O-Wal, Inc.
      - d) "Lox-All Adjustable Eye-Wire"; Hohman & Barnard, Inc.
- C. Flexible Anchors: Where flexible anchors are indicated for connecting masonry to structural framework, provide 2-piece anchors as described below which permit vertical or horizontal differential movement between wall and framework parallel to, but resist tension and compression forces perpendicular to, plane of wall.
  1. For anchorage to steel framework provide manufacturer's standard anchors which fasten thru exterior sheathing and extent thru rigid insulation.
    - a. Wire Size: 0.1875" diameter.
    - b. Products: Subject to compliance with requirements, provide the following:
      - 1) "HCL-911", Wire-Bond as distributed by Masonpro. Phone No. 800-659-4731
      - 2) RAP-TIE, Fero Corporation as distributed by Masonpro Phone No. 800-659-4731
  2. Joint Stabilizing Anchors: Single-piece assembly with sliding rods held in receiver which allows vertical and horizontal movement but resists tension and compression forces perpendicular to plane of wall.
    - a. Receiver Section: Fabricated with stainless steel 1/32 inch sheet steel sleeves, one side embedded in masonry, the other connected to the steel frame with self tapping screws for full capacity of the anchor assembly.
    - b. Tie Section: Two 8 gauge stainless wires encased in plastic sleeves held in the receiver section.
      - 1) Dur-O-Wal # D/A 2200 or approved equal.
- D. Adjustable Anchors for Connecting to Structure: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
  1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- (6.4-mm-) diameter, hot-dip galvanized steel.
  2. Tie Section for Steel Frame : Triangular-shaped wire tie, sized to extend within 1 inch (25 mm) of masonry face, made from 0.188-inch- (4.8-mm-) diameter, hot-dip galvanized steel.

- E. Masonry Veneer Anchors (Interior use only): Not less than 22 gauge and not less than 7/8 inch wide and 7 inches long, with one end crimped for attachment to substrate. Size to extend within 3/4" of face of masonry veneer.
- F. Galvanized steel channel slot anchors for anchoring new masonry to existing.
  - 1. Provide Heckmann No. 133/133-P continuous channel and mounting plate, with standard triangular type wire tie.
- G. Rigid Anchors: Provide straps of form and length indicated, fabricated from metal strips 1-1/2 inches wide x 1/4 inch thick (12 inches long) unless other sizes indicated.
- H. Un-coated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.
- I. INTERSECTING WALL ANCHORS
  - 1. Exterior Walls and Interior Bearing Walls: Fabricate steel bars as follows:
    - a. 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins.
    - b. Finish: Hot-dip galvanized to comply with ASTM A 153.
    - c. Lay-up in alternate courses between adjacent intersection walls which are not interlocked or at control joint locations.
  - 2. Interior Non-Bearing Walls and Interior Partitions:
    - a. Provide continuity with masonry joint reinforcement by using prefabricated T-shaped units.

## 2.8 CONCEALED FLASHING MATERIALS

- A. Sheet Metal Flashing: Fabricate from the following metal complying with requirements specified in Division 7 Section "Sheet Metal Flashing and Trim" and below:
  - 1. Stainless Steel: 0.015" thick.
- B. Solder and Sealants for Sheet Metal Flashings: As specified in Division 07 Section "Sheet Metal Flashing and Trim."
- C. Bituthene Sheet Flashing (Rubberized Asphalt): Flexible sheet flashing especially formulated from modified bituthene flexible and waterproof in concealed masonry applications, black in color and of thickness indicated below:
  - 1. Thickness: 40 mils.
  - 2. Manufacturer: W.R. Grace & Co.
  - 3. Provide stainless steel drip under flexible sheet flashing at lintels and where indicated.
  - 4. Form end dams at lintel ends.
- D. Single-Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from high-density polyethylene incorporating chemical stabilizers that prevent UV degradation. Cell flashing pans have integral weep spouts that are designed to be built into mortar bed joints and weep collected moisture to the exterior of CMU walls and that extend into the cell to prevent clogging with mortar.



1. Product: Subject to compliance with requirements, provide Blok-Flash as manufactured by Eben LLC and distributed by the following:
  - a. Advanced Building Products Inc.
  - b. MASONPRO, Inc.

2.9 MISCELLANEOUS MASONRY ACCESSORIES

- A. Reinforcing Bars: Deformed steel, ASTM A 615, Grade 60 for bars No. 3 to No. 18.
- B. Control Joint Strips: Premolded, flexible cellular neoprene rubber filler strips complying with ASTM D 1056, Grade RE41E1, capable of compression up to 35%, of width and thickness indicated.
- C. Bond Breaker Strips: Asphalt-saturated organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- D. Steel Column Isolation Material: 1/2 inch thickness asphalt impregnated fiberboard.
- E. Weepholes: Provide full open head joints with Duro-W-Wall "Cell Vent Weep - Hole Ventilator" inserts. Color to be selected by Architect from manufacturer's standards. Spacing shall be as follows:
  1. At Concrete Masonry Units: Provide 2-1/2 inch high weepholes at 32 inches on center.
  2. And as indicated on Drawings.
- F. Cavity Drainage Material: Provide and install "Mortar Net" as distributed by Belden Brick.
  1. Size 10" high x thickness of cavity unless noted otherwise.
- G. Compressible Joint Fillers: For use between the top of unrated masonry walls and the underside of structural steel or roof deck: Closed cell neoprene conforming to the requirements of ASTM D 1056, Grade SCE-42, board stock of sufficient thickness to be under compression when in the joint.
- H. Column Wrap: Wrap steel columns with "Boxboard" 1/4 inch corrugated, asphalt impregnated, cardboard as manufactured by Williams Products.
- I. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 0.187-inch steel wire, hot-dip galvanized after fabrication.
  1. Provide self-positioning units with either two loops or four loops as needed for number of bars indicated recessed downward into core a minimum of 1-1/4".
  2. Reinforcing Bar Positioners Manufacturer:
  3. Wire-Bond: Core-Lock Seated Rebar Positioner.

2.10 INSULATION

- A. Extruded Polystyrene Board Insulation: Rigid cellular polystyrene thermo insulation with closed cells and integral high density skin, formed by the expansion of polystyrene base resin in an extrusion process to comply with ASTM C 578, Type IV; 5-year aged r-value of 5 Btu/(hr x sf x °F) at 75°F (24°C); in manufacturer's standard lengths and widths; thicknesses as indicated.

1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
  - a. "Styrofoam Cavitymate Plus"; Dow Chemical USA.
  - b. "Foamular 250"; UC Industries.
  - c. "Certifoam", Minnesota Diversified Products, Inc.
  - d. "Tuff-RC", Celotex
- B. Adhesive: Type recommended by insulation board manufacturer for application indicated.

#### 2.11 MASONRY CLEANERS

- A. Job-mixed Detergent Solution: Solution of trisodium phosphate (1/2 cup dry measure) and laundry detergent (1/2 cup dry measure) dissolved in one gallon of water.
  1. Available Products: Subject to compliance with requirements, a product which may be used to clean unit masonry surfaces includes, but is not limited to, the following:
    - a. "Sure Klean" No. 600 Detergent; ProSoCo, Inc.

#### 2.12 MORTAR AND GROUT MIXES

- A. General: Do not add admixtures including coloring pigments, air-entraining agents, accelerators, retarders, water repellent agents, anti-freeze compounds or other admixtures, unless otherwise indicated.
  1. Water-Repellent Admixture: Provide at all mortar joints in concrete masonry exposed to the exterior.
- B. Mixing: Combine and thoroughly mix cementitious, water and aggregate in a mechanical batch mixer; comply with referenced ASTM standards for mixing time and water content.
- C. Pre-blended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a pre-blended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- D. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specifications, for types of mortar required, unless otherwise indicated.
  1. Limit cementitious materials in mortar to Portland cement-lime.
  2. Use Type M mortar for masonry below grade and in contact with earth, and where indicated.
  3. Use Type M or S mortar for reinforced masonry and where indicated.
  4. For interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
  5. For veneers, use Type N. Coordinate with other architectural requirements specified herein for veneer mortars.
- E. Grout for Unit Masonry: Comply with ASTM C 476.
  1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 7 of **the MSJC Code** for dimensions of grout spaces and pour height. Fine grout shall not be used unless absolutely necessary to comply with Table 7.

2. Proportion grout in accordance with ASTM C 476, Paragraph 4.2.2 for specified 28-day compressive strength indicated by Article 1.4.B Performance Requirements of this specification, but not less than 2000 psi.
3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION, GENERAL

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
  1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
  2. Verify that foundations are within tolerances specified.
  3. Verify that reinforcing dowels are properly placed.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
- D. Wetting Clay Brick: Wet brick made from clay or shale which have ASTM C 67 initial rates of absorption (suction) of more than 30 grams per 30 sq. in. per minute. Use wetting methods which ensure each clay masonry unit being nearly saturated but surface dry when laid.
- E. Do not wet concrete masonry units.
- F. Cleaning Reinforcing: Before placing, remove loose rust, ice and other coatings from reinforcing.
- G. Thickness: Build cavity and composite walls, floors and other masonry construction to the full thickness shown. Build single-wythe walls (if any) to the actual thickness of the masonry units, using units of nominal thickness indicated.
- H. Build chases and recesses as shown or required for the work of other trades. Provide not less than 8" of masonry between chase or recess and jamb of openings, and between adjacent chases and recesses.
- I. Leave openings for equipment to be installed before completion of masonry work. After installation of equipment, complete masonry work to match work immediately adjacent to the opening.
- J. Cut masonry units using motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous pattern and to fit adjoining work. Use full-size units without cutting where possible.
  1. Use dry cutting saws to cut concrete masonry units.
- K. Matching Existing Masonry Work: Match coursing, bonding, color and texture of new masonry work with existing work. Tooth masonry infill into existing masonry coursing.
- L. Bond Break: Provide a continuous bond breaker strip in all mortar joints between clay masonry and concrete masonry.

3.2 CONCRETE MASONRY UNIT (CMU) WALL SHALL BE PREPARED AS FOLLOWS TO ACCEPT THE AIR & VAPOR BARRIER:

- A. Surfaces shall be free of contaminants such as grease, oil and wax on surfaces to receive membrane
- B. The CMU surfaces shall be free from projections.
- C. Strike all mortar joints flush to the face of the concrete block.
- D. Fill all voids and holes greater than ¼ inch across at any point with mortar, sealant or other approved fill material.
- E. Surface irregularities exceeding ¼ inch in height or sharp to touch shall be ground flush or made smooth.
- F. Fill around all penetrations with mortar, sealant or other approved fill material and strike flush.
- G. If the surfaces cannot be made smooth to the satisfaction of the Architect, it will be the responsibility of the trade to alternatively apply a parge coat (typically one part cement to three parts sand) over the entire surface to receive Air & Vapor Barrier Membrane
- H. Remove mortar droppings on brick ties, shelf angles, brick shelves or other horizontal obstructions.

3.3 CONSTRUCTION TOLERANCES

- A. Variation From Plumb: For vertical lines and surfaces of columns, walls and arises do not exceed 1/4" in 10', or 3/8" in a story height not to exceed 20', nor 1/2" in 40' or more. For external corners, expansion joints, control joints and other conspicuous lines, do not exceed 1/4" in any story or 20' maximum, nor 1/2" in 40' or more. For vertical alignment of head joints do not exceed plus or minus 1/4" in 10', 1/2" maximum.
- B. Variation From Level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, do not exceed 1/4" in any bay or 20' maximum, nor 1/2" in 40' or more. For top surface of bearing walls do not exceed 1/8" between adjacent floor elements in 10' or 1/16" within width of a single unit.
- C. Variation of Linear Building Line: For position shown in plan and related portion of columns, walls and partitions, do not exceed 1/2" in any bay or 20' maximum, nor 3/4" in 40' or more.
- D. Variation in Cross-Sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 1/4" nor plus 1/2".
- E. Variation in Mortar Joint Thickness: Do not exceed bed joint thickness indicated by more than plus or minus 1/8", with a maximum thickness limited to 1/2". Do not exceed head joint thickness indicated by more than plus or minus 1/8".

3.4 LAYING MASONRY WALLS:

- A. Layout walls in advance for accurate spacing of surface bond patterns with uniform joint widths and to accurately locate openings, movement-type joints, returns and offsets. Avoid the use of less-than-half-size units at corners, jambs and wherever possible at other locations.
- B. Lay-up walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other work.

- C. Pattern Bond: Lay exposed masonry in the bond pattern shown or, if not shown, lay in running bond with vertical joint in each course centered on units in courses above and below. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2". Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4" horizontal face dimensions at corners or jambs.
1. Grind miter internal corner to match intersection of bullnose.
- D. Stopping and Resuming Work: Rack back 1/2-unit length in each course; do not tooth. Clean exposed surfaces of set masonry, wet units lightly (if required) and remove loose masonry units and mortar prior to laying fresh masonry.
- E. Built-in Work: As the work progresses, build-in items specified under this and other sections of these specifications. Fill in solidly with masonry around built-in items.
1. Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.
  2. Column Wrap: Wrap steel columns with corrugated, asphalt impregnated, cardboard prior to grouting or building into masonry surrounds.
  3. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.
  4. Fill cores in hollow concrete masonry units with grout 3 courses (24") under bearing plates, beams, lintels, posts and similar items, unless otherwise indicated.
- F. Masonry walls indicated to extend to the roof deck shall terminate 1" below the underside of the deck and resulting space shall be filled with a firestop joint assembly suitable for permanent placement and complying with Division 7 Section "Firestop Joint Systems". Provide a 4 x 4 x 12 gauge x 8" long angle at 5'-0" (+ or -) o.c. at each face of wall.
1. Where run of wall is parallel to deck flutes, provide a supplemental 12 gauge plate to link both opposing angles. Width of plate and angles is to be 8".
  2. Where run of wall is perpendicular to the deck flutes, the supplemental plate can be omitted and length of angle sized to bridge two flutes. Secure assembly to metal deck with two #12 tech screws per side. Do not weld.

### 3.5 MORTAR BEDDING AND JOINTING

- A. Lay solid brick size masonry units with completely filled bed and head joint; butter ends with sufficient mortar to fill head joints and shove into place. Do not slush head joints.
- B. Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical face shells. Bed webs in mortar in starting course on footings and in all courses of piers, columns and pilasters, and where adjacent to cells or cavities to be reinforced or filled with concrete or grout. For starting course on footings where cells are not grouted, spread out full mortar bed including areas under cells.
- C. Maintain joint widths shown, except for minor variations required to maintain bond alignment. If not shown, lay walls with 3/8" joints.
- D. Cut joints flush for masonry walls which are to be concealed or to be covered by other materials, unless otherwise indicated.

- E. Tool exposed joints slightly concave for brick and slightly concave for block including scored joint using a jointer larger than joint thickness, unless otherwise indicated.
- F. Remove masonry units disturbed after laying; clean and reset in fresh mortar. Do not pound corners or jambs to shift adjacent stretcher units which have been set in position. If adjustments are required, remove units, clean off mortar and reset in fresh mortar.
- G. Set stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.
  - 1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
  - 2. Wet joint surfaces thoroughly before applying mortar.

### 3.6 STRUCTURAL BONDING OF MULTI-WYTHER MASONRY

- A. Use continuous horizontal joint reinforcement installed in horizontal mortar joints for bond tie between wythes. Install at not more than 16" o.c. vertically.
  - 1. For horizontally reinforced masonry, provide continuity at corners with prefabricated "L" units, in addition to masonry bonding.
- B. Exterior Walls and Intersecting or Abutting Interior Bearing Walls: Unless vertical expansion or control joints are shown at juncture:
  - 1. Provide rigid metal anchors not more than 24 inches o.c. If used with hollow masonry units, embed ends in mortar-filled cores.
  - 2. Lay-up in alternate courses between adjacent intersection walls which are not interlocked or at control joint locations.
- C. Intersecting or Abutting Interior, Non-Bearing Walls and Interior Partitions:
  - 1. Provide continuity with masonry joint reinforcement by using prefabricated T-shaped units laid up in alternate courses.

### 3.7 CAVITY WALLS

- A. Keep cavity clean of mortar droppings and other materials during construction. Strike joints facing cavity flush.
- B. Tie exterior wythe to back-up with continuous horizontal joint reinforcing, installed in mortar joints at not more than 16" o.c. vertically.
- C. Provide weep holes (2-1/2" high open head joints) in exterior wythe of cavity wall located immediately above ledges and flashing, spaced 24" o.c., unless otherwise indicated.
- D. Provide 10" depth of cavity drainage material located immediately above all lintels, flashings and ledges.

### 3.8 CAVITY WALL INSULATION

- A. On units of plastic insulation, install small pads of adhesive spaced approximately 1'-0" o.c. both ways on inside face. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.

1. Fill all cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.9 HORIZONTAL JOINT REINFORCEMENT

- A. General: Provide continuous horizontal joint reinforcement as indicated. Install longitudinal side rods in mortar for their entire length with a minimum cover of 5/8" on exterior side of walls, 1/2" elsewhere. Lap reinforcing a minimum of 6".
- B. Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
- C. Reinforce walls with continuous horizontal joint reinforcing unless specifically noted to be omitted.

3.10 ANCHORING MASONRY WORK:

- A. General: Provide anchor devices of type specified.
  1. Anchor masonry to structural members where masonry abuts or faces structural members.

3.11 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
  1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
  2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in **the MSJC Code**.
  1. Install reinforcing bar positioners in locations coordinated with the vertical reinforcement spacing. Positioners shall be located accurately to install reinforcement bars in the center of the unit core or offset as specified on the Drawings.
    - a. Based on the size of the vertical wall reinforcement, do not exceed the following maximum vertical spacing of positioners:
      - 1) #3 Bar: 6'-3"
      - 2) #4 Bar: 8'-4"
      - 3) #5 Bar: 10'-0"
      - 4) #6 Bar: 12'-6"
      - 5) #7 Bar: 14'-7"
      - 6) #8 Bar: 16'-8"
- C. At lap splices, the upper reinforcement bar shall be held within the positioner adjacent to the lower bar being spliced.
- D. Reinforcement Splices:
  1. The following lap splice requirements shall supersede the MSCJ Code requirements. Specified wall heights refer to the distance from the top of foundation or slab support to

the upper joist or beam bearing or slab/deck tie-in elevation. For wall heights which equal the specified limit, the lesser provision may apply. As a minimum, reinforcing bars shall be lapped according to the following:

Wall Configuration	#4 Bar	#5 Bar	#6 Bar	#7 Bar	#8 Bar
8" Walls less than 12 ft. high	20"	32	32	40	40"
8" Walls greater than 12 ft. high	40	48	56	64	72"
10" Walls less than 15 ft. high	20"	32	32	40	40"
10" Walls greater than 15 ft. high	40	48	56	64	72"
12" Walls less than 18 ft. high	20"	32	32	40	40"
12" Walls greater than 18 ft. high	40	48	56	64	72"

E. Grouting:

1. Grouting may not proceed until the grout cavity is inspected, vertical reinforcement spacing and position and lap dimensions are confirmed, and anchor size, spacing and position are confirmed.
2. Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
3. General: Grout the cores of all masonry at all locations of reinforcement, bond beams, bearing plates, anchors and embedded items.
4. Comply with requirements in the MSJC Code for cleanouts and for grout placement, including minimum grout space, maximum lift and pour height, vibration and consolidation.
5. Unless previously approved, limit height of vertical grout lifts to not more than 60 inches.
6. Stop grout placement 1.5 inches lower than top of masonry to form a grout key between successive lifts.

3.12 CONTROL AND EXPANSION JOINTS:

- A. General: Install control and expansion joints in unit masonry where indicated in Drawings but not spaced more than 20'-0" apart. Build-in related items as masonry progresses. Do not form a continuous span through movement joints. Verify control joint locations with Architect.
- B. Form control joints in concrete masonry as follows using one of the following methods:
  1. Fit bond-breaker strips into hollow contour in ends of concrete masonry units on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
  2. Install preformed control-joint gaskets designed to fit standard sash block.
  3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.



4. Location and spacing of control joints shall comply with industry standards.
5. Interrupt joint reinforcing each side of joint.
- C. Form expansion joints in brick made from clay or shale as follows:
  1. Build flanges of factory-fabricated, expansion-joint units into masonry.
  2. Form open joint of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Division 07 Section "Joint Sealants."
- D. Build in horizontal, pressure-relieving joints where required and indicated; construct joints by either leaving an air space or inserting a compressible filler of width required."
  1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry veneer and attached to structure behind masonry veneer.

3.13 LINTELS:

- A. Provide steel lintels where shown and wherever openings of more than 1'-0" for brick size units and 2'-0" for block size units are shown without structural steel or other supporting lintels. Refer to Metal Fabrications specification section additional information.
- B. Provide minimum bearing of 8" at each jamb, unless otherwise indicated.
- C. One end of lintel shall remain un-connected to allow for movement. The choice of which end to remain free is arbitrary, but if possible, it end should located adjacent to the nearest control joint.

3.14 FLASHING OF MASONRY WORK:

- A. General: Provide concealed flashing in masonry work at, or above, shelf angles, lintels, ledges and other obstructions to the downward flow of water in the wall so as to divert such water to the exterior. Prepare masonry surfaces smooth and free from projections which could puncture flashing. Place through-wall flashing on sloping bed of mortar and cover with mortar. Seal penetrations in flashing with mastic before covering with mortar. Extend flashings through exterior face of masonry and turn down to form drip. Do not allow any penetrations in flashing.
- B. Extend flashing the full length of lintels and shelf angles and minimum of 4" into masonry each end. Extend flashing from exterior face of outer wythe of masonry, through the outer wythe, turned up a minimum of 4", and through the inner wythe to within 1/2" of the interior face of the wall in exposed work. Where interior surface of inner wythe is concealed by furring, carry flashing completely through the inner wythe and turn up approximately 2". At heads and sills turn up ends not less than 2" to form a pan/end dam.
- C. Fabricate through-wall metal flashings embedded in masonry with ribs formed in sawtooth pattern at 3-inch intervals along length of flashing to provide a 3-way integral mortar bond and weep hole drainage as indicated.
- D. Interlock end joints of deformed metal flashings by over-lapping deformations not less than 1-1/2" and seal lap with elastic sealant.
- E. Install flashing to comply with manufacturer's instructions.
- F. Install single-wythe CMU flashing system to comply with manufacturer's instructions.
- G. Provide weep holes as specified.

- H. Install reglets and nailers for flashing and other related work where shown to be built into masonry work.

3.15 FIELD QUALITY CONTROL

- A. Inspectors: Construction Manager/Owner will engage a qualified, independent agency to perform field inspections and prepare inspection reports.
- B. Testing: Construction Manager/Owner will engage a qualified, independent agency to perform field tests indicated below and prepare test reports.
- C. Quality Assurance Level and Frequency:
  - 1. Testing Frequency for Non-Essential Facilities - Level B Quality Assurance:
    - a. Assurance level to be in accordance with Table 4 of the MSJC Specification for Masonry Structures.
    - b. Frequency level for Category I, II or III buildings to be in accordance with Table 1704.5.1 Level 1 Special Inspections of the Michigan Building Code.
    - c. Note: The MSJC and Michigan Building Codes require inspectors to observe all grouting operations continuously. Communication with inspector is the contractor's responsibility. Grouting shall not proceed until the inspector is onsite and has made the required pre-grouting observations.
    - d. Allow inspectors access to scaffolding and work areas, as needed to perform inspections.
    - e. Place grout only after inspectors have verified compliance of grout spaces and grades, sizes, locations and position of reinforcement.
- D. Clay Masonry Unit Test: For each type of unit provided, per ASTM C 67.
- E. Concrete Masonry Unit Test: For each type of unit provided, per ASTM C 140.
- F. Mortar Test (Property Specification): For each mix provided, per ASTM C 780.
- G. Grout Test (Compressive Strength): For each mix provided, per ASTM C 1019.
- H. Testing agency will report results of tests and inspections promptly, in detail and in writing to Contractor, Architect and authorities having jurisdiction.
- I. Remove and replace work that does not comply with specified requirements.
- J. Retesting of materials failing to comply with specified requirements shall be done at Contractor's expense.

3.16 REPAIR, POINTING AND CLEANING:

- A. Remove and replace masonry units which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Point-up all joints including corners, openings and adjacent work to provide a neat, uniform appearance, prepared for application of sealants.
- C. Final cleaning: After mortar is thoroughly set and cured, clean masonry as follows:

SECTION 042000  
UNIT MASONRY  
ASSEMBLIES

1. Remove large mortar particles by hand with wooden paddles and non-metallic scrape hoes or chisels.
  2. Test cleaning methods on sample wall panel; leave 1/2 panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
  3. Saturate wall surfaces with water prior to application of cleaners; remove cleaners promptly by rinsing thoroughly with clear water.
    - a. Detergent.
    - b. Acidic Cleaner; apply in compliance with directions of cleaner manufacturer.
  4. Clean concrete unit masonry to comply with masonry manufacturer's directions and applicable NCMA "Tek" bulletins.
  5. Clean stone trim to comply with stone supplier's written instructions.
    - a. Clean limestone units to comply with recommendations in ILI's "Indiana Limestone Handbook."
- D. Protection: Provide final protection and maintain conditions in a manner acceptable to Installer, which ensures unit masonry work being without damage and deterioration at time of substantial completion.

**\*\*END OF SECTION\*\***

## STRUCTURAL STEEL FRAMING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes fabrication and erection of structural steel work, as shown on drawings including schedules, notes, and details showing size and location of members, typical connections, and types of steel required.

- 1. Structural steel is that work defined in American Institute of Steel Construction (AISC) "Code of Standard Practice" and as otherwise shown on drawings.

- B. Related Sections: The following Sections contain requirements that relate to this Section:

- 1. Division 03 Section "Cast-in-Place Concrete" for anchor bolt installation in concrete.
  - 2. Division 04 Section "Unit Masonry" for anchor bolt installation in masonry.
  - 3. Division 05 Section "Metal Fabrication" for miscellaneous metal fabrications.

#### 1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

- B. Product data or manufacturer's specifications and installation instructions for following products. Include laboratory test reports and other data to show compliance with specifications (including specified standards).

- 1. Structural steel (each type), including certified copies of mill reports covering chemical and physical properties.
  - 2. High-strength bolts (each type), including nuts and washers.
    - a. Include Direct Tension Indicators if used.
  - 3. Structural steel primer paint.
  - 4. Shrinkage-resistant grout.

- C. Shop drawings prepared under supervision of a licensed Structural Engineer, including complete details and schedules for fabrication and assembly of structural steel members, procedures, and diagrams.

- 1. Include details of cuts, connections, camber, holes, and other pertinent data. Indicate welds by standard AWS symbols and show size, length, and type of each weld.
  - 2. Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorages to be installed as work of other sections.

- D. Test reports conducted on shop- and field-bolted and welded connections. Include data on type(s) of tests conducted and test results.
- E. Certified copies of each survey conducted by a licensed Land Surveyor, showing elevations and locations of base plates and anchor bolts to receive structural steel and final elevations and locations for major members. Indicate discrepancies between actual installation and contract documents.

#### 1.4 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of following, except as otherwise indicated:
  - 1. American Institute of Steel Construction (AISC) "Code of Standard Practice for Steel Buildings and Bridges."
    - a. Paragraph 4.4 of the above code is hereby modified to allot 15 business days for Shop Drawing review in accordance with Specification Section 01330.
    - b. Paragraph 4.4.1(b) of the above code is hereby modified as follows:

"Confirmation that the Owner's designated representative for Design has reviewed the Connection details shown on the Shop and Erection Drawings and submitted in accordance with Section 3.1.2, if applicable."
  - 2. AISC "Specifications for Structural Steel Buildings," including "Commentary."
  - 3. AISC "Specifications for the Design of Steel Hollow Structural Sections."
  - 4. "Specifications for Structural Joints using ASTM A 325 or A 490 Bolts" approved by the Research Council on Structural Connections.
  - 5. American Welding Society (AWS) D1.1 "Structural Welding Code - Steel."
  - 6. ASTM A 6 "General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use."
- B. Qualifications for Welding Work: Qualify welding procedures and welding operators in accordance with AWS "Qualification" requirements.
  - 1. Provide certification that welders to be employed in work have satisfactorily passed AWS qualification tests.
  - 2. If recertification of welders is required, retesting will be Contractor's responsibility.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to site at such intervals to ensure uninterrupted progress of work.
- B. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete or masonry, in ample time to not to delay work.
- C. Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged

materials from erosion and deterioration. If bolts and nuts become dry or rusty, clean and relubricate before use.

1. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Metal Surfaces, General: For fabrication of work that will be exposed to view, use only materials that are smooth and free of surface blemishes including pitting, rust and scale seam marks, roller marks, rolled trade names, and roughness. Remove such blemishes by grinding, or by welding and grinding, prior to cleaning, treating, and applying surface finishes.
- B. Structural Steel Wide Flange Shapes: ASTM A992, Grade 50; ASTM A572, Grade 50.
- C. Angles, Channels, Plates and Bars: ASTM A36.
- D. Cold-Formed HSS Square and Rectangular: ASTM A 500, Grade B.
- E. Hot-Formed Round HSS: ASTM A 501.
- F. Round HSS: ASTM A 53, Type E or S, Grade B.
  1. Finish: Black, except where indicated to be galvanized.
- G. Anchor Bolts: ASTM A 307, nonheaded type unless otherwise indicated.
- H. Unfinished Threaded Fasteners: ASTM A 307, Grade A, regular low-carbon steel bolts and nuts.
  1. Provide hexagonal heads and nuts for all connections.
  2. Provide either hexagonal or square heads and nuts, except use only hexagonal units for exposed connections.
- I. High-Strength Threaded Fasteners: Heavy hexagon structural bolts, heavy hexagon nuts, and hardened washers, as follows:
  1. Quenched and tempered medium-carbon steel bolts, nuts, and washers, complying with ASTM A 325.
  2. Where indicated as galvanized, provide units that are zinc coated, either mechanically deposited complying with ASTM B 695, Class 50, or hot-dip galvanized complying with ASTM A 153.
  3. Quenched and tempered alloy steel bolts, nuts, and washers, complying with ASTM A 490.
- J. Electrodes for Welding: Comply with AWS Code.

- K. Nonmetallic Shrinkage-Resistant Grout: Premixed, nonmetallic, noncorrosive, nonstaining product containing selected silica sands, Portland cement, shrinkage compensating agents, plasticizing and water-reducing agents, complying with CE-CRD-C621.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Euco N.S.; Euclid Chemical Co.
- b. Crystex; L & M Construction Chemicals, Inc.
- c. Masterflow 713; Master Builders.
- d. Sealtight 588 Grout; W.R. Meadows.

## 2.2 FABRICATION

- A. Shop Fabrication and Assembly: Fabricate and assemble structural assemblies in shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC Specifications and as indicated on final shop drawings. Provide camber in structural members where indicated.
1. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence that will expedite erection and minimize field handling of materials.
  2. Where finishing is required, complete assembly, including welding of units, before start of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs, and other defects.
- B. Connections: Weld or bolt shop connections.
- C. Bolt field connections, except where welded connections or other connections are indicated.
1. Provide high-strength threaded fasteners for all bolted connections.
- D. High-Strength Bolted Construction: Install high-strength threaded fasteners in accordance with AISC "Specifications for Structural Joints using ASTM A 325 or A 490 Bolts."
- E. Welded Construction: Comply with AWS Code for procedures, appearance and quality of welds, and methods used in correcting welding work.
- F. Assemble and weld built-up sections by methods that will produce true alignment of axes without warp.
- G. Holes for Other Work: Provide holes required for securing other work to structural steel framing and for passage of other work through steel framing members, as shown on final shop drawings.
- H. Provide threaded nuts welded to framing and other specialty items as indicated to receive other work.
- I. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame-cut holes or enlarge holes by burning. Drill holes in bearing plates.

2.3 SHOP PAINTING

A. General:

1. Shop-paint exposed structural steel, except those members or portions of members to be embedded in concrete or mortar. Paint embedded steel that is partially exposed on exposed portions and initial 2 inches of embedded areas only.
  - a. Do not paint surfaces to be welded or high-strength bolted with friction-type connections.
  - b. Do not paint surfaces scheduled to receive sprayed-on fireproofing.
  - c. Apply two (2) coats of paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.
  - d. Interior steel not exposed to view may be left unpainted.
  - e. Do not paint top flange of composite beams.
2. No coatings shall be applied until approved by the Architect and Owner's Representative.
3. Intermediate and finish coats shall be applied by the painting contractor per Division 9 Section "Painting."
4. Inspection and Testing: During the shop painting process and prior to shipping steel, the fabricator shall have the primer manufacturer representative inspect structural steel for proper dry film thickness in accordance with specifications.
  - a. Fabricator shall use testex tape to keep a permanent and verifiable record of the surface profile. A minimum of three (3) random tests shall be taken per ton of steel.

B. Exterior – Exposed:

1. Surface Preparation: SSPC-SP6 Commercial Blast Cleaning removing mill scale, rust, paint and other foreign matter except for staining, by use of abrasives. All surfaces must be clean, dry and free of oil, grease, dust, dirt or contaminants detrimental to the coating system.
2. Primer:
  - a. TNEMEC: One (1) coat TNEMEC Series 90-97 Tneme-Zinc @ 2.5 to 3.5 mil DFT.
  - b. Wasser: One (1) coat of Wasser MC-Zinc @ 3.0-5.0 mils DFT.
3. For warranty purposes, the Contractor shall insure that the intermediate and finish coats specified in Division 9 "Painting" and the applied primer specified above are from the same manufacturer.

C. Preparation and Coating over Galvanized Steel:

1. Preparation: All galvanized metal receiving additional coats shall be tested by use of a copper sulfate test. This includes using a 10% solution of copper sulfate dissolved in water and applied to the galvanized surface. The reaction time between the copper sulfate and zinc should result in turning the galvanized area black within 15 seconds or less. If the reaction takes longer than 15 seconds, further cleaning is required as follows:



- a. Preparation for TNEMEC paints: Apply Oakite CrysCoat 747 or 747 LTS as recommended by manufacturer. Allow to dry and air chuck entire prepared area removing excess materials.
    - b. Preparation for Wasser paints: Apply Great Lakes Clean and Etch or Oakite 747 as recommended by manufacturer followed by a thorough rinse.
  2. Primer:
    - a. TNEMEC: One (1) coat TNEMEC Series N 27 S.T. Typoxy @ 2.0 to 4.0 mil DFT.
    - b. Wasser: One (1) coat of Wasser MC-CR @ 3.0-4.0 mils DFT.
  3. For warranty purposes, the Contractor shall insure that the intermediate and finish coats specified in Division 9 "Painting" and the applied primer specified above are from the same manufacturer.
- D. Pool Environment:
1. Surface Preparation: SSPC-SP6 Commercial Blast Cleaning, removing mill scale, rust, paint and other foreign matter except for staining, by use of abrasives. All surfaces must be clean, dry and free of oil, grease, dust, dirt or contaminants detrimental to the coating system.
  2. Primer:
    - a. TNEMEC: One (1) coat TNEMEC Series N 90-97 Tneme-Zinc @ 2.5 to 3.5 mil DFT.
    - b. Wasser: One (1) coat of Waaer MC-Zinc @ 3.0-5.0mils DFT.
  3. For warranty purposes, the Contractor shall insure that the intermediate and finish coats specified in Division 9 "Painting" and the applied primer specified above are from the same manufacturer.
- E. Interior – Exposed:
1. Surface Preparation: After inspection and before shipping, clean steelwork to be painted. Remove loose rust, loose mill scale, and spatter, slag, or flux deposits. Clean steel in accordance with Steel Structures Painting Council (SSPC) as follows:
    - a. SP-1 "Solvent Cleaning".
    - b. SP-2 "Hand Tool Cleaning".
    - c. SP-3 "Power Tool Cleaning".
  2. Primer: Manufacturer's standard rust-inhibiting primer.

## 2.4 SOURCE QUALITY CONTROL

- A. General: Materials and fabrication procedures are subject to inspection and tests in mill, shop, and field, conducted by a qualified inspection agency. Such inspections and tests will not relieve Contractor of responsibility for providing materials and fabrication procedures in compliance with specified requirements.
  1. Promptly remove and replace materials or fabricated components that do not comply.
- B. Design of Members and Connections: Details shown are typical; similar details apply to similar conditions, unless otherwise indicated. Verify dimensions at site whenever possible without causing delay in the work.

1. Promptly notify Architect whenever design of members and connections for any portion of structure are not clearly indicated.

### PART 3- EXECUTION

#### 3.1 ERECTION

- A. Surveys: Employ a licensed land surveyor for accurate erection of structural steel. Check elevations of concrete and masonry bearing surfaces, and locations of anchor bolts and similar devices, before erection work proceeds, and report discrepancies to Architect. Do not proceed with erection until corrections have been made or until compensating adjustments to structural steel work have been agreed upon with Architect.
- B. Temporary Shoring and Bracing: Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads. Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guy lines to achieve proper alignment of structures as erection proceeds.
- C. Temporary Planking: Provide temporary planking and working platforms as necessary to effectively complete work.
- D. Setting Bases and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of base and bearing plates.
  1. Set leveling plates for structural columns on a bed of shrinkage resistant grout and level to proper elevation.
  2. Tighten anchor bolts after supported members have been positioned and plumbed.
  3. For proprietary grout materials, comply with manufacturer's instructions.
- E. Field Assembly: Set structural frames accurately to lines and elevations indicated. Align and adjust various members forming part of complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces that will be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
- F. Level and plumb individual members of structure within specified AISC tolerances.
- G. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be when completed and in service.
- H. Splice members only where indicated and accepted on shop drawings.
- I. Erection Bolts: On exposed welded construction, remove erection bolts, fill holes with plug welds, and grind smooth at exposed surfaces.
  1. Comply with AISC Specifications for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
  2. Do not enlarge unfair holes in members by burning or by using drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.

- J. Gas Cutting: Do not use gas cutting torches in field for correcting fabrication errors in primary structural framing. Cutting will be permitted only on secondary members that are not under stress, as acceptable to Architect. Finish gas-cut sections equal to a sheared appearance when permitted.
- K. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint. Apply paint to exposed areas using same material as used for shop painting.
  - 1. Apply by brush or spray to provide minimum dry film thickness of 1.5 mils.
- L. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

### 3.2 QUALITY CONTROL

- A. Owner will engage an independent testing and inspection agency to inspect high-strength bolted connections and welded connections and to perform tests and prepare test reports.
- B. Testing agency shall conduct and interpret tests, state in each report whether test specimens comply with requirements, and specifically state any deviations therefrom.
- C. Provide access for testing agency to places where structural steel work is being fabricated or produced so that required inspection and testing can be accomplished.
- D. Testing agency may inspect structural steel at plant before shipment.
- E. Correct deficiencies in structural steel work that inspections and laboratory test reports have indicated to be not in compliance with requirements. Perform additional tests, at Contractor's expense, as necessary to reconfirm any noncompliance of original work and to show compliance of corrected work.
- F. Shop-Bolted Connections: Inspect or test in accordance with AISC specifications.
- G. Field-Bolted Connections: Inspect in accordance with AISC specifications.
- H. Field Welding: Inspect and test during erection of structural steel as follows:
  - 1. Conduct inspections and tests as required. Record types and locations of defects found in work. Record work required and performed to correct deficiencies.
  - 2. Perform visual inspection of all welds to AWS D1.1/D1.1M.
  - 3. Perform tests of welds as follows:
    - a. Liquid Penetrant Inspection: ASTM E 165.
    - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration not acceptable.
    - c. Radiographic Inspection: ASTM E 94 and ASTM E 142; minimum quality level "2-2T."
    - d. Ultrasonic Inspection: ASTM E 164.

\*\*END OF SECTION\*\*

ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

1.2 SUMMARY:

- A. Types of work in this section include rough carpentry for the following:

1. Wood grounds, nailers and blocking
2. Framing with dimension lumber.

1.3 DEFINITIONS:

- A. Rough carpentry includes carpentry work not specified in other sections and not exposed to view, except as otherwise indicated.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
  1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
  2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
  3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
  4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
  5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.
- B. Fastener Patterns: Full-size templates for fasteners in exposed framing.

1.5 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
- B. Evaluation Reports: For the following, from ICC-ES:
  1. Wood-preservative-treated wood.

2. Fire-retardant-treated wood.

1.6 QUALITY ASSURANCE

- A. Single source responsibility for Fire-Retardant-Treated wood: Obtain each type of fire-retardant-treated wood product from one source and by a single producer.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Keep materials under cover and dry. Protect against exposure to weather and contact with damp or wet surfaces. Stack lumber as well as plywood and other panels, provide for air circulation within and around stacks and under temporary coverings including polyethylene and similar materials.
- B. For lumber and plywood pressure treated with waterborne chemicals, place spacers between each bundle to provide air circulation.

1.8 PROJECT CONDITIONS:

- A. Coordination: Fit carpentry work to other work; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds and similar supports to allow attachment of other work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Wood Preservative-Treated materials:
  - a. Baxter: J.H. Baxter Co.
  - b. Chemical Specialties, Inc.
  - c. Continental Wood Preservers, Inc.
  - d. Hickson Corp.
  - e. Hoover Treated Wood Products, Inc.
  - f. Osmose Wood Preserving, Inc.
2. Fire-Retardant-Treated Materials, Exterior Type:
  - a. American Wood Treaters, Inc.
  - b. Hoover Treated Wood Products, Inc.

2.2 LUMBER, GENERAL:

- A. Lumber Standards: Manufacture lumber to comply with DOC PS 20 "American Lumber Standard" and with applicable grading rules of inspection agencies certified by American Lumber Standards Committee's (ALSC) Board of Review.
- B. Inspection Agencies: Inspection agencies and the abbreviations to reference them, include the following:
1. NELMA - Northeastern Lumber Manufacturers Association

2. RIS - Redwood Inspection Service.
  3. SPIB - Southern Pine Inspection Bureau.
  4. WCLIB - West Coast Lumber Inspection Bureau.
  5. WWPA - Western Wood Products Association.
  6. APA - American Plywood Association.
- C. Grade Stamps: Factory-mark each piece of lumber with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.
1. Provide seasoned lumber with 19 percent maximum moisture content at time of dressing and shipment for sizes 2 inches or less in nominal thickness, unless otherwise indicated.
  2. For exposed lumber, furnish pieces with grade stamps applied to ends or back of each piece, or omit grade stamps and provide grade-compliance certificates issued by the inspection agency.
- D. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
- E. Plywood Standards: Comply with PS1 "U.S. Product standard for Construction and Industrial Plywood" for plywood construction panels and, for products not manufactured under PS1 provision, with APA PRP-108. Furnish panels factory marked with APA trademarks evidencing compliance with grade requirements.

2.3 MISCELLANEOUS LUMBER AND PLYWOOD:

- A. Provide wood for support or attachment of other work including rooftop equipment curbs and support bases, cant strips, bucks, nailers, blocking, furring, grounds, stripping and similar members. Provide lumber of sizes indicated, worked into shapes shown, or as required, and as follows:
- B. Moisture content: 19 percent maximum for lumber items not specified to receive wood preservative treatment.
- C. Grade: Standard Grade light framing size lumber of any species or board size lumber as required. No. 3 Common or Standard grade boards per WCLIB or WWPA rules or No. 3 boards per SPIB rules.
- D. Plywood Grade: APA C-D PLUGGED EXTERIOR, with minimum space rating to suit support spacing and plywood thickness indicated.

2.4 MISCELLANEOUS MATERIALS:

- A. Fasteners and Anchorages: Provide size, type, material and finish as indicated and as recommended by applicable standards, complying with applicable Federal Specifications for nails, staples, screws, bolts, nuts, washers and anchoring devices. Provide metal hangers and framing anchors of the size and type recommended by the manufacturer for each use including recommended nails.

1. Where rough carpentry work is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners and anchorages with a hot-dip zinc coating (ASTM A 153).

2.5 PRESERVATIVE WOOD TREATMENT BY PRESSURE PROCESS:

- A. General: Where lumber or plywood is indicated as preservative- treated wood or is specified herein to be treated, comply with applicable requirements of AWPAs Standards C2 (Lumber) and C9 (Plywood). Mark each treated item with the AWPB or SPIB Quality Mark Requirements.
  1. Do not use chemicals containing chromium or arsenic.
- B. Pressure-treat above-ground items with water-borne preservatives to a minimum retention of 0.25 pcf. For interior uses, after treatment, kiln-dry lumber and plywood to a maximum moisture content, respectively, of 19% and 15%. Treat indicated items and the following:
  1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
  2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
- C. Complete fabrication of treated items prior to treatment, where possible. If cut after treatment, coat cut surfaces to comply with AWPAs M4. Inspect each piece of lumber or plywood after drying and discard damaged or defective pieces.

2.6 FIRE-RETARDANT TREATMENT BY PRESSURE PROCESS:

- A. General: Where fire-retardant-treated wood is indicated, pressure impregnate lumber and plywood with fire-retardant chemicals to comply with AWPAs C20 and C27, respectively, for treatment type indicated; identify "fire-retardant-treated wood" with appropriate classification marking of Underwriters Laboratories, Inc. (UL), U.S. Testing, Timber Products Inspection, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.
  1. Current Evaluation/Research Reports: Provide fire-retardant- treated wood for which a current model code evaluation/research report exists that is acceptable to authorities having jurisdiction and that evidences compliance of fire-retardant- treated wood for application indicated.
- B. Exterior Type: Use for exterior locations and where indicated.
- C. Inspect each piece of treated lumber or plywood after drying and discard damaged or defective pieces.

2.7 DIMENSION LUMBER

- A. General: Provide dimension lumber of grades indicated according to the ALSC National Grading Rule (NGR) provisions of the inspection agency indicated.
  1. Grade: Construction, Stud, or No.3
  2. Species:
    - a. Douglas fir-larch; WCLIB or WWPA
    - b. Hem-fir; WCLIB or WWPA

- c. Southern Pine; SPIB
- d. Douglas fir south; WWPA
- e. Any species above

### PART 3 - EXECUTION

#### 3.1 INSTALLATION GENERAL:

- A. Discard units of material with defects which might impair quality of work, and units which are too small to use in fabricating work with minimum joints or optimum joint arrangement.
- B. Set carpentry work to required levels and lines, with members plumb and true and accurately cut and fitted.
- C. Securely attach carpentry work to substrate by anchoring and fastening as shown and as required by recognized standards.
- D. Countersink nail heads on exposed carpentry work and fill holes.
- E. Use common wire nails, except as otherwise indicated. Use finishing nails for finish work. Select fasteners of size that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting of wood; pre-drill as required.
- F. Apply field treatment complying with AWPA M4 to cut surfaces of preservative treated lumber and plywood.

#### 3.2 WOOD GROUNDS, NAILERS, BLOCKING AND SLEEPERS:

- A. Provide wherever shown and where required for screeding or attachment of other work. Form to shapes as shown and cut as required for true line and level of work to be attached. Coordinate location with other work involved.
- B. Attach to substrates as required to support applied loading. Countersink bolts and nuts flush with surfaces, unless otherwise indicated. Build into masonry during installation of masonry work. Where possible, anchor to form work before concrete placement.
- C. Provide permanent grounds of dressed, preservative treated, key-beveled lumber not less than 1-1/2" wide and of thickness required to bring face of ground to exact thickness of finish material involved. Remove temporary grounds when no longer required.

#### 3.3 WOOD FURRING:

- A. Install plumb and level with closure strips at edges and openings. Shim with wood as required for tolerance of finished work.

#### 3.4 WOOD FRAMING, GENERAL:

- A. Provide framing members of sizes and on spacings shown, and frame openings as shown, or if not shown, comply with recommendations of "Manual for House Framing" of National Forest Products Association (N.F.P.A.). Do not splice structural members between supports.

**\*\*END OF SECTION\*\***



BUILT-UP ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE OF WORK

- A. Furnish and install specified roofing and related components to new construction, additions and existing construction to be re-roofed and reworked.
- B. Work includes:
  - 1. Installation of the following with new construction:
    - a. Roof insulation.
    - b. Hot applied built-up roofing system.
    - c. Gravel surfaced.
    - d. Specified flashings and accessories.
  - 2. Re-roofing and reworking exiting construction indicated and repair of roofing required by new construction.

1.3 QUALITY CONTROL

- A. Contractor shall:
  - 1. Be experienced in hot multi-ply roofing. Five (5) years minimum.
    - a. Be acceptable by Owner.
    - b. Has not been in Chapter 7 during the last ten (10) years.
    - c. Provide list of at least 5 projects available for inspection employing same system within 50 mile radius of Owner.
- B. Roofing material supplier shall:
  - 1. Be Associate Member in good standing with National Roofing Contractors' Association (NRCA) for at least five (5) years.
  - 2. Be approved by owner.
  - 3. Has not been in Chapter 11 during the last five (5) years.
  - 4. The building owner is desirous of working with a financially strong organization, which has the ability to protect and insulate the building owner from both product liability and warranty claims, relating to roofing, that could be brought before the building owner during the course of the roofing warranty period. As financial strength of suppliers are a requirement of the building owner proof of such must be shown. To this end, the following information is required by the building owner:

- a. The manufacturer must present to the building owner a certificate of insurance for product liability with minimum limits of \$100 million.
    - b. The manufacturer must have a current net worth equivalent to 25% of yearly sales and demonstrate such with a financial statement supported by an affidavit from a corporate officer.
  5. The building owner is desirous of quality performance in all areas of roofing construction and as a result is requiring a primary source of material from one company in order to insure consistent quality. The material manufacturer supplying material for the building owner's roofs must manufacture at least 70% of the materials, they supply, in facilities actually owned or solely leased by said manufacturer. The material manufacturer shall submit verification of the foregoing by affidavit of corporate officer.
  6. Building owner, to assure that the manufacturer can consistently deliver quality materials, requires the Manufacturer to provide evidence of twenty (20) quarters of continuous plant inspections of roofing manufacturing sites over the past five (5) years by an independent Nationally Recognized Testing Laboratory (NRTL) as defined in 29 CFR Ch. XVII (7-1-93 Edition) from the Occupational Safety and Health Administration (OSHA).
  7. Provide Owner names of at least 5 qualified applicators.
  8. Employ full-time Field Technical Services Representative with a minimum of ten (10) years of hands on roofing experience, available for monitoring project work on a periodic basis.
  9. Employ full-time Field Technical Services Representative available for final roof inspection.
  10. Provide local Field Representative to make daily site visits, report work quality and job progress in writing with photographs.
  11. Provide list of at least 5 projects available for inspection employing same roofing system within 50 mile radius of Owner.
  12. The presence and activity of the manufacturer's/ specifier's representative and/or owner's representative shall in no way relieve the contractor of contractual responsibilities or duties.
- C. Project Meetings:
1. Pre-construction conference:
    - a. Will be scheduled by Owner within fifteen (15) days after notice of award.
    - b. Attendance:
      - 1) Roofing material supplier/specifier
      - 2) Contractor
    - c. Agenda:
      - 1) Designation of responsible personnel.
      - 2) Walkover inspection.

2. Progress Meetings:
    - a. Will be scheduled by Owner rep as required.
    - b. Attendance:
      - 1) Roofing material manufacturer/specifier/ contractor.
      - 2) Job superintendent.
    - c. Minimum Agenda:
      - 1) Review of work progress.
      - 2) Field observations, problems, and decisions.
  3. Final Inspection:
    - a. Will be scheduled by roofing material manufacturer upon job completion with manufactures Technical Service rep.
    - b. Attendance:
      - 1) Contractor.
      - 2) Roofing material manufacturer/specifier.
      - 3) Owner.
    - c. Minimum agenda:
      - 1) Walkover inspection.
      - 2) Identification of problems which may impede issuance of warranty.
- D. Random Sampling:
1. Roofing material:
    - a. During course of work, Owner's Representative may secure samples according to ASTM D140-88 of materials being used from containers at job site and submit them to an independent laboratory for comparison to specified material.
    - b. Should test results prove that a material is not functionally equal to specified material:
      - 1) Contractor shall pay for all testing.
      - 2) Roofing installed and found not to comply with the specifications shall be removed and replaced at no change in the contract price.
- E. Regulatory Requirements:
1. BOCA National Building Code.
  2. UL 790.
    - a. Class A.
  3. FM 4470.
    - a. Class I, I-90 Windstorm.

F. Plans and Specifications:

1. Contractor must notify owner and specifier of any omissions, contradictions or conflicts seven (7) days before bid date. Owner and specifier will provide necessary corrections or additions to plans and specifications by addendum. If contractor does not so notify owner and specifier of any such condition, it will be assumed that the contractor has included the necessary items in the bid to complete this specification.
2. It is the intent that this be a completed project as far as the contract documents set forth. It is not the intent that different phases of work on this project be delegated to various trades and subcontractors by the contract documents. Contractor must make own contracts with various subcontractors, setting forth the work these subcontractors will be held responsible for. Contractor alone will be held responsible by the owner for the completed project.
3. If the contractor feels a conflict exists between what is considered good roofing practice and these specifications contractor shall state in writing all objections prior to submitting quotations.
4. It is the contractor's responsibility during the course of the work, to bring to the attention of the owner's representative any defective membrane, insulation or deck discovered where not previously identified.

1.4 REFERENCES

- A. ASTM - American Society for Testing and Materials, Philadelphia, PA.
- B. FM - Factory Mutual System, Norwood, MA.
- C. NRCA - National Roofing Contractors Association, Chicago, IL.
- D. SMACNA - Sheet Metal and Air Conditioning Contractors National Association, Vienna, VA.
- E. UL - Underwriters Laboratories, Northbrook, IL.

1.5 SUBMITTALS

A. Submit at Pre-Bid Conference:

1. Product compatibility:
  - a. Written verification from roofing material supplier that major roofing components, including (but not limited to) coatings, cold process adhesives; roofing ply sheets; reinforcement fabric felts and mats; mastics; and sealants are all compatible with each other and existing construction where reworked and reroofed.
2. Test reports:
  - a. Written verification from roofing material supplier that roofing system meets or exceeds regulatory agency/s requirements.
3. Product data:
  - a. Product data sheets.
  - b. Material safety data sheets.

1.6 DELIVERY, STORAGE AND HANDLING

A. Delivery of materials:

1. Deliver materials to job-site in new, dry, unopened, and well-marked containers showing product and manufacturer's name.
2. Deliver materials in sufficient quantity to allow continuity of work.
3. Coordinate delivery with Owner.

B. Do not order project materials or start work before receiving Owner's written approval.

C. Storage of Materials:

1. Store roll goods on ends only. Discard rolls which have been flattened, creased, or otherwise damaged. Place materials on pallets. Do not stack pallets.
2. Stack insulation on pallets.
3. Store materials marked "keep from freezing" in areas where temperatures will remain above 40°F (5°C).
4. Store metal roof deck on pallets with one end elevated to provide drainage.
5. For insulation, remove plastic packaging shrouds. For felt rolls, slit the top of the plastic shrink wrap only. Cover top and sides of all stored materials with tarpaulin, Secure tarpaulin.
6. Rooftop storage: Disperse material to avoid concentrated loading.
7. No materials may be stored in open or in contact with ground or roof surface.
8. Should Contractor be required to quickly cover material temporarily, such as during an unanticipated rain shower, all materials shall be stored on a raised platform covered with secured canvas tarpaulin (not polyethylene), top to bottom.
9. Contractor shall assume full responsibility for the protection and safekeeping of products stored on premises.

D. Material Handling:

1. Handle materials to avoid bending, tearing, or other damage during transportation and installation.
2. Material handling equipment shall be selected and operated so as not to damage existing construction or applied roofing. Do not operate or situate material handling equipment in locations that will hinder smooth flow of vehicular or pedestrian traffic.
3. Cold Process Trilaminate Ply Sheet: Do not remove packaging tubes until roll is ready for use.

1.7 SITE CONDITIONS

A. Field measurements and material quantities:

1. Applicator shall have SOLE responsibility for accuracy of all measurements, estimates of material quantities and sizes, and site conditions that will affect work.

B. Existing conditions:

1. Building space directly under roof area covered by this specification will be utilized by on-going operations. Do not interrupt Owner operations unless prior written approval is received from Owner.
2. Access to roof shall be from exterior only.
3. Air-conditioning units and other equipment shall be moved as required to install roofing materials complete and in accordance with plans and specifications. When units and equipment are to be moved, they shall be carefully disconnected and removed to a protected area so as not to damage any part or component thereof, and shall be reconnected in such a way that they are restored to a prior work operating condition. Appropriate measures shall be taken to prevent dust, vapors, gases or odors from entering the building during roof removal, replacement or repair.
4. All disconnection and re-connection shall be performed by a mechanical an/or electrical company licensed to perform such work.
5. Contractor or owner shall perform appropriate inspections, surveys and file timely notifications to proper authorities prior to starting roof renovation or demolition activities. Inspectors, project planners, project managers, contractors and workers involved in the roof project shall have appropriate training, licenses and registrations. Contractor and owner shall be responsible for determining and implementing regulatory compliance activities, including but not limited to work practices, engineering controls, personal protection, air monitoring, testing, hazard communication, material handling, record retention, and arranging for waste disposal/handling.
6. Contractor must file a Uniform Hazardous Waste Manifest from proper landfill site for each load of asbestos containing material removed. Copies must be sent to owner and material manufacturer/ specifier. Transportation of waste shall be in accordance with applicable Department of Transportation (DOT) requirements.

C. Safety Requirements:

1. All application, material handling, and associated equipment shall conform to and be operated in conformance with OSHA safety requirements.
2. Comply with federal, state, local and Owner fire and safety requirements.
3. Advise Owner whenever work is expected to be hazardous to Owner, employees, and/or operators.
4. Maintain a crewman as a floor area guard whenever roof decking is being repaired or replaced.
5. Maintain fire extinguisher within easy access whenever power tools, roofing kettles, and torches are being used.

D. Waste Disposal:

1. Do not re-use, re-cycle or dispose of material manufacturers product containers except in accordance with all applicable regulations. The user of manufactured products is responsible for proper use and disposal of product containers.

E. Environmental requirements:

1. Do not work in rain, snow, or in presence of water.
2. Do not work in temperatures below 40°F (4.44°C).
3. Do not install materials marked "keep from freezing" when daily temperatures are scheduled to fall below 40°F (4.44°C).
4. Do not perform masonry work below 40°F (4.44°C).
5. Remove any work exposed to freezing.
6. Advise Owner when volatile materials are to be used near air ventilation intakes so that they can be shut down or blocked as owner requires.

1.8 WARRANTY/GUARANTEE

A. Warranty:

1. Upon project completion, Manufacturer acceptance, and once complete payment has been received by both Contractor and Manufacturer, Manufacturer shall deliver to Owner a ten (10) year manufacturer Roofing System Quality Assurance Warranty and Owner's Manual. Manufacturer will, during the second and fifth year of this warranty, inspect and provide a written Executive Summary.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Comply with quality control, references, specifications, and manufacturer's data. Products containing asbestos are prohibited on this project. Use only asbestos-free products.
- B. Use products with personal protection. User must read container label and material safety data sheets prior to use.

2.2 MANUFACTURERS

- A. Tremco Inc., Cleveland, OH
- B. Thermo Systems, Clawson, MI
- C. Garland Inc., Cleveland, OH

2.3 WOOD BLOCKING & CURBS

A. Lumber:

1. Southern Pine; No. 2 grade; free from warping and visible decay; pressure-treated with chromated copper arsenate (CCA) to meet AWPB, LP-22, 0.40 retention, and marked.
2. Free floating fascia cant: 2" x 4" (50 mm x 100 mm) cut on bias.

2.4 INSULATION

A. Bottom layer:

1. FS HH-I-1972/2(1), Class 1, isocyanurate.

B. Top layer:

1. ASTM C 208-72(1982), Asphalt coated fiberboard.
2. Asphalt coated, Top surface.

C. Bottom layer thickness: 4' x 8' x thickness to match existing.

D. Top layer thickness: 4' x 8' x thickness to match existing.

E. Insulation adhesive:

1. ASTM D 312-84, Type III Asphalt.

2.5 MECHANICAL FASTENERS

A. Insulation to steel deck:

1. Deckfast #12 screw, plastic disc or metal plate by Construction Fasteners, Inc., Wyomissing, PA.
2. Insul-Fixx #12, plastic disc or metal plate by Fabco RIF, Elyria, OH.
3. Kwik-Deck screw, plastic disc or metal plate; Atlas Bolt & Screw, Ashland, OH.
4. Olympic Fastener #12-10, plastic or metal plate by Olympic Manufacturing Group, Agawam, MA.
5. Rawl Deck #12 Deck Screw, plastic or metal plate by The Rawlplug Co., Inc New Rochelle, NY.
6. ROOFGRIP, plastic disc or metal plate by ITW Buildex, Itasca, IL.
7. Length: Sufficient to penetrate steel deck 1/2 inch (12.7 mm).

B. Wood to wood:

1. Galvanized, common, annular ring nail.



2. Length: Sufficient to penetrate underlay blocking 1-1/4 inches (32 mm).
- C. Wood to steel deck:
  1. Deckfast #12 screw, plastic disc or metal plate by Construction Fasteners, Inc., Wyomissing, PA.
  2. Insul-Fixx #12, plastic disc or metal plate by Fabco RIF, Elyria, OH.
  3. Kwik-Deck screw, plastic disc or metal plate; Atlas Bolt & Screw, Ashland, OH.
  4. Olympic Fastener #12-10, plastic or metal plate by Olympic Manufacturing Group, Agawam, MA.
  5. Rawl Deck #12 Deck Screw, plastic or metal plate by The Rawlplug Co., Inc., New Rochelle, NY.
  6. ROOFGRIP, plastic disc or metal plate by ITW Buildex, Itasca, IL.
  7. Length: Sufficient to penetrate steel deck 1/2 inch (12.7 mm).
  8. Aluminum sheet metal to wood blocking:
  9. FS FF-N-105B(3) Type II, Style 20, roofing nails; 6061-T913 alloy wire, flat head, diamond point, round, barbed shank.
  10. Length: Sufficient to penetrate wood blocking 1-1/4 inches (32 mm) minimum.

## 2.6 ROOFING MATERIALS

- A. Adhesives:
  1. Base ply adhesive:
    - a. ASTM D 312-84, Type III asphalt.
  2. Interply adhesive:
    - a. Hot-melt SEBS modified bitumen with Shell Kraton polymer "G".
  3. Surfacing adhesive:
    - a. Hot-melt SEBS modified bitumen with Shell Kraton polymer "G".
- B. Base ply:
  1. Trilaminate reinforced ply sheet.
- C. Ply sheet:
  1. ASTM D 2178, Type IV:

D. Related materials:

1. Asphalt mastic:
  - a. ASTM D 4586-86 fibrated asphalt mastic.
2. Asphalt primer:
  - a. ASTM D 41-85.
3. Flashing adhesive:
  - a. Hypalon flashing adhesive.
    - 1) Black.
4. Flashing bitumen:
  - a. ASTM D 312-84, Type III asphalt.
5. Flashing emulsion:
  - a. Self-reinforcing, polymer modified, asphalt emulsion.
6. Flashing surfacing:
  - a. Ready-mixed aluminum coating.
7. Flashing ply:
  - a. Trilaminate reinforced ply sheet.
8. Flashing sheet:
  - a. Reinforced CSPE, 0.045 inches (1.1 mm) thick.
  - b. Color: black
9. Roofing aggregate:
  - a. Hard, durable, opaque; washed free of clay, loam, sand or other foreign substances.
  - b. Do not use: Crushed gravel, white dolomite (marble chips), Joplin chats, scoria, limestone, volcanic rock, crushed oyster and clam shells, crushed brick tile, or cinders.
  - c. ASTM D 1863-86, size six (6).
10. Stripping bitumen for metal flanges:
  - a. Hot melt SEBS modified bitumen with Shell Kraton polymer "G".
11. Stripping ply:
  - a. ASTM D 2178, Type IV.

2.7 METAL FLASHINGS

- A. Free floating extruded aluminum fascia.
  - 1. Fascia width: 8 inches (203 mm).
  - 2. Elastomeric sheeting color: Black.
  - 3. Membrane width: Sufficient to extend onto horizontal roofing 6 inches (152 mm) minimum.
  - 4. Extended aluminum specified in Flashing and Sheet Metal Section.
- B. Counterflashing: Flashing and Sheet Metal Section: Another Division 7 Section.
- C. Stainless Steel Flashings:
  - 1. ISI Type 302/304, complying with ASTM A167, 2D annealed finish except where harder temper required, 0.0156" thick.
- D. Work shall be in accordance with Architectural Sheet Metal Manual, as issued by Sheet Metal and Air Conditioning Contractors' National Association, Inc., (SMACNA).

2.8 ACCESSORIES

- A. Walkway pads.
  - 1. Bitumen-impregnated mineral fiber boards with granular surfaces compatible with roofing materials.
  - 2. Size: As indicated.

2.9 TAPERED INSULATION

- A. Tapered Roof Insulation: Fabricate from perlite board roof insulation, factory cut to provide roof slopes and saddles.
  - 1. Provide undamaged insulation, free of fractures, damaged edges and corners, and cap sheet punctures. Prevent damage to insulation during handling and roofing procedures. Discard damaged insulation and remove from the site.
  - 2. Install tapered roof insulation in accordance with the approved shop drawings, manufacture's instructions and as specified above. Provide 4" ridge at drainage saddles for slope to drains. Use licensed applicators as approved manufacturer.

2.10 SYSTEM PERFORMANCE REQUIREMENTS:

A. TRILAMINATE REINFORCED PLY SHEET

<u>Property Typical Value</u>	<u>Test Method</u>
Weight 1.5 kg/m <sup>2</sup> (31 lb/100 ft <sup>2</sup> )	ASTM D 228-69 (1978)
Breaking strength 23.6 N/mm MD (135 lbf/in.) 22.8 N/mm XD (130 lbf/in.)	ASTM D 146-78a (1986)
Pliability, 12.7 mm No failures (1/2") radius bend	ASTM D 146-78a (1986)
Mass of desaturated 0.12 kg/m <sup>2</sup> polyester/glass (2.2 lb/100 ft <sup>2</sup> ) mat, min	ASTM D 146-78a (1986)
Tear strength 62.3 N MD (14 lbf) 40.0 N XD (9 lbf)	ASTM D 1117-80
Surfacing & 65% stabilizer, max	ASTM D 146-78a (1986)
Asphalt 0.49 kg/m <sup>2</sup> (10 lb/100 ft <sup>2</sup> )	ASTM D 228-69 (1978)
Resistance to 534 N (120 lbf) puncture	ASTM E 154-68 (1979)

B. NON-SHRINKING, NON-ROTTING WOVEN GLASS MESH

<u>Property Typical Value</u>	<u>Test Method</u>
Weight 0.065 kg/m <sup>2</sup> (1.32 lb/100 ft <sup>2</sup> )	ASTM D 146-78a (1986)
Moisture based on None net weight	ASTM D 146-78a (1986)
Average tensile strength @25°C (77°F) Wrap threads 334 N (75 lbf) Filling threads 334 N (75 lbf)	ASTM D 146-78a (1986) ASTM D 146-78a (1986)
Organic content Weight 18.7% Type PVC/acrylic water- based	ASTM D 579-83

C. READY MIXED ALUMINUM COATING

<u>Property Typical Value</u>	<u>Test Method</u>
Asbestos content None	ASTM D 276-87
Viscosity @25°C (77°F) 13.5 s (Ford cup No. 4)	ASTM D 1200-82
Density @25°C (77°F) 0.90 kg/L (7.5 lb/gal)	ASTM D 1475-85
Nonvolatile Content 35.2%	ASTM D 1644-88

D. FIBRATED ASPHALT MASTIC

<u>Property Typical Value</u>	<u>Test Method</u>
Asbestos content None	ASTM D 276-87
Viscosity @ 25°C 480 - 1000 Pa s (77°F) (480000-1000000 cP)	ASTM D 2196-86
Density @ 25°C 1.11 kg/L (77°F) (9.3 lb/gal)	ASTM D 1475-85
Nonvolatile Matter 80%	ASTM D 4586-86
Behavior at 140° F (Sag Resistance) 3.18 mm (1/8 in.)	ASTM D 4586-86
Moisture vapor 2 - 6 g/m <sup>2</sup> /24 hrs. transmission rate @ 0.51 mm (0.10 - 0.40 g/100 in. <sup>2</sup> / 24 hrs @ 0.020 in.) thickness	ASTM E398-83

E. FIBRATED ASPHALT MASTIC

<u>Property Typical Value</u>	<u>Test Method</u>
Asbestos content None	ASTM D 276-87
Viscosity @ 25°C 480 - 1000 Pa s (77°F) (480000-1000000 cP)	ASTM D 2196-86
Density @ 25°C 1.11 kg/L (77°F) (9.3 lb/gal)	ASTM D 1475-85
Nonvolatile Matter 80%	ASTM D 4586-86
Behavior at 140° F (Sag Resistance) 3.18 mm (1/8 in.)	ASTM D 4586-86
Moisture vapor 1.55 - 6.2 g/m <sup>2</sup> /24 transmission rate hrs. @ 0.51 mm (0.10 - 0.40 g/100 in. <sup>2</sup> /24 hrs @ 0.020 in.) thickness	ASTM E398-83

F. HYPALON ELASTOMERIC SHEETING

<u>Property Typical Value</u>	<u>Test Method</u>
Thickness 1.14 mm (0.045 in.)	ASTM D751-89
Tensile strength 1000 N (225 lbf)	ASTM D751-89
Elongation @ fabric 25% break	ASTM D751-89
Tear resistance 423 N (95 lbf)	ASTM D751-89

Water absorption < 5% within 7 days @ 22°C (72°F)	ASTM D471-89
Dimensional stability 1 hr @ 100°C (212°F) 1.0 - 1.25%	ASTM D1204-84
Low temperature -40°C to -43°C flexibility (-40°F to -45°F)	ASTM D2136-84(1989)
Ply adhesion 2.1 N/mm (12 lbf/in.)	ASTM D413-82(1988)
Water vapor transmission 2.87 ng/(Pa s m <sup>2</sup> ) (0.05 perms)	ASTM E96-88

G. ASTM D 312-84, TYPE III ASPHALT

<u>Property Typical Value</u>	<u>Test Method</u>
Softening point 91 - 96°C (195 - 205°F)	ASTM D 36-86
Penetration @ 25°C 15 - 30 dmm (77°F)	ASTM D 5-86
Flash point, min 274°C (525°F)	ASTM D 92-85
Ductility @ 25°C, 2.5 cm (77°F) min	ASTM D 113-86
Equiviscous temperature range 204 to 221°C (400 to 430°F) (125cP)	ASTM D 4402-87

H. HOT MELT SEBS MODIFIED BITUMEN WITH SHELL KRATON POLYMER "G"

<u>Property Typical Value</u>	<u>Test Method</u>
Softening point 91 - 96°C (195 - 205°F)	ASTM D 36-86
Elongation @ 38°C 1000% (77°F)	ASTM D 412-87
Density @ 38°C 0.99 kg/L (77°F) (8.3 lb/gal)	ASTM D 70-82 (1986)
Flash point	274°C (525°F) ASTM D 92-85
Penetration @ 38°C 25 - 40 dmm (77°F)	ASTM D 5-86
Penetration index	4.5 Calculated value

I. COMPOSITION FLASHING

<u>Property Typical Value</u>	<u>Test Method</u>
Tensile strength @ 731 N (164.4 lbf) MD -18°C (0°F) 609 N (137.0 lbf) XD (1989)	ASTM D2523-78
Elongation @ -18°C 2.6% MD (0°F) 1.6% XD (1989)	ASTM D2523-78
Weight 2.42 kg/m <sup>2</sup> (49.55 lbs/100 sq ft)	ASTM D146-90
Pliability 12.7 mm No failures (1/2") radius bend @25°C (77°F)	ASTM D146-90
Tear strength	

(Trapezoid) @ 25°C 57 N (12.7 lbf) MD ASTM D1117-80  
(77°F) 54 N (12.2 lbf) XD  
Asphalt coating weight 0.99 kg/m<sup>2</sup> ASTM D146-90  
(20.27 lbs/100 ft<sup>2</sup>)  
Puncture strength 672 N @ 23 mm ASTM E154-88  
(151 lbf @ 0.9 in.)

J. SELF-REINFORCING, POLYMER MODIFIED, ASPHALT EMULSION

<u>Property Typical Value</u>	<u>Test Method</u>
Asbestos content None	ASTM D 276-87
Density @ 25°C 1.0 kg/L (77°F) (8.4 lb/gal)	ASTM D 1475-85
Residue by evaporation 50%	ASTM D 2939-78
Ash content 4.0% (total sample)	ASTM D 2939-78
Tensile strength 310 kPa (45 psi) @ 25°C (77°F), min	ASTM D 412-87
Elongation @ 25°C 200% (77°F), min	ASTM D 412-87
Moisture vapor 62 g/m <sup>2</sup> /24 hrs. @ transmission rate 0.51 mm (4.0 g/100 in. <sup>2</sup> /24 hrs @ 0.020 in.) thickness	ASTM E398-83

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify conditions as satisfactory to receive work.
- B. Do not begin roofing until all unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions.
- C. Verify that work of other trades penetrating roof deck or requiring men and equipment to traverse roof deck has been approved by Owner, manufacturer, and roofing contractor.
- D. Check projections, curbs, and deck for inadequate anchorage, foreign material, moisture, or unevenness that would prevent quality and execution of new roofing system.

3.2 GENERAL WORKMANSHIP

- A. Substrate: Free of foreign particles prior to laying roof membrane.
- B. Phased application: Not permitted. All plies shall be completed each day.
- C. Traffic and equipment: Kept off completed plies until adhesive has set.
- D. Wrapper and packaging materials: Not to be included in roofing system.
- E. Entrapped aggregate: Not permitted within new membrane. Its discovery is sufficient cause for rejection.
- F. Ply shall never touch ply, even at roof edges, laps, tapered edge strips, and cants.
- G. Fit plies into roof drain rims; install lead flashing and finishing plies; secure clamping collars; install domes.
- H. Extend roofing membrane to top edge of cant at wall and projection bases.

- I. Cut out fishmouths/side laps which are not completely sealed; patch. Replace all sheets which are not fully and continuously bonded.
- J. Modified bitumen heating:
  - 1. Use low burner flames during initial melt-downs, circulate modified bitumen after initial melt-down.
    - a. Maximum bitumen temperature: 525°F (274°C).
    - b. EVT: 415°F - 465°F (213°C - 241°C).
  - 2. Kettle: Free of contaminants (asphalt or coal tar pitch).
  - 3. Use separate kettle for asphalt bitumen heating.
  - 4. Application rates: Bitumen quantities for waterstop/tie-offs, flashings, miscellaneous detail applications, and minimum kettle capacity are not included in application rates. To account for these factors, add approximately 25 percent additional bitumen on a total-job average basis.
- K. Asphalt Heating:
  - 1. Use low burner flames during initial melt-downs, circulate asphalt after initial melt-down.
    - a. Maximum bitumen temperature: 525°F (274°C).
    - b. EVT: 400°F - 430°F (204°C - 221°C).
  - 2. Kettle: Free of contaminants.
  - 3. Application rates: Bitumen quantities for waterstop/tie-offs, flashings, miscellaneous detail applications, and minimum kettle capacity are not included in application rates. To account for these factors, add approximately 25 percent additional bitumen on a total-job average basis.
- L. Mechanical Fasteners:
  - 1. Seated firmly in discs with fastener heads flush or below disc's top surface.
  - 2. Length: Sufficient to accommodate roof insulation thickness and engage metal deck 1/2 inch (13 mm).
- M. Insulation:
  - 1. Install insulation boards in courses parallel to roof edges mopping surface up.
    - a. Firmly butt each insulation board to surrounding boards. Do not jam or deform boards.
    - b. Eliminate open joints and uneven surfaces.
  - 2. Maximum insulation gap: 1/4 inch (6 mm).
  - 3. Fill insulation board joint gaps larger than 1/4 inch (6 mm) with roof insulation.
  - 4. Maximum elevation variation between boards at joints: 1/8 inch (3 mm).



5. Cut and fit insulation boards where roof deck intersects vertical surfaces. Cut board 1/4 inch (6 mm) from vertical surface.
  6. Stagger joints at least 6 inches (150 mm).
  7. Filler size: 18 inches (460 mm) in length or width, minimum.
- N. Insulation: Form continuous insulation joints over deck flange. Do not cantilever insulation edges over deck ribs. Minimum bearing surface: 1-1/2 inches (38 mm).

### 3.3 PREPARATION

A. Protection:

1. Contractor shall be responsible for protection of property during course of work. Lawns, shrubbery, paved areas, and building shall be protected from damage. Repair damage at no extra cost to Owner.
2. Provide at site prior to commencing removal of debris, a dumpster or dump truck to be located adjacent to building where directed by Owner.
3. Roofing, flashings, membrane repairs, and insulation shall be installed and sealed in a watertight manner on same day of installation or before arrival of inclement weather.
4. At start of each work day drains within daily work area shall be plugged. Plugs to be removed at end of each work day or before arrival of inclement weather.
5. Preparation work shall be limited to those areas that can be covered with installed roofing material on same day and before arrival of inclement weather.
6. Arrange work sequence to avoid use of newly constructed roofing for storage, walking surface, and equipment movement. Move equipment and ground storage areas as work progresses.
7. Protect building surfaces at set-up areas with tarpaulin. Secure tarpaulin. Remove dumpster from premises when full and empty at approved dumping or refuse area. Deliver empty dumpster to site for further use. Upon job completion, dumpster shall be removed from premises. Spilled or scattered debris shall be cleaned-up immediately. Removed material to be disposed from roof as it accumulates.
8. At end of each working day, removal areas shall be sealed with water stops along edges to prevent water entry.
9. Provide clean plywood walkways and take other precautions required to prevent tracking of aggregate/debris from existing membrane into new work area where aggregate/debris pieces can be trapped within new roofing membrane. Contractor shall instruct and police workmen to ensure that aggregate/debris is not tracked into new work areas on workmen's shoes or equipment wheels. Discovery of entrapped aggregate/debris within new membrane is sufficient cause for its rejection.

B. Surface preparation:

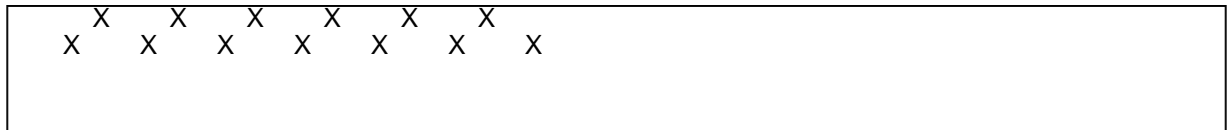
1. Sweep clean roof deck.

3.4 CARPENTRY

A. Roof Edge:

1. Mechanically attach wood blocking. Offset blocking layers 12 inches (300 mm); weave corners.
  - a. Blocking thickness: Equal to final insulation thickness including tapered edge strips.
2. Fasteners shall be installed in two (2) rows staggered. Spacing in any 1 row shall not exceed 24 inches (610 mm). Within 8 feet (2.4 meter) of outside corners, spacing shall not exceed 12 inches (300 mm) in any one (1) row.
3. Install wood cants over extruded aluminum fascia deck brackets. Nail two (2) rows at a spacing not to exceed 12 inches (300 mm) from each side of deck brackets. Miter corners.

B. Wood blocking fastening pattern:



C. Prefinished aluminum Fascia:

1. Mechanically attach wood blocking with 3/8 inch (9.5 mm) diameter wedge anchors 4 feet o.c., minimum 2 fasteners per section of blocking. Countersink anchors flush with blocking surface.
  - a. Blocking thickness: 2 inches (50 mm) nominal.
  - b. Blocking width: Flush with edges.

3.5 THERMAL INSULATION

A. Mechanically attach insulation to deck, unless otherwise recommended by roof manufacturer.

1. Fastener density: 1 every 2 sq. ft. (1 every 0.19 sq. meter.) or per local Factory Mutual requirements.
2. Install additional fasteners to ensure insulation is firm under foot.

B. Drive mechanical fasteners flush to top surface.

C. Filler insulation requires 2 fasteners per piece minimum.

D. Adhere each layer(s) with a uniform and continuous application of asphalt at a rate of 30 lbs. per 100 sq. ft. (1.5 kg/m<sup>2</sup>) ± 20 percent.

1. Immediately after placement, walk insulation boards into hot bitumen to achieve solid bond.
2. Promptly spread any bitumen pools that may accumulate on insulation surface to achieve smooth surface for roofing installation.

3.6 ROOF SYSTEM APPLICATION

- A. Install base ply to roof and all wall, curb, and projection bases in a uniform and continuous mopping of asphalt.
- B. Ply laps: 4 inches (100 mm).
- C. Apply adhesive no more than 10 feet (3 meter) ahead of each roll being embedded.
- D. Broom ply before adhesive cools from unmopped side. Ensure complete and continuous seal and contact between bitumen and ply sheets, including ends, edges, and laps without wrinkles, fish mouths, or blisters. Broom width: 34 inches (860 mm) minimum. Avoid walking on plies until adhesive has set.
- E. Roofing ply shall never touch roofing ply, even at roof edges, laps, tapered edge strips, and cants.
- F. Cut out fishmouths/side laps which are not completely sealed; patch. Replace all sheets which are not fully and continuously bonded.
- G. Lap ply membrane ends 4 inches (100 mm). Stagger end laps 3 feet (910 mm) minimum.
  - 1. Adhesive application rate: 25 lbs. per 100 sq. ft. (1.2 kg/m<sup>2</sup>) average, tolerance  $\pm$  20 percent.
- H. Install three (3) plies of ply sheet, shingle fashion. Overlap starter strips 26 inches (660 mm) with first ply, then overlap each succeeding ply 24-2/3 inches (630 mm). Place ply sheets to ensure water will flow over or parallel to, but never against exposed edges.
- I. Use 12, 24, 36 inch (305, 610, and 910 mm) wide plies to start and finish roof membrane along roof edges and termination's.
- J. Lap ply sheet ends 6 inches (150 mm). Stagger end laps 12 inches (305 mm) minimum.
- K. Apply adhesive no more than 10 feet (3 meter) ahead of each roll being embedded.
- L. Broom each ply before adhesive cools from unmopped side. Ensure complete and continuous seal and contact between bitumen and ply sheets, including ends, edges, and laps without wrinkles, fish mouths, or blisters. Broom width: 34 inches (860 mm) minimum. Avoid walking on plies until adhesive has set.
- M. Embed each ply in a uniform and continuous mopping of modified hot-melt adhesive.
  - 1. Interply mopping rate: 25 lbs. per 100 sq. ft. (1.2 kg/m<sup>2</sup>) average, tolerance  $\pm$  20 percent.

3.7 FLASHINGS

- A. General flashing requirements:
  - 1. Elastomeric Flashing:
    - a. Adhere elastomeric sheeting completely to flashing surface, cant, and roofing with a continuous mopping of hot melt modified bitumen.
    - b. Ensure complete bond and continuity without wrinkles or voids. Lap sheeting ends 4 inches (100 mm). Adhere laps with Hypalon flashing adhesive.

- c. Elastomeric sheeting width: Sufficient to extend at least 6 inches (150 mm) beyond toe of cant onto new roof.
    - d. Seal vertical and horizontal edges of sheeting with reinforcing membrane embedded in a base course of Modified Mastic and a top course Modified Mastic
  - 2. Composition flashing (Two Plies):
    - a. Cut flashing ply in lengths not to exceed 10 feet (3 meter).
    - b. Adhere first flashing ply to flashing substrate in a continuous application of flashing bitumen. Remove wrinkles and voids. Overlap sections 4 inches (100 mm).
    - c. Extend flashing ply 4 inches (100 mm) beyond toe of cant.
    - d. Cut additional flashing ply in lengths not to exceed 10 feet (3.1 meter). Apply flashing bitumen to first flashing ply in a continuous application. Embed second flashing ply into bitumen. Lap flashing membrane ends 4 inches (100 mm); extend membrane 6 inches (150 mm) beyond toe of cant; press sheet firmly in place. Ensure complete bond and continuity without wrinkles or voids. Adhere laps with flashing bitumen.
  - 3. Two-Ply Stripping:
    - a. Set flange in asphalt mastic. Seal flange with two (2) stripping plies embedded between alternate applications of stripping adhesive/bitumen. Extend first ply 4 inches (100 mm) beyond flange; second ply 2 inches (50 mm) beyond first ply.
- B. At Perimeter Edges:
- 1. Install new roofing to blocking edge. Nail with spiral or annular shank nails, 8 inches (200 mm) o.c. Nails to have 1 inch (25 mm) integral cap.
  - 2. Install extruded aluminum free-floating fascia system according to manufacturer's published instructions.
    - a. Use prefabricated corners.
    - b. Minimum fascia length: 24 inches (61 cm), 2 deck brackets minimum.
  - 3. Elastomeric sheeting shall be of sufficient width that after being inserted and secured by fascia top cap, will extend at least 6 inches (15.2 cm) onto new roof.
  - 4. Solidly adhere sheeting completely to cant and roofing in a uniform and continuous application of flashing adhesive.
  - 5. Seal horizontal and vertical edges of sheeting with reinforcing membrane embedded in a base course of hypalon flashing adhesive and a top course of modified asphalt mastic.
- C. At Wood Curb Flashings:
- 1. Remove mechanical equipment from curb.
  - 2. Install new roofing to top edge of cant. Nail 8 inches (200 mm) o.c. with spiral or annular nails, with a 1 inch (25 mm) cap.
  - 3. Install composition base flashing as described in general flashing requirements section.
  - 4. Secure top edge of flashing to substrate with spiral or annular shank nails, with a 1 inch (2.54 cm) cap, 8 inches (20.3 cm) o.c.

- a. Fabricate and install counterflashing.
5. Reinstall mechanical equipment onto curb. Refasten.
- D. At Plumbing Vents:
  1. Wedge plumbing vent tight against deck.
  2. Apply 1/16 inch (1.6 mm) uniformly thick layer of asphalt mastic to surface receiving metal flange.
  3. Fabricate and install plumbing vent flashing from lead. Flange: 4 inches (100 mm) wide minimum; extend completely around periphery of vent flashing. Set flange into mastic. Neatly dress flange with wood block.
  4. Prime metal flange with asphalt primer.
    - a. Pipe outside diameter greater than 2 inches (50 mm): Bend lead inside pipe 1 inch (25 mm) minimum with pliers or rubber/plastic mallet; replace cracked lead.
    - b. Pipe outside diameter 2 inches (50 mm) or less: Cut lead at vent top; fabricate and install integral lead cap.
  5. Install two (2) ply stripping described in general flashing requirements section.
- E. At Fascias:
  1. Installation of fascia.
    - a. Install wood blocking unless existing reused.
    - b. Install continuous bent plate on edge of wood blocking. Anchor 32 inches (800 mm).
    - c. Fabricate and install fascia. Connect fascia sections as recommended by manufacturer. Extend front and 2 inches (50 mm) beyond wood blocking. Bend lower edges out 45 degrees maximum to form drip edge. Attach outside edge to continuous cleat with 3/4 inch (19 mm) lock. Attach inside edge to wood blocking 24 inches (610 mm) o.c. At corners, form standing seam and miter.
- F. At Roof Drains:
  1. Install tapered edge strip around drain to create approximate 48 x 48 inch (1220 x 1220 mm) sump. Miter corners. Seal toe of tapered edge to drain rim with reinforcing membrane embedded between alternate courses of asphalt mastic.
  2. Install roofing system into sump and onto drain rim.
  3. Plug drain to prevent water entry until service connection is completed.
  4. Apply 1/16 inch (1.6 mm) uniformly thick layer of asphalt mastic to surface receiving lead flashing.
  5. Set single piece stainless stool flashing in mastic centered over drain; extend lead 6 inches (150 mm) beyond drain rim. Neatly dress lead with wood block.
  6. Clamp flashing collar to drain in bed of mastic.

7. Neatly cut stainless steel felts within drain at rim. Lead to extend 1 inch (25 mm) into bowl.
8. Prime lead with asphalt primer.
9. Install two (2) ply stripping described in general flashing requirements section. Stripping shall not extend under clamping ring.

3.8 SURFACING TREATMENT ON FLASHINGS

- A. Apply surfacing emulsion to flashing at 3 gallons per 100 sq. ft. (1.2 L/m<sup>2</sup>).
- B. Allow surfacing emulsion to set for 30 days, then coat flashing surface with 1 coat of aluminized heat reflective coating to flashing surface at approximate rate of 130 sq. ft. per gallon (3.2 m<sup>2</sup>/L).
- C. Coat elastomeric flashing with 1 coat of aluminized heat reflective coating applied at an approximate rate of 130 sq. ft. per gallon (3.2 m<sup>2</sup>/L).

3.9 SURFACING APPLICATION

- A. Flood coat:
  1. Prior to application of surface treatment system, contractor shall inspect roof with manufacturer's representative.
  2. Over entire roof surface apply uniform and continuous flood coat of hot-melt SEBS modified bitumen with Shell Kraton polymer "G" at minimum rate of 50 lbs. per 100 sq. ft. (2.4 kg/m<sup>2</sup>) ± 20%.
  3. Immediately broadcast minimum 400 lbs./100 sq. ft. (19.5 kg/m<sup>2</sup>) of new, clean roofing gravel. Cover flood coat material completely.

3.10 ADJUSTING AND CLEANING

- A. Repair of deficiencies:
  1. Installations of details noted as deficient during final inspection must be repaired and corrected by applicator, and made ready for reinspection, within five (5) working days.
- B. Clean-up:
  1. Immediately upon job completion, roof membrane and flashing surfaces shall be cleaned of debris.
  2. Clean gutters and downspouts of debris.

3.

STATEMENT OF ROOFING MANUFACTURER'S QUALIFICATIONS

Each bidder for the work included in the specifications and drawings and the contract documents shall submit with their bid the data requested in the following schedule of information. This data must be included in and made part of each bid document and contained in the sealed envelope. Failure to comply with this instruction may be regarded as justification for rejecting the Contractor's Proposal. Submit one (1) copy of this statement.

1. Name of bidder\_\_\_\_\_
2. Name of Material Supplier\_\_\_\_\_
3. Number of years manufacturing this roof system\_\_\_\_\_
4. Location of wholly owned and operated manufacturing facilities.  

Facility_____	Facility_____
Product_____	Product_____
Street_____	Street_____
City_____	City_____
State _____	State_____
% of product used mfg at this plant_____	% of product used mfg at this plant_____
Facility_____	Facility_____
Product_____	Product_____
Street_____	Street_____
City_____	City_____
State _____	State_____
% of product used mfg at this plant_____	% of product used mfg at this plant_____
5. Submit Material Safety Data Sheets on products to be used.
6. Submit current independent laboratory results on roofing system that is proposed, prior to award of contract.
7. The proposed roof system to be installed shall meet all local and state safety, health, fire and building code requirements.

\*\*END OF SECTION\*\*

## FIRESTOPPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes firestopping for the following:
  - 1. Penetrations through fire-resistance-rated floor and roof construction including both empty openings and openings containing cables, pipes, ducts, conduits, and other penetrating items.
  - 2. Penetrations through fire-resistance-rated walls and partitions including both empty openings and openings containing cables, pipes, ducts, conduits, and other penetrating items.
  - 3. Penetrations through smoke barriers and construction enclosing compartmentalized areas involving both empty openings and openings containing penetrating items.
  - 4. Sealant joints in fire-resistance-rated construction.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
  - 1. Division 3 Section "Cast-In-Place Concrete" for construction of openings in concrete slabs.
  - 2. Division 4 Section "Unit Masonry Assemblies" for joint fillers for non-fire-resistive-rated masonry construction.
  - 3. Division 7 Section "Building Insulation" for safin insulation and accessories.
  - 4. Division 7 Section "Joint Sealants" for non-fire-resistive-rated joint sealants.
  - 5. Division 15 Sections specifying ducts and piping penetrations.
  - 6. Division 16 Sections specifying cable and conduit penetrations.

#### 1.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. General: Provide firestopping systems that are produced and installed to resist the spread of fire, according to requirements indicated, and the passage of smoke and other gases.
- B. F-Rated Through-Penetration Firestop Systems: Provide through-penetration firestop systems with F ratings indicated, as determined per ASTM E 814, but not less than that equaling or exceeding the fire-resistance rating of the constructions penetrated.
- C. T-Rated Through-Penetration Firestop Systems: Provide through-penetration firestop systems with T ratings, in addition to F ratings, as determined per ASTM E 814, where indicated and where systems protect penetrating items exposed to contact with adjacent materials in occupiable floor areas. T-rated assemblies are required where the following conditions exist:



1. Where firestop systems protect penetrations located outside of wall cavities.
  2. Where firestop systems protect penetrations located outside fire-resistive shaft enclosures.
  3. Where firestop systems protect penetrations located in construction containing doors required to have a temperature-rise rating.
  4. Where firestop systems protect penetrating items larger than a 4-inch-diameter nominal pipe or 16 sq. in. in overall cross-sectional area.
- D. Fire-Resistive Joint Sealants: Provide joint sealants with fire-resistance ratings indicated, as determined per ASTM E 119, but not less than that equaling or exceeding the fire-resistance rating of the construction in which the joint occurs.
- E. For firestopping exposed to view, traffic, moisture, and physical damage, provide products that do not deteriorate when exposed to these conditions.
1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
  2. For floor penetrations with annular spaces exceeding 4 inches or more in width and exposed to possible loading and traffic, provide firestop systems capable of supporting the floor loads involved either by installing floor plates or by other means.
  3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.
- F. For firestopping exposed to view, provide products with flame-spread values of less than 25 and smoke-developed values of less than 450, as determined per ASTM E 84.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency.
1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

1.6 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Provide firestopping that complies with the following requirements and those specified under the "System Performance Requirements" article:
1. Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL, Warnock Hersey, or another agency performing testing and follow-up inspection services for firestop systems that is acceptable to authorities having jurisdiction.
  2. Through-penetration firestop systems are identical to those tested per ASTM E 814 under conditions where positive furnace pressure differential of at least 0.01 inch of water is maintained at a distance of 0.78 inch below the fill materials surrounding the penetrating items in the test assembly. Provide rated systems complying with the following requirements:
    - a. Through-penetration firestop system products bear classification marking of qualified testing and inspecting agency.
    - b. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by UL in their "Fire Resistance Directory," by Warnock Hersey, or by another qualified testing and inspecting agency.
  3. Fire-resistive joint sealant systems are identical to those tested for fire-response characteristics per ASTM E 119 under conditions where the positive furnace pressure differential is at least 0.01 inch of water, as measured 0.78 inch from the face exposed to furnace fire. Provide systems complying with the following requirements:
    - a. Fire-Resistance Ratings of Joint Sealants: As indicated by reference to design designations listed by UL in their "Fire Resistance Directory" or by another qualified testing and inspecting agency.
    - b. Joint sealants, including backing materials, bear classification marking of qualified testing and inspection agency.
- B. Installer Qualifications: Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary experience, staff, and training to install manufacturer's products per specified requirements. A manufacturer's willingness to sell its firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.
- C. Single-Source Responsibility: Obtain through-penetration firestop systems for each kind of penetration and construction condition indicated from a single manufacturer.
- D. Provide firestopping products containing no detectable asbestos as determined by the method specified in 40 CFR Part 763, Subpart F, Appendix A, Section 1, "Polarized Light Microscopy."
- E. Coordinating Work: Coordinate construction of openings and penetrating items to ensure that designated through-penetration firestop systems are installed per specified requirements.
- F. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 1 Section "Project Meetings."
- G. Owner will employ and pay a qualified inspection agency to check installed firestopping systems for compliance with requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

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

1.8 PROJECT CONDITIONS

- A. Environmental Conditions: Do not install firestopping when ambient or substrate temperatures are outside limits permitted by firestopping manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Ventilation: Ventilate firestopping per firestopping manufacturers' instructions by natural means or, where this is inadequate, forced air circulation.

1.9 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.
- C. Notify Owner's testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. A/D Fire Protection Systems, Inc.
  - 2. DAP, Inc.
  - 3. Firestop Systems, Inc.
  - 4. Hilti Construction Chemicals, Inc.
  - 5. 3M Fire Protection Products
  - 6. Tremco
  - 7. USG, Co.
  - 8. International Protective Coatings Corporation

2.2 FIRESTOPPING, GENERAL

- A. Compatibility: Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by firestopping manufacturer based on testing and field experience.
- B. Accessories: Provide components for each firestopping system that are needed to install fill materials and to comply with "System Performance Requirements" article in Part 1. Use only components specified by the firestopping manufacturer and approved by the qualified testing and inspecting agency for the designated fire-resistance-rated systems. Accessories include but are not limited to the following items:
  - 1. Permanent forming/damming/backing materials including the following:
    - a. Semirefractory fiber (mineral wool) insulation.
    - b. Ceramic fiber.
    - c. Sealants used in combination with other forming/damming materials to prevent leakage of fill materials in liquid state.
    - d. Fire-rated formboard.
    - e. Joint fillers for joint sealants.
  - 2. Temporary forming materials.
  - 3. Substrate primers.
  - 4. Collars.
  - 5. Steel sleeves.
- C. Applications: Provide firestopping systems composed of materials specified in this Section that comply with system performance and other requirements.

2.3 FILL MATERIALS FOR THROUGH-PENETRATION FIRESTOP SYSTEMS

- A. Ceramic-Fiber and Mastic Coating: Ceramic fibers in bulk form formulated for use with mastic coating, and ceramic fiber manufacturer's mastic coating.
- B. Ceramic-Fiber Sealant: Single-component formulation of ceramic fibers and inorganic binders.
- C. Endothermic, Latex Compound Sealant: Single-component, endothermic, latex formulation.
- D. Intumescent, Latex Sealant: Single-component, intumescent, latex formulation.
- E. Intumescent Putty: Nonhardening, dielectric, water-resistant putty containing no solvents, inorganic fibers, or silicone compounds.
- F. Intumescent Wrap Strips: Single-component, elastomeric sheet with aluminum foil on one side.
- G. Job-Mixed Vinyl Compound: Prepackaged vinyl-based powder product for mixing with water at Project site to produce a paintable compound, passing ASTM E 136, with flame-spread and smoke-developed ratings of zero per ASTM E 84.
- H. Mortar: Prepackaged dry mix composed of a blend of inorganic binders, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogenous mortar.

- I. Pillows/Bags: Re-usable, heat-expanding pillows/bags composed of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents and fire-retardant additives.
- J. Silicone Foam: Two-component, silicone-based liquid elastomer that, when mixed, expands and cures in place to produce a flexible, nonshrinking foam.
- K. Silicone Sealant: Moisture-curing, single-component, silicone-based, neutral-curing elastomeric sealant of grade indicated below:
  - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces and nonsag formulation for openings in vertical and other surfaces requiring a nonslumping/ gunnable sealant, unless indicated firestop system limits use to nonsag grade for both opening conditions.
  - 2. Grade for Horizontal Surfaces: Pourable (self-leveling) grade for openings in floors and other horizontal surfaces.
  - 3. Grade for Vertical Surfaces: Nonsag grade for openings in vertical and other surfaces.
- L. Solvent-Release-Curing Intumescent Sealant: Solvent-release-curing, single-component, synthetic-polymer-based sealant of grade indicated below:
  - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces and nonsag formulation for openings in vertical and other surfaces requiring a nonslumping/ gunnable sealant, unless indicated firestop system limits use to nonsag grade for both opening conditions.
  - 2. Grade for Horizontal Surfaces: Pourable (self-leveling) grade for openings in floors and other horizontal surfaces.
  - 3. Grade for Vertical Surfaces: Nonsag grade for openings in vertical and other surfaces.

#### 2.4 FIRE-RESISTIVE ELASTOMERIC JOINT SEALANTS

- A. Elastomeric Sealant Standard: Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer indicated that complies with ASTM C 920 requirements, including those referenced for Type, Grade, Class, and Uses, and requirements specified in this Section applicable to fire-resistive joint sealants.
- B. Sealant Colors: Provide color of exposed joint sealants to comply with the following:
  - 1. Provide selections made by Architect from manufacturer's full range of standard colors for products of type indicated.
- C. Single-Component, Neutral-Curing Silicone Sealant: Type S; Grade NS; Class 25; exposure-related Use NT, and joint-substrate-related Uses M, G, A, and (as applicable to joint substrates indicated) O.
  - 1. Additional Movement Capability: Provide sealant with the capability to withstand the following percentage changes in joint width existing at time of installation, when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719, and remain in compliance with other requirements of ASTM C 920 for uses indicated:
    - a. 50 percent movement in both extension and compression for a total of 100 percent movement.

- b. 100 percent movement in extension and 50 percent movement in compression for a total of 150 percent movement.
- D. Multicomponent, Nonsag, Urethane Sealant: Type M; Grade NS; Class 25; exposure-related Use NT, and joint-substrate-related Uses M, A, and (as applicable to joint substrates indicated) O.
  - 1. Additional Movement Capability: Provide sealant with the capability to withstand the following percentage change in joint width existing at time of installation, when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719, and remain in compliance with other requirements of ASTM C 920 for uses indicated:
    - a. 40 percent movement in extension and 25 percent in compression for a total of 65 percent movement.
    - b. 50 percent movement in both extension and compression for a total of 100 percent movement.
- E. Single-Component, Nonsag, Urethane Sealant: Type S; Grade NS; Class 25; and Uses NT, M, A, and (as applicable to joint substrates indicated) O.

## 2.5 MIXING

- A. For those products requiring mixing prior to application, comply with firestopping manufacturer's directions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other procedures needed to produce firestopping products of uniform quality with optimum performance characteristics for application indicated.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of firestopping. Do not proceed with installation until unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Cleaning: Clean out openings and joints immediately prior to installing firestopping to comply with recommendations of firestopping manufacturer and the following requirements:
  - 1. Remove all foreign materials from surfaces of opening and joint substrates and from penetrating items that could interfere with adhesion of firestopping.
  - 2. Clean opening and joint substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with firestopping. Remove loose particles remaining from cleaning operation.
  - 3. Remove laitance and form release agents from concrete.
- B. Priming: Prime substrates where recommended by firestopping manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent firestopping from contacting adjoining surfaces that will remain exposed upon completion of Work and that would otherwise be permanently

stained or damaged by such contact or by cleaning methods used to remove smears from firestopping materials. Remove tape as soon as it is possible to do so without disturbing firestopping's seal with substrates.

### 3.3 INSTALLING THROUGH-PENETRATION FIRESTOPS

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

### 3.4 INSTALLING FIRE-RESISTIVE JOINT SEALANTS

- A. General: Comply with the "System Performance Requirements" article in Part 1, with ASTM C 1193, and with the sealant manufacturer's installation instructions and drawings pertaining to products and applications indicated.
- B. Install joint fillers to provide support of sealants during application and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability and develop fire-resistance rating required.
- C. Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint width that optimum sealant movement capability. Install sealants at the same time joint fillers are installed.
- D. Tool nonsag sealants immediately after sealant application and prior to the time skinning or curing begins. Form smooth, uniform beads of configuration indicated or required to produce fire-resistance rating, as well as to eliminate air pockets, and to ensure contact and adhesion of sealants with sides of joint. Remove excess sealant from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

### 3.5 IDENTIFICATION

- A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently

bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.6 FIELD QUALITY CONTROL

- A. Inspecting agency employed and paid by Owner will examine completed firestopping to determine, in general, if it is being installed in compliance with requirements.
- B. Inspecting agency will report observations promptly and in writing to Contractor and Architect.
- C. Do not proceed to enclose firestopping with other construction until reports of examinations are issued.
- D. Where deficiencies are found, repair or replace firestopping so that it complies with requirements.

3.7 CLEANING

- A. Clean off excess fill materials and sealants adjacent to openings and joints as work progresses by methods and with cleaning materials approved by manufacturers of firestopping products and of products in which opening and joints occur.
- B. Protect firestopping during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated firestopping immediately and install new materials to produce firestopping complying with specified requirements.

**\*\*END OF SECTION\*\***



## JOINT SEALANTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes joint sealants for the following locations:
  - 1. Exterior joints in vertical surfaces and nontraffic horizontal surfaces as indicated below:
    - a. Control and expansion joints in cast-in-place concrete.
    - b. Control and expansion joints in unit masonry.
    - c. Joints of stonework set without mortar.
    - d. Joints between different materials listed above.
    - e. Perimeter joints between materials listed above and frames of doors and windows.
    - f. Control and expansion joints in ceiling and overhead surfaces.
    - g. Other joints as indicated.
  - 2. Exterior joints in horizontal traffic surfaces as indicated below:
    - a. Control and expansion joints in brick pavers.
    - b. Control, expansion, and isolation joints in cast-in-place concrete slabs.
    - c. Tile control and expansion joints.
    - d. Joints between different materials listed above.
    - e. Other joints as indicated.
  - 3. Interior joints in vertical surfaces and horizontal nontraffic surfaces as indicated below:
    - a. Control and expansion joints on exposed interior surfaces of exterior walls.
    - b. Perimeter joints of exterior openings where indicated.
    - c. Tile control and expansion joints.
    - d. Vertical control joints on exposed surfaces of interior unit masonry and concrete walls and partitions.
    - e. Perimeter joints between interior wall surfaces and frames of interior doors, windows, and elevator entrances.
    - f. Perimeter joints of toilet fixtures.
    - g. Other joints as indicated.
  - 4. Interior joints in horizontal traffic surfaces as indicated below:
    - a. Control and expansion joints in cast-in-place concrete slabs.
    - b. Control and expansion joints in tile flooring.
    - c. Other joints as indicated.

#### 1.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. Provide elastomeric joint sealants that have been produced and installed to establish and to maintain watertight and airtight continuous seals without causing staining or deterioration of joint substrates.

- B. Provide joint sealants for interior applications that have been produced and installed to establish and maintain airtight continuous seals that are water resistant and cause no staining or deterioration of joint substrates.
- C. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
  - 1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
  - 2. Conduct field tests for each application indicated below:
    - a. Each kind of sealant and joint substrate indicated.
  - 3. Notify Architect seven days in advance of dates and times when test joints will be erected.
  - 4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
    - a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
      - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
  - 5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
  - 6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. LEED Submittals:
  - 1. Product Data for Credit IEQ 4.1: For sealants and sealant primers used inside the weatherproofing system, documentation including printed statement of VOC content.
  - 2. Laboratory Test Reports for Credit IEQ 4: For sealants and sealant primers used inside the weatherproofing system, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- D. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- E. Joint-Sealant Schedule: Include the following information:
  - 1. Joint-sealant application, joint location, and designation.

2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.
- C. Sealant, Waterproofing, and Restoration Institute (SWRI) Validation Certificate: For each sealant specified to be validated by SWRI's Sealant Validation Program.
- D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.
- E. Preconstruction Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
  1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
  2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- F. Preconstruction Field-Adhesion Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
- G. Field-Adhesion Test Reports: For each sealant application tested.
- H. Warranties: Sample of special warranties.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has completed joint sealant applications similar in material, design, and extent to that indicated for Project that have resulted in construction with a record of successful in-service performance.

1.7 DELIVERY, STORAGE, AND HANDLING

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

1.8 PROJECT CONDITIONS

- A. Environmental Conditions: Do not proceed with installation of joint sealants under the following conditions:
  1. When ambient and substrate temperature conditions are outside the limits permitted by joint sealant manufacturer.
  2. When joint substrates are wet.

- B. Joint Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than allowed by joint sealant manufacturer for application indicated.
- C. Joint Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with their adhesion are removed from joint substrates.

1.9 SEQUENCING AND SCHEDULING

- A. Sequence installation of joint sealants to occur not less than 21 nor more than 30 days after completion of waterproofing, unless otherwise indicated.

1.10 WARRANTY

- A. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

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

- B. Special Manufacturer's Warranty: Manufacturer's standard form in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.

- C. Special warranties specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:

- 1. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
- 2. Disintegration of joint substrates from natural causes exceeding design specifications.
- 3. Mechanical damage caused by individuals, tools, or other outside agents.
- 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, joint fillers, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
- B. Colors: Provide color of exposed joint sealants to comply with the following:
  - 1. Provide selections made by Architect from manufacturer's full range of standard colors for products of type indicated.

2.2 ELASTOMERIC JOINT SEALANTS

- A. Elastomeric Sealant Standard: Provide manufacturer's standard chemically curing elastomeric sealants that comply with ASTM C 920 and other requirements indicated on each Elastomeric

Joint Sealant Data Sheet at end of this Section, including those requirements referencing ASTM C 920 classifications for Type, Grade, Class, and Uses.

- B. Products: Subject to compliance with requirements, provide one of the products specified in each Elastomeric Joint Sealant Data Sheet.
- C. GLAZING SEALANT shall be Dow Corning silicone sealant No. 795 or Tremco "Spectrem 2" or General Electric "Silglaze", in a standard color designated by the Architect.
- D. CONSTRUCTION SEALANT shall be Tremco "Spectrem 3" silicone Type S, Grade-NS. Class 50 or approved equal from Dow Corning or General Electric, in standard color designated by architect.
- E. ACRYLIC LATEX SEALANT shall be one-part conforming to ASTM C-834-76 as manufactured by TREMCO "Tremflex 834", PECORA or PTI. Color shall be selected by the Architect from standard colors. This material shall be used at interior areas around windows, doors, frames, precast concrete slabs, and interior masonry walls.
- F. ACOUSTICAL SEALANT shall conform to ASTM-D-217 and be a synthetic rubber base, as manufactured by TREMCO. This material shall be used wherever interior partitions butt up against exterior walls or drywall ceilings.
- G. ON-GRADE JOINT SEALANT shall be one or two-part, self-leveling pouring grade polyurethane as manufactured by Tremco THC 900/901", Pecora "NR-200", Sonaborn SL-2 or Master Mechanics "Vulkem #245".

## 2.3 JOINT SEALANT BACKINGS

- A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Plastic Foam Joint Fillers: Preformed, compressible, resilient, nonstaining, nonwaxing, nonextruding strips of flexible plastic foam of material indicated below and of size, shape, and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
  - 1. Open-cell polyurethane foam.
  - 2. Closed-cell polyethylene foam, nonabsorbent to liquid water and gas, nonoutgassing in unruptured state.
  - 3. Proprietary, reticulated, closed-cell polymeric foam, nonoutgassing, with a density of 2.5 pcf and tensile strength of 35 psi per ASTM D 1623, and with water absorption less than 0.02 gms/cc per ASTM C 1083.
  - 4. Any material indicated above.
- C. PRIMER: Provide type as recommended by the sealant manufacturer for the varied joint surfaces.

## 2.4 COMPRESSION SEALS

- A. Performed Foam Sealant: Manufacturer's standard preformed, precompressed, impregnated open-cell foam sealant manufactured from high-density urethane foam impregnated with a nondrying, water repellant agent; factory-produced in precompressed sizes and in roll or stick form to fit joint widths indicated and to develop a watertight and airtight seal when compressed

to degree specified by manufacturer. Provide products which are permanently elastic, mildew-resistant, non-migratory, nonstaining, compatible with joint substrates and other joint sealers, and comply with the following requirements:

1. Impregnating Agent: Neoprene rubber suspended in chlorinated.
2. Density: 9-10 lb./cu. ft.
3. Backing: Pressure sensitive adhesive, factory applied to one side, with protective wrapping.
4. Color: Manufacturers standard gray at building expansion joint, black at all other locations.
5. Acceptable Manufacturers/Products: Subject to compliance with requirements, provide one of the following or approved equal:
  - a. Dayton Superior Specialty Chemicals; Polytite Standard.
  - b. EMSEAL Joint Systems, Ltd.; Emseal 25V.
  - c. Sandell Manufacturing Co., Inc.; Polyseal.
  - d. Schul International, Inc.; Sealtitle
  - e. Willseal USA, LLC; Willseal 150

## 2.5 MISCELLANEOUS MATERIALS

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

## PART 3 - APPLICATION

### 3.1 SEALANT TYPE DETERMINATION

- A. USE EXTERIOR CONSTRUCTION SEALANT at above-grade exterior joints. Use same sealant at interior side of joint if exterior material is the same through the wall, such as a metal frame or single-wythe block wall.
- B. USE INTERIOR ACRYLIC LATEX SEALANT at all other above-grade interior joints, such as at interior hollow metal frames, wood, stone, brick or drywall, in any combination.
- C. USE PAVING SEALANT at all sealed joints on traffic bearing surfaces and at grade.

### 3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with recommendations of joint sealant manufacturer and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
  2. Clean concrete, masonry, unglazed surfaces of ceramic tile, and similar porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.
  3. Remove laitance and form release agents from concrete.
  4. Clean metal, glass, porcelain enamel, glazed surfaces of ceramic tile, and other nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
- B. Joint Priming: Prime joint substrates where indicated or where recommended by joint sealant manufacturer based on preconstruction joint sealant-substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's recommendations. Confine primers to areas of joint sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

### 3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint sealant manufacturer's printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply.
- B. Elastomeric Sealant Installation Standard: Comply with recommendations of ASTM C 962 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Solvent-Release-Curing Sealant Installation Standard: Comply with requirements of ASTM C 804 for use of solvent-release-curing sealants.
- D. Latex Sealant Installation Standard: Comply with requirements of ASTM C 90 for use of latex sealants.
- E. Acoustical Sealant Application Standard: Comply with recommendations of ASTM C 19 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.
- F. Installation of Sealant Backings: Install sealant backings to comply with the following requirements:
1. Install joint fillers of type indicated to provide support of sealants during application and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
    - a. Do not leave gaps between ends of joint fillers.
    - b. Do not stretch, twist, puncture, or tear joint fillers.
    - c. Remove absorbent joint fillers that have become wet prior to sealant application and replace with dry material.

2. Install bond breaker tape between sealants where backer rods are not used between sealants and joint fillers or back of joints.
- G. Installation of Sealants: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability. Install sealants at the same time sealant backings are installed.
- H. Tooling of Nonsag Sealants: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
1. Provide concave joint configuration per Figure 5A in ASTM C 62, unless otherwise indicated.
  2. Provide flush joint configuration, per Figure 5B in ASTM C 962, where indicated.
    - a. Use masking tape to protect adjacent surfaces of recessed tooled joints.
  3. Provide recessed joint configuration, per Figure 5C in ASTM C 962, of recess depth and at locations indicated.
- I. Installation of Preformed Foam Sealants: Install each length of sealant immediately after removing protective wrapping, taking care not to pull or stretch material, and to comply with sealant manufacturer's directions for installation methods, materials, and tools that produce seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures where expansion of sealant requires acceleration to produce seal, apply heat to sealant in conformance with sealant manufacturer's recommendations.
- 3.4 CLEANING
- A. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.
- 3.5 PROTECTION
- A. Protect joint sealants during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so that and installations with repaired areas are indistinguishable from original work.

**\*\*END OF SECTION\*\***



STANDARD STEEL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following products manufactured in accordance with SDI Recommended Standards:
  - 1. Doors: Seamless, hollow or composite construction standard steel doors for interior and exterior locations. (Indicated as Hollow Metal "HM" on the Door Schedules.)
  - 2. Frames: Pressed steel frames for doors, transoms, sidelights, borrowed lights, mullions, interior glazed panels, and other interior and exterior openings of following type: (Indicated as Hollow Metal "HM" on the Door Schedules.):
    - a. Welded unit type.
  - 3. Assemblies: Provide standard steel door and frame assemblies as required for the following:
    - a. Labeled and fire rated.
    - b. Thermal rated (insulated).
    - c. Sound rated (acoustical).
  - 4. Provide factory primed doors and frames to be field painted.
- B. The following sections contain requirements that relate to this Section:
  - 1. Division 04 Section "Unit Masonry Assemblies" for building in of anchors and grouting of frames in masonry construction.
  - 2. Division 08 Section "Door Hardware" for door hardware.
  - 3. Division 09 Section "Painting" for painting primed doors and frames.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, core descriptions, and finishes.
- B. Shop Drawings: Include the following:
  - 1. Elevations of each door type.
  - 2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
  - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.

4. Locations of reinforcement and preparations for hardware.
  5. Details of each different wall opening condition.
  6. Details of anchorages, joints, field splices, and connections.
  7. Details of accessories.
  8. Details of moldings, removable stops, and glazing.
  9. Details of conduit and preparations for power, signal, and control systems.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification:
1. For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches (75 by 127 mm).
  2. For "Doors" and "Frames" subparagraphs below, prepare Samples approximately 8 by 10 inches (203 by 254 mm to demonstrate compliance with requirements for quality of materials and construction:
    - a. Doors: Show vertical-edge, top, and bottom construction; core construction; and hinge and other applied hardware reinforcement. Include separate section showing glazing if applicable.
    - b. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow-metal panels and glazing if applicable.
- E. Schedule: Provide a schedule of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.
- B. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.

#### 1.5 QUALITY ASSURANCE

- A. Provide doors and frames complying with Steel Door Institute "Recommended Specifications Standard Steel Doors and Frames" ANSI/SDI-100 and as herein specified.
- B. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- C. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated, as documented according to ASTM E 548.
- D. Source Limitations: Obtain standard steel doors and frames through one source from a single manufacturer.
- E. Fire-Rated Door Sidelight and Transom Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated.

1. Test Pressure: Test according to NFPA 252 or UL 10C. After 5 minutes into the test, the neutral pressure level in furnace shall be established at 40 inches or less above the sill.
  2. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a testing agency acceptable to authorities having jurisdiction that doors comply with standard construction requirements for tested and labeled fire-protection-rated door assemblies except for size.
  3. Temperature-Rise Rating: At exit enclosures, provide doors that have a temperature-rise rating of 450 deg F maximum in 30 minutes of fire exposure.
- F. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9. Label each individual glazed lite.
- G. Smoke-Control Door Assemblies: Comply with NFPA 105 or UL 1784.
- H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver doors and frames cardboard-wrapped or crated to provide protection during transit and job storage. Provide additional protection to prevent damage to finish of factory-finished doors and frames.
- B. Inspect doors and frames upon delivery for damage. Minor damages may be repaired provided refinished items are equal in all respects to new work and acceptable to Architect; otherwise, remove and replace damaged items as directed.
- C. Store doors and frames at building site under cover. Place units on minimum 4-inches high wood blocking. Avoid use of non-vented plastic or canvas shelters which could create humidity chamber. If cardboard wrapper on door becomes wet, remove carton immediately. Provide 1/4-inches spaces between stacked doors to promote air circulation.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide standard steel doors and frames by one of the following:
1. Standard Steel Doors and Frames:
    - a. Ceco Corp.
    - b. Curries Company.
    - c. Republic Builders Products.
    - d. Pioneer Industries.
    - e. Steelcraft

#### 2.2 MATERIALS

- A. Hot-Rolled Steel Sheets and Strip: Commercial quality carbon steel, pickled and oiled, complying with ASTM A 569 and ASTM A 568.

- B. Cold-Rolled Steel Sheets: Commercial quality carbon steel, complying with ASTM A 366 and ASTM A 568.
- C. Galvanized Steel Sheets: Zinc-coated carbon steel sheets of commercial quality, complying with ASTM A 526, or drawing quality, ASTM A 642, hot dipped galvanized in accordance with ASTM A 525, with A60 or G60 coating designation, mill phosphatized.
  - 1. Stainless Steel: ASTM Type 2, AISI Type 302, other 300 series to suit specified requirements.
- D. Supports and Anchors: Fabricate of not less than 18-gage sheet steel; galvanized where used with galvanized frames.
- E. Inserts, Bolts, and Fasteners: Manufacturer's standard units. Where items are to be built into exterior walls, hot-dip galvanize in compliance with ASTM A 153, Class C or D as applicable.
- F. Shop Applied Paint: Apply after fabrication.
  - 1. Primer: Rust-inhibitive enamel or paint, either air-drying or baking, suitable as a base for specified finish paints complying with ANSI A224.1, "Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames."

## 2.3 DOORS

- A. Provide metal doors of SDI grades and models specified below or as indicated on drawings or schedules:
  - 1. Interior Doors: ANSI/SDI-100, Grade II, heavy-duty, Level 3 or 4, minimum 18-gage cold-rolled sheet steel faces.
  - 2. Exterior Doors: ANSI/SDI-100, Grade III, extra heavy-duty, Level 4, minimum 16-gage hot dipped A60 galvanized steel faces, also galvanized hardware reinforcement.
  - 3. Doors shall have beveled (1/8" in 2") hinge and lock edge with edge seam welded and ground smooth.

## 2.4 FRAMES

- A. Provide metal frames for doors, transoms, sidelights, borrowed lights, and other openings, of types and styles as shown on drawings and schedules. Conceal fastenings, unless otherwise indicated. Fabricate frames of minimum 16-gage cold-rolled steel.
  - 1. Fabricate frames with mitered, coped, or welded corners.
  - 2. Form exterior frames from 14-gage hot dipped A60 galvanized steel.
- B. Door Silencers: Except on weatherstripped frames, drill stops to receive 3 silencers on strike jambs of single-door frames and 2 silencers on heads of double-door frames.
- C. Plaster Guards: Provide minimum 26-gage steel plaster guards or mortar boxes at back of hardware cutouts where mortar or other materials might obstruct hardware operation and to close off interior of openings.

2.5 FABRICATION

- A. Fabricate steel door and frame units to be rigid, neat in appearance and free from defects, warp or buckle. Wherever practicable, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory-assembled before shipment, to assure proper assembly at project site. Comply with ANSI/SDI-100 requirements.
  - 1. Internal Construction: Manufacturer's standard honeycomb, polyurethane, unitized steel grid, vertical steel stiffeners, or rigid mineral fiber core with internal sound deadener on inside of face sheets where appropriate in accordance with SDI standards.
  - 2. Clearances: Not more than 1/8 inch at jambs and heads except between non-fire-rated pairs of doors not more than 1/4 inch. Not more than 3/4 inch at bottom.
- B. Fabricate exposed faces of doors and panels, including stiles and rails of nonflush units, from only cold-rolled steel.
- C. Tolerances: Comply with SDI 117 "Manufacturing Tolerances Standard Steel Doors and Frames."
- D. Fabricate frames, concealed stiffeners, reinforcement, edge channels, louvers and moldings from either cold-rolled or hot-rolled steel.
- E. Fabricate exterior doors, panels, and frames from galvanized sheet steel in accordance with SDI-112. Close top and bottom edges of exterior doors as integral part of door construction or by addition of minimum 16-gage inverted steel channels.
- F. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.
- G. Thermal-Rated (Insulating) Assemblies: At exterior locations and elsewhere as shown or scheduled, provide doors fabricated as thermal insulating door and frame assemblies and tested in accordance with ASTM C 236 or ASTM C 976 on fully operable door assemblies.
  - 1. Unless otherwise indicated, provide thermal-rated assemblies with U factor of .13 Btu/(hr x sq ft x deg F.) or better.
- H. Sound-Rated (Acoustical) Assemblies: Where shown or scheduled, provide door and frame assemblies fabricated as sound-reducing type, tested in accordance with ASTM E 90, and classified in accordance with ASTM E 413.
  - 1. Unless otherwise indicated, provide acoustical assemblies with sound ratings of STC 33 or better.
- I. Finish Hardware Preparation: Prepare doors and frames to receive mortised and concealed hardware in accordance with final Door Hardware Schedule and templates provided by hardware supplier. Comply with applicable requirements of ANSI A115 Series Specifications for door and frame preparation for hardware.
  - 1. For concealed hardware, provide space, cutouts, reinforcing and provisions for fastening in doors and frames, as applicable.
- J. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied hardware to be done at project site.

- K. Locate hardware as indicated on final shop drawings or, if not indicated, in accordance with "Recommended Locations for Builder's Hardware on Standard Steel Doors and Frames," published by Door and Hardware Institute.
- L. Shop Painting: Clean, treat, and paint exposed surfaces of steel door and frame units, including galvanized surfaces.
  - 1. Clean steel surfaces of mill scale, rust, oil, grease, dirt, and other foreign materials before application of paint.
  - 2. Apply shop coat of prime paint of even consistency to provide a uniformly finished surface ready to receive finish paint.
- M. Glazing Stops: Minimum 20 gage steel or .040-inch-thick aluminum.
  - 1. Provide non-removable stops on outside of exterior doors and on secure side of interior doors for glass, louvers, and other panels in doors.
  - 2. Provide screw applied removable glazing beads on inside of glass, louvers, and other panels in doors.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. General: Install standard steel doors, frames, and accessories in accordance with final shop drawings, manufacturer's data, and as herein specified.
- B. Placing Frames: Comply with provisions of SDI-105 "Recommended Erection Instructions For Steel Frames," unless otherwise indicated.
  - 1. Except for frames located at existing concrete, masonry or drywall installations, place frames prior to construction of enclosing walls and ceilings. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders leaving surfaces smooth and undamaged.
  - 2. In masonry construction, locate 3 wall anchors per jamb adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Acceptable anchors include masonry wire anchors and masonry Tee anchors. Provide four (4) wall anchors per jamb for frame over 7'-2" high.
  - 3. At existing concrete or masonry construction, provide 3 completed opening anchors per jamb adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb, set frames and secure to adjacent construction with bolts and masonry anchorage devices.
    - a. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
  - 4. Install fire-rated frames in accordance with NFPA Standard No. 80.
  - 5. In metal stud partitions, install at least 3 wall anchors per jamb at hinge and strike levels. In closed steel stud partitions, attach wall anchors to studs with screws.

6. At existing in-place drywall partitions install knock down slip-on drywall frames.

C. Door Installation: Fit hollow metal doors accurately in frames, within clearances specified in ANSI/SDI-100.

1. Install fire-rated doors with clearances as specified in NFPA Standard No. 80.

3.2 ADJUST AND CLEAN

A. Prime Coat Touch-up: Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.

B. Protection Removal: Immediately prior to final inspection, remove protective plastic wrappings from prefinished doors.

C. Final Adjustments: Check and readjust operating hardware items, leaving steel doors and frames undamaged and in complete and proper operating condition.

**\*\*END OF SECTION\*\***

FRP DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS/DESCRIPTION

- A. Drawings and General provision of Contract, including General and Supplementary Conditions and Division 01 Specification sections, are a part of this Section for the Base Bid and applicable alternates.
- B. This Section includes:
  - 1. FRP doors - provide FRP doors as specified, shown or scheduled, with components and accessories for a complete and proper installation.
  - 2. Factory glazing of FRP door lites.
  - 3. Manufacturer hardware.
  - 4. Factory installation of finish hardware.
- C. The following sections contain requirements that relate to this Section:
  - 1. Division 07 Section "Joint Sealants" for sealants and gaskets.
  - 2. Division 08 Section "Glazing" for glass and glazing.
  - 3. Division 08 Section "Door Hardware" for door hardware.
- D. System Performance:
  - 1. Provide exterior and interior doors assemblies that have been designed and fabricated to comply with requirements for system performance characteristics listed below as demonstrated by testing manufacturer's corresponding stock systems according to test methods designated.
    - a. Thermal Transmittance (exterior doors): U-value of not more than 0.09 Btu/(hr x sf x Degrees F.) per AAMA 1503.1.

1.2 QUALITY ASSURANCE

- A. Comply with fire-resistance, flammability, regulations as interpreted by governing authorities and as follows:
  - 1. Face Sheets tested in accordance with ASTM E84-79A shall have the following ratings; Standard Face sheets:
    - a. Smoke Developed: not greater than 345.
    - b. Flame Spread: not greater than 145.
  - 2. Class A Face Sheets (Required on interior face of all exterior doors):
    - a. Smoke Developed not greater than 340.
    - b. Flame Spread: not greater than 15.



- B. Manufacturer Qualifications: Shall have produced fiberglass reinforced doors for at least five years.
- C. Field Measurement:
  - 1. Take field measurements prior to fabrication of doors and frames to insure proper fitting of assemblies. Successful bidders are expected to field verify all dimensions, sizes, quantities and the material required to complete this project. Failure to do so will not relieve the successful contractor from the necessity of furnishing any and all materials that may be required, without any additional cost to the Owner.

1.3 COORDINATION

- A. Door manufacturer shall be responsible for coordinating all necessary information from hardware supplier in order that doors shall be properly prepared to receive hardware and fit frames properly. Contractor shall provide manufacturer with copies of approved schedules necessary to complete manufacturing of doors. This information shall be in the possession of the door manufacturer 60 days prior to desired delivery date of doors.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.
  - 1. Substitutions for products as specified MUST be submitted in accordance with Division 01. Substitute products not submitted in accordance with Division 01 Section "Product Requirements" will NOT be considered.
- B. Product Data: Submit manufacturer's specifications, standard details, and installation recommendations for components of FRP (fiberglass reinforced polyester) doors required for project, including test reports certifying that products have been tested and comply with performance requirements.
- C. Shop Drawings: Submit shop drawings for fabrication and installation of FRP (fiberglass reinforced polyester) doors, including elevations, detail sections of typical composite members, hardware mounting heights, anchorages, reinforcement, expansion provisions, and glazing.
- D. Samples: Submit 6" samples of each type and color of FRP (fiber reinforced polyester) finish, and 12" long sections of extrusions or formed shapes. Where normal color and texture variations are to be expected, include 2 or more units in each set of samples showing limits of such variations.

1.5 PRODUCT DELIVERY, HANDLING, AND STORAGE

- A. All materials supplied shall be delivered to the jobsite in their original, unopened packages with labels intact. Materials shall be inspected for damage, and the manufacturer informed of any discrepancies. Unsatisfactory materials shall not be used.
- B. All materials supplied shall be packaged in individual corrugated cartons. Doors shall "floated" within cartons, with no portion of door in contact with outer shell.
- C. All doors to be marked with individual opening numbers to correlate with the designation system used on the shop drawings for doors, frames and hardware. Markings shall be temporary, removable, or concealed.

1.6 WARRANTY

- A. Provide written warranty signed by Manufacturer, Installer, and Contractor, agreeing to replace FRP (fiberglass reinforced polyester) doors which fail in materials or workmanship within time period indicated below of acceptance. Failure of materials or workmanship includes excessive deflections, faulty operation of entrances, and deterioration of finish or construction in excess of normal weathering.
  - 1. Time Period: Five years from date of substantial completion.
- B. Provide written warranty signed by Manufacturer guaranteeing hardware attachment of factory installed finish hardware.
  - 1. Time Period: Five years from date of substantial completion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide SL17 FRP Flush Doors as manufactured by Special-Lite, Inc., and Aluminum Frames for FRP Doors as specified herein or equal products by the following.
  - 1. Vale FRP Doors.

2.2 MATERIALS AND ACCESSORIES

- A. Aluminum Members: Alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish; ASTM B 221 for extrusions, ASTM B 209 for sheet/plate, minimum wall thickness of 1/8".
- B. Fasteners: Aluminum, or other materials warranted by manufacturer to be non-corrosive and compatible with aluminum components.
  - 1. For exposed fasteners, provide Phillips head flat head screws with finish matching item to be fastened.
- C. Brackets and Reinforcements: Manufacturer's high-strength aluminum units where feasible; otherwise provide nonmagnetic stainless steel or hot-dip galvanized steel complying with ASTM A 386.
  - 1. Provide manufacturer's standard reinforcement for each type of hardware required, not less than .125" thick.
  - 2. Provide manufacturer's recommended fastener reinforcement.
- D. Door Face Material: Fiberglass reinforced polyester, SpecLite 3, 0.120" minimum thickness, with pebble-like embossed finish.
  - 1. Acceptable Product: Subject to compliance with the following requirements:
    - a. Impact Strength of Face Sheets: ASTM D256, Izod Impact Strength, 13.5 footpounds per inch of notch.
    - b. Abrasion Resistance of Face Sheets: ASTM D1242, 1000 cycles of Model 503 Taber Abraser with a 1000 gram load, not to exceed 0.23% weight loss.

- c. Hardness of Face Sheets: ASTM D2583, Barcol Meter Hardness Test, not more than 50.
  - d. Humidity Resistance of Face Sheets: ASTM D570, water absorption not greater than 0.40% after 24 hour immersion.
  - e. Ultra-Violet Degradation: Only slight color change, and negligible change in surface gloss and other physical properties after exposure to 500,000 Langleys.
- E. Weatherstripping: Provide manufacturer's standard replaceable weathering pile.
- 1. Factory installed concealed adjustable bottom brush with double nylon brush weatherstripping.
- F. Sealants and Gaskets: Provide sealants and gaskets in the fabrication, assembly and installation of the work, which are recommended by the manufacturer to remain permanently elastic, non-shrinking, non-migrating, and weatherproof.

## 2.3 FIBERGLASS REINFORCED POLYESTER (FRP) DOORS

- A. FRP Doors are to be constructed as follows:
- 1. Doors are to be 1 3/4" thick.
  - 2. Constructed of aluminum alloy rails and stiles, joined with steel tie rods, and have an inner core consisting of foamed-in-place Urethane.
  - 3. Stiles to be tubular shape to accept hardware as specified.
  - 4. Top and bottom rails to be extruded with internal legs for interlocking rigid weather bar.
  - 5. Face Sheets to be secured with extruded interlocking edges. (No snap-on trim will be accepted).
  - 6. Joinery to be 3/8" tie rods, top and bottom, bolted through an extruded spline and 3/16" riveted reinforcing angles, and secured with hex nuts.
  - 7. Core to be of Urethane foam of 3 pounds per cubic ft. density. All doors are to be properly reinforced for hardware prior to Urethane core foaming in door.
  - 8. Face Sheets:
    - a. Fiberglass Reinforced Plastic Sheets to be polyester SpecLite 3, 0.120" thick, with pebble-like finish.
  - 9. Pairs of Doors: Meeting stiles to beveled.
  - 10. All doors shall be machined for finish hardware at the factory in accordance with the templates from the hardware supplier and the Approved Hardware Schedule. For surface applied hardware, doors shall have necessary reinforcement, including the attachment of RIVNUT blind bolt fasteners. With the exception of door holders, which require field application, doors are to be shipped with surface hardware factory applied.
  - 11. Door Lites: Provide door lites factory glazed as indicated, with manufacturer's standard aluminum moldings and stops, with removable stops on inside only. Glass to be 1" insulated safety glass.

## 2.4 FLUSH INSULATED PANELS

- A. Flush insulated panels shall be constructed as follows:
  - 1. Panels shall be 1" thick.
  - 2. Panel stiles shall be formed of hardwood.
  - 3. Core to be Urethane of 3 pounds per cubic foot density.
  - 4. Face Skins to be as follows:
    - a. Fiberglass Reinforced polyester panel faces to be SpecLite 3, 0.120" thick, with pebble-like embossed finish.

## 2.5 ALUMINUM CAPPING SYSTEM

- A. Where indicated, provide a Frame capping system fabricated of .062" Aluminum, as manufactured by Special-Lite, Inc. Finish capping to match finish as supplied on other framing sections.

## 2.6 INSERT FRAMING

- A. Where indicated, provide insert frames fabricated of extruded 6063T5 Aluminum alloy fitted with .34 inch high by .36 inch wide wool-poly-propylene blend pile. Corner joints are to be mitered and secured with prefabricated aluminum clips. Framing as manufactured by Special-Lite, Inc., and finished to match other framing sections.

## 2.7 FINISH HARDWARE

- A. Hardware supplied by the door manufacturer and factory installed:
  - a. Pull: Special-Lite SL-86.
- B. Supplier: Refer to Section 08710 of these specifications for the Finish Hardware requirements for this project. Refer to approved Finish Hardware Schedule for items to be supplied to the door and frame manufacturer to install.
- C. Receive Hardware supplied in accordance with Section 08710, and Hardware Schedule, and coordinate with the Hardware requirements of this section. Report discrepancies (in writing) to the Architect immediately.
- D. Ship hardware, to be installed by manufacturer, to manufacturer with cartons marked with door numbers correlating with designation system used on shop drawings.
- E. Install all Hardware, except door holders at the fabrication plant. Remove only Hardware as required for final finishing or delivery to jobsite. Package and identify such Hardware and ship with doors and frames for installation at the project site.

## 2.8 FINISHES AND COLORS

- A. Fiberglass Reinforced Polyester Colors: As selected by Architect from manufacturer's complete range.
- B. Aluminum Stiles and Rails: Comply with the following:
  - 1. General: Comply with NAAMM "Metal Finishes Manual" for recommendations relative to application and designations of finishes.

2. Finish designations prefixed by "AA" conform to the system established by the Aluminum Association for designating aluminum finishes.
3. Class I Clear Anodized Finish: AA-M12C22A41 (Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class I Architectural, clear film thicker than 0.7 mil) complying with AAMA 607.1.\

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Comply with manufacturer's recommendations and specifications for the installation of the doors and frames.
- B. Set units plumb, level and true to line, without warp or rack of doors, frames or panels. Anchor securely in place. Separate aluminum, and other corrodible metal surfaces, from sources of corrosion or electrolytic action at points of contact with other materials, with bituminous coatings, or other means as approved by Architect.
- C. Set saddles in a bed of compound.
- D. Clean Aluminum surfaces promptly after installation of doors and frames, exercising care to avoid damage to the protective coating (if any). Remove excess glazing and sealant compounds, dirt and other substances.
- E. Provide protective treatment and other precautions required through the remainder of the construction period, to ensure that the doors and frames will be without damage or deterioration (other than normal weathering) at the time of acceptance.
- F. Adjusting: Adjust operating hardware to function properly, for smooth operation without binding, and for weathertight seal.
- G. Caulking: Refer to Section 07900 "Joint Sealants."

**\*\*END OF SECTION\*\***

ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawing 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. Wall access doors and frames.
  - 2. Fire-rated wall access doors and frames.
  - 3. Ceiling access doors and frames.
  - 4. Fire-rated ceiling access doors and frames.
- B. Related Sections include the following:
  - 1. Division 03 Section "Cast-in-Place Concrete" for blocking out openings for access doors and frames in concrete.
  - 2. Division 04 Section "Unit Masonry" for anchoring and grouting access door frames set in masonry construction.
  - 3. Division 07 Section "Roof Accessories" for roof hatches.
  - 4. Division 08 Section "Door Hardware" for mortise or rim cylinder locks and master keying.
  - 5. Division 09 Section "Acoustical Tile Ceilings" for suspended acoustical tile ceilings.
  - 6. Division 22 Section "Facility Storm Drainage Piping" for connection of floor door drainage couplings to drains.
  - 7. Division 23 Section "Air Duct Accessories" for heating and air-conditioning duct access doors.

1.3 SUBMITTALS

- A. Product Data: For each type of door and frame indicated. Include construction details relative to materials, individual components and profiles, finishes, and fire ratings (if required) for access doors and frames.
- B. Shop Drawings: Show fabrication and installation details of customized doors and frames. Include plans, elevations, sections, details, and attachments to other Work.
- C. Samples: For each door face material, at least 3 by 5 inches (75 by 125 mm) in size, in specified finish.

- D. Schedule: Provide complete door and frame schedule, including types, general locations, sizes, construction details, latching or locking provisions, and other data pertinent to installation.
- E. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items with concealed framing, suspension systems, piping, ductwork, and other construction. Show the following:
  - 1. Method of attaching door frames to surrounding construction.
  - 2. Ceiling-mounted items including access doors and frames, lighting fixtures, diffusers, grilles, speakers, sprinklers, and special trim.

#### 1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain doors and frames through one source from a single manufacturer.
- B. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics per the following test method and that are labeled and listed by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction:
  - 1. NFPA 252 or UL 10B for vertical access doors.
  - 2. ASTM E 119, UBC Standard 7.1 or UL 263 for horizontal access doors and frames.
- C. Size Variations: Obtain Architect's acceptance of manufacturer's standard-size units, which may vary slightly from sizes indicated.

#### 1.5 COORDINATION

- A. Verification: Determine specific locations and sizes for access doors needed to gain access to concealed equipment, and indicate on schedule specified in "Submittals" Article.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cesco Products.
  - 2. Jensen Industries.
  - 3. J. L. Industries, Inc.
  - 4. Karp Associates, Inc.
  - 5. Larsen's Manufacturing Company.
  - 6. Milcor Limited Partnership.
  - 7. Nystrom Building Products Co.

## 2.2 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Cold-Rolled Steel Sheets: ASTM A 366/A 366M, Commercial Steel (CS), or ASTM A 620/A 620M, Drawing Steel (DS), Type B; stretcher-leveled standard of flatness; with minimum thickness indicated representing specified nominal thickness according to ASTM A 568/A 568M. Electrolytic zinc-coated steel sheet, complying with ASTM A 591/A 591M, Class C coating, may be substituted at fabricator's option.
- C. Electrolytic Zinc-Coated Steel Sheet: ASTM A 591/A 591M, Commercial Steel (CS), with Class C coating and phosphate treatment to prepare surface for painting; with minimum thickness indicated representing specified nominal thickness according to ASTM A 568/A 568M for uncoated base metal.
- D. Drywall Beads: Edge trim formed from 0.0299-inch (0.76-mm) zinc-coated steel sheet formed to receive joint compound and in size to suit thickness of gypsum board.

## 2.3 PAINT

- A. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements in FS TT-P-664; selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.
- B. Shop Primer for Metallic-Coated Steel: Organic zinc-rich primer complying with SSPC-Paint 20 and compatible with topcoat.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

## 2.4 ACCESS DOORS AND FRAMES

- A. Flush, Uninsulated, Fire-Rated Access Doors and Frames with Exposed Trim: Fabricated from steel sheet.
  - 1. Locations: Masonry walls.
  - 2. Fire-Resistance Rating: As indicated.
  - 3. Temperature Rise Rating: 250 deg F (139 deg C) at the end of 30 minutes.
  - 4. Door: Minimum 0.060-inch- (1.5-mm-) thick sheet metal, flush construction.
  - 5. Frame: Minimum 0.060-inch- (1.5-mm-) thick sheet metal with 1-inch- (25-mm-) wide, surface-mounted trim.
  - 6. Hinges: Continuous piano hinge.
  - 7. Automatic Closer: Spring type.
  - 8. Latch: Self-latching bolt operated by key with interior release.
- B. Flush, Uninsulated, Fire-Rated Access Doors and Trimless Frames: Fabricated from steel sheet.



1. Locations: Gypsum board wall and ceiling surfaces.
  2. Fire-Resistance Rating: As indicated.
  3. Temperature Rise Rating: 250 deg F (139 deg C) at the end of 30 minutes.
  4. Door: Minimum 0.060-inch- (1.5-mm-) thick sheet metal, flush construction.
  5. Frame: Minimum 0.060-inch- (1.5-mm-) thick sheet metal with drywall bead.
  6. Hinges: Continuous piano hinge.
  7. Automatic Closer: Spring type.
  8. Latch: Self-latching bolt operated by key with interior release.
- C. Flush Access Doors and Frames with Exposed Trim: Fabricated from steel sheet.
1. Locations: Masonry wall surfaces.
  2. Door: Minimum 0.060-inch- (1.5-mm-) thick sheet metal, set flush with exposed face flange of frame.
  3. Frame: Minimum 0.060-inch- (1.5-mm-) thick sheet metal with 1-inch- (25-mm-) wide, surface-mounted trim.
  4. Hinges: Continuous piano hinge.
  5. Latch: Screwdriver-operated cam latch.
- D. Flush Access Doors and Trimless Frames: Fabricated from steel sheet.
1. Locations: Gypsum board wall and ceiling surfaces.
  2. Door: Minimum 0.060-inch- (1.5-mm-) thick sheet metal, set flush with surrounding finish surfaces.
  3. Frame: Minimum 0.060-inch- (1.5-mm-) thick sheet metal with drywall bead.
  4. Hinges: Concealed continuous piano hinge.
  5. Latch: Screwdriver-operated cam latch.
- E. Recessed Access Doors and Trimless Frames: Fabricated from steel sheet.
1. Locations: Gypsum board wall and ceiling surfaces.
  2. Door: Minimum 0.060-inch- (1.5-mm-) thick sheet metal in the form of a pan recessed 5/8 inch (16 mm) gypsum board infill.
  3. Frame: Minimum 0.060-inch- (1.5-mm-) thick sheet metal with drywall bead for gypsum board surfaces.
  4. Hinges: Concealed pivoting rod hinge.
  5. Latch: Screwdriver-operated cam latch with plastic grommet for access through pan recess.

2.5 FABRICATION

- A. General: Provide access door assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Steel Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of supports indicated.
  - 1. Exposed Flanges: Nominal 1 to 1-1/2 inches (25 to 38 mm) wide around perimeter of frame.
  - 2. For trimless frames with drywall bead for installation in gypsum board assembly, provide edge trim for gypsum board securely attached to perimeter of frames.
  - 3. Provide mounting holes in frames to attach frames to metal or wood framing in plaster and drywall construction and to attach masonry anchors in masonry construction. Furnish adjustable metal masonry anchors.
- D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling.
- E. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
  - 1. For recessed panel doors, provide access sleeves for each locking device. Furnish plastic grommets and install in holes cut through finish.

2.6 FINISHES, GENERAL

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

2.7 STEEL FINISHES

- A. Surface Preparation: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed metal fabrications:
  - 1. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
- B. Apply shop primer to uncoated surfaces of metal fabrications. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Advise installers of other work about specific requirements relating to access door and floor door installation, including sizes of openings to receive access door and frame, as well as locations of supports, inserts, and anchoring devices.

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.
- B. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces.
- C. Install access doors with trimless frames flush with adjacent finish surfaces or recessed to receive finish material.

3.3 ADJUSTING AND CLEANING

- A. Adjust doors and hardware after installation for proper operation.
- B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

**\*\*END OF SECTION\*\***

ALUMINUM ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:
  - 1. Exterior storefront framing.
  - 2. Storefront framing for window walls.
  - 3. Exterior and interior manual-swing entrance doors and door-frame units.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Provide aluminum-framed systems, including anchorage, capable of withstanding, without failure, the effects of the following:
  - 1. Structural loads.
  - 2. Thermal movements.
  - 3. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
  - 4. Dimensional tolerances of building frame and other adjacent construction.
  - 5. Failure includes the following:
    - a. Deflection exceeding specified limits.
    - b. Thermal stresses transferred to building structure.
    - c. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
    - d. Glazing-to-glazing contact.
    - e. Noise or vibration created by wind and thermal and structural movements.
    - f. Loosening or weakening of fasteners, attachments, and other components.
    - g. Sealant failure.
    - h. Failure of operating units to function properly.

- B. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by aluminum-framed systems without failing adhesively or cohesively. Provide sealant that fails cohesively before sealant releases from substrate when tested for adhesive compatibility with each substrate and joint condition required.
1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
  2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.
- C. Structural-Sealant Joints: Designed to produce tensile or shear stress in structural-sealant joints of less than 20 psi (138 kPa).
- D. Structural Loads:
1. Show design loads determined by Project's structural engineer on Drawings or insert loads in two subparagraphs below. Verify requirements of authorities having jurisdiction. See Evaluations.
  2. Thermal Movement: Provide systems capable of withstanding thermal movements resulting from an ambient temperature range of 120°F (67°C), that could cause a metal surface temperature range of 180°F (100°C) within the framing system.
  3. Wind Loading: Provide assemblies capable of withstanding a uniform test pressure of 25 psf inward and 25 psf outward when tested in accordance with ASTM E 330.
- E. Deflection of Framing Members:
1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m) or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19 mm), whichever is less.
  2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch (3.2 mm), whichever is the smaller amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components directly below to less than 1/8 inch (3.2 mm) and clearance between members and operable units directly below to less than 1/16 inch (1.5 mm).
- F. Structural-Test Performance: Provide aluminum-framed systems tested according to ASTM E 330 as follows:
1. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.
  2. When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
  3. Test Durations: As required by design wind velocity but not less than 10 seconds.

- G. Aluminum Entrance Transmission Characteristics: Provide entrance doors with jamb and head frames that comply with requirements indicated for transmission characteristics.
1. Air Infiltration: Provide doors with an air infiltration rate of not more than 0.50 CFM for single doors and 1.0 for pairs of doors when tested in accordance with ASTM E 283 at an inward test pressure differential of 1.567 psf.
  2. Condensation Resistance: Provide entrance door units tested for thermal performance in accordance with AAMA 1502 showing a condensation resistance factor (CRF) of not less than 48.

1.4 SUBMITTALS:

- A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.
1. Substitutions for products as specified MUST be submitted in accordance with Division 01. Substitute products not submitted in accordance with Division 01 Section "Product Requirements" will NOT be considered.
- B. Product Data: Submit manufacturer's product specifications, technical product data, standard details, and installation recommendations for each type of entrance and storefront product required. Include the following information:
1. Fabrication methods.
  2. Finishing.
  3. Accessories.
- C. Shop Drawings: Submit shop drawings for fabrication and installation of entrances and storefronts, including the following:
1. Elevations.
  2. Detail sections of typical composite members.
  3. Hardware, mounting heights.
  4. Anchorages and reinforcements.
  5. Glazing details.
- D. Samples: Submit pairs of samples of each type and color of aluminum finish, on 12" long sections of extrusions or formed shapes and on 6" square sheets. Where color or texture variations are anticipated, include 2 or more units in each set of samples indicating extreme limits of variations.
- E. Certification: Provide certified test results showing that entrance and storefront systems have been tested by a recognized testing laboratory or agency and comply with specified performance characteristics.

1.5 QUALITY ASSURANCE:

- A. Installer's Qualifications: Entrances and storefront shall be installed by a firm that has not less than 5-years successful experience in the installation of systems similar to those required.
- B. Design Criteria: Drawings are based on one manufacturer's entrance and storefront system. Another manufacturer's system of a similar and equivalent nature will be acceptable when, in the Architect's sole judgment, differences do not materially detract from the design concept or intended performance.

1.6 PROJECT CONDITIONS:

- A. Field Measurements: Check openings by field measurement before fabrication to ensure proper fitting of work; show measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay in the work. Where necessary, proceed with fabrication without field measurement, and coordinate fabrication tolerances to ensure proper fit.

1.7 WARRANTY:

- A. Special Product Warranty: Submit a written warranty, executed by the Contractor, Installer and Manufacturer, agreeing to repair or replace units (including reglazing) which fail in materials or workmanship within the specified warranty period. Failures include, but are not necessarily limited to structural failures including excessive deflection, excessive leakage or air infiltration, faulty operation, and deterioration of metals, metal finishes and other materials beyond normal weathering. This warranty shall be in addition to and not a limitation of other rights the Owner may have against the Contractor under the Contract Documents.
  - 1. Warranty period for aluminum entrances and storefront is 3 years after the date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Manufacturer: Subject to compliance with requirements, provide EFCO Corp. "Series 403" System or approved equal from one of the following:
  - 1. Tube Lite.
  - 2. Kawneer.
  - 3. Special Lite.

2.2 MATERIALS:

- A. Aluminum Members: Provide alloy and temper recommended by the manufacturer for strength, corrosion resistance, and application of required finish; comply with ASTM B 221 for extrusions and ASTM B 209 for sheet or plate.
- B. Fasteners: Provide fasteners of aluminum, nonmagnetic stainless steel, or other materials warranted by the manufacturer to be non-corrosive and compatible with aluminum components, hardware, anchors and other components.

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1. Reinforcement: Where fasteners screw-anchor into aluminum less than 0.125" thick, reinforce the interior with aluminum or nonmagnetic stainless steel to receive screw threads, or provide standard non-corrosive pressed-in splined grommet nuts.
- C. Concealed Flashing: Provide 26 gage minimum dead-soft stainless steel, or 0.026" minimum extruded aluminum of alloy and type selected by manufacturer for compatibility with other components.
- D. Brackets and Reinforcements: Where feasible, provide high-strength aluminum brackets and reinforcements; otherwise provide nonmagnetic stainless steel or hot-dip galvanized steel complying with ASTM A 386.
- E. Concrete/Masonry Inserts: Provide concrete and masonry inserts fabricated from cast-iron, malleable iron, or hot-dip galvanized steel complying with ASTM A 386.
- F. Compression Weatherstripping: Provide the manufacturer's standard replaceable compressible weatherstripping gaskets of molded neoprene complying with ASTM D 2000 or molded PVC complying with ASTM D 2287.
- G. Sliding Weatherstripping: Provide the manufacturer's standard replaceable weatherstripping of wool, polypropylene, or nylon woven pile, with nylon fabric or aluminum strip backing, complying with AAMA 701.2.
- H. Glass and Glazing Materials: Glass and glazing materials shall comply with requirements of "Glazing" section of these specifications.

2.3 COMPONENTS:

- A. Storefront Framing System: Provide inside-outside matched resilient center-glazed storefront framing system with provisions for glass replacement. Shop-fabricate and pre-assemble frame components where possible.
  1. Construction: Fabricate storefront framing system with integrally concealed, low conductance thermal barrier, located between exterior materials and exposed interior members to eliminate direct metal-to-metal contact. Use manufacturer's standard construction that has been in use for similar projects for period of not less than 3 years
  2. Glazing system: Retained mechanically with gaskets on four sides
  3. Glazing Plane: Center
  4. Framing size: 2" x 4 1/2"
  5. Fabrication Method: Field-fabricated stick system with shear blocks
- B. Aluminum Perimeter Door Framing:
  1. Fabricate tubular frame assemblies from the size and type shown. 0.125" minimum wall thickness and type 6063-T5 aluminum alloy. 0.625" x 1.25" applied door stops with screws and weatherstripping.
  2. Where wide strikes or electric strikes are used, a 0.625" x 1.75" stop with screws and weatherstripping shall be applied.



3. Where surface applied hardware (exit device strikes, closer shoes, overhead stops, etc.) is to be mounted to the frame stop, provide solid bar stock steel reinforcement under the stop.
4. Frame members are to be box type with four (4) enclosed sides. Open back framing will not be accepted. Frames must be anchored by removing the door stop, drilling a 0.5" pilot hole on the door side of the frame, and anchoring the frame from the wall side of the frame.

#### 2.4 HARDWARE

- A. General: Refer to hardware section in Division-8 for requirements for hardware items other than those indicated to be provided by the aluminum entrance manufacturer.

#### 2.5 FABRICATION

- A. General: Sizes of door and frame units, and profile requirements, are indicated on drawings. Variable dimensions are indicated, with maximum and minimum dimensions required to achieve design requirements and coordination with other work.
- B. Fabricate components that, when assembled, have the following characteristics:
  1. Profiles that are sharp, straight, and free of defects or deformations.
  2. Accurately fitted joints with ends coped or mitered.
  3. Physical and thermal isolation of glazing from framing members.
  4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
  5. Provisions for field replacement of glazing from exterior
  6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- C. Storefront Framing: Fabricate components for assembly using shear-block system
- D. Prefabrication: Before shipment to the project site, complete fabrication, assembly, finishing, hardware application, and other work to the greatest extent possible. Disassemble components only as necessary for shipment and installation.
  1. Pre-glaze door and frame units to greatest extent possible.
  2. Do not drill and tap for surface-mounted hardware items until time of installation of project site.
  3. Perform fabrication operations, including cutting, fitting, forming, drilling and grinding of metal work to prevent damage to exposed finish surfaces. For hardware, perform these operations prior to application of finishes.
- E. Welding: Comply with AWS recommendations; grind exposed welds smooth and restore mechanical finish.
- F. Reinforcing: Install reinforcing as required for hardware and necessary for performance requirements, sag resistance and rigidity.

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1. Attachments of all hardware shall be made using machine screws which are supplied by the manufacturer.
  2. All holes shall be drilled and tapped using the recommended drill size for the tap required.
  3. Frame stops shall be applied stop. Minimum 5/8" high x minimum 1 1/4" wide.
  4. Frame tubes sections should be closed back, minimum of 1/8" wall thickness.
  5. Door skins should be minimum of 1/8" wall thickness.
  6. Where hardware is to be attached to frame stop (i.e., exit device strike, door closer shoe), a piece of solid bar stock aluminum sized to fill the frame stop void x 18" long shall be securely attached to the frame tube.
  7. Where it is not practical to have solid bar stock reinforcement at attachment points, use Riv-Nuts for attachment.
- G. Dissimilar Metals: Separate dissimilar metals with zinc chromate primer, bituminous paint, or other separator that will prevent corrosion.
1. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.
- H. Continuity: Maintain accurate relation of planes and angles, with hairline fit of contacting members.
1. Uniformity of Finish: Abutting extruded aluminum members shall not have an integral color or texture variation greater than half the range indicated in the sample pair submittal.
- I. Fasteners: Conceal fasteners wherever possible.
- J. Weatherstripping: For exterior doors, provide compression weatherstripping against fixed stops; at other edges, provide sliding weatherstripping retained in adjustable strip mortised into door edge.
1. Provide EPDM or vinyl blade gasket weatherstripping in bottom door rail, adjustable for contact with threshold.
  2. At interior doors and other locations without weatherstripping, provide neoprene silencers on stops to prevent metal-to-metal contact.
  3. Provide finger guards of collapsible neoprene or PVC gasketing securely anchored into frame at hinge-jamb of center-pivoted doors.

2.6 FINISHES:

- A. High-Performance Organic Coating: AA-M12-C42-R1X (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: chemical conversion coating, acid chromate-fluoride-phosphate pretreatment; Organic Coating: as specified below). Prepare, pre-treat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturer's instruction.

SECTION 084113  
ALUMINUM  
ENTRANCES AND  
STOREFRONTS

1. Fluorocarbon 2-Coat Coating System: Manufacturer's standard 2-coat thermo-cured system, composed of specially formulated inhibitive primer and fluorocarbon color coat, with color coat containing not less than 70 percent polyvinylidene fluoride resin by weight; comply with AAMA 2605-98.
2. Color
  - a. Hamilton Elementary School; PVDF/ Kynar 500 - Medium Bronze
  - b. International Academy East; PVDF/ Kynar 500 MICA – Warm Silver

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Comply with manufacturer's instructions and recommendations for installation.
- B. Set units plumb, level, and true to line, without warp or rack of framing members, doors, or panels. Provide proper support and anchor securely in place.
  1. Separate aluminum and other corrodible metal surfaces from sources of corrosion of electrolytic action at points of contact with other materials. Comply with requirements specified under paragraph "Dissimilar Materials" in the Appendix to AAMA 101-85.
- C. Drill and tap frames and doors and apply surface-mounted hardware items. Comply with hardware manufacturer's instructions and template requirements. Use concealed fasteners wherever possible.
- D. Set sill members and other members in bed of sealant as indicated, or with joint fillers or gaskets as indicated to provide weathertight construction. Comply with requirements of Division 7 for sealant, fillers, and gaskets.
- E. Refer to Division 8 Section "Glazing" for installation of glass and other panels indicated to be glazed into doors and framing, and not pre-glazed by manufacturer.

3.2 ADJUSTING:

- A. Adjust operating hardware to function properly, for smooth operation without binding, and for weathertight closure.

3.3 CLEANING:

- A. Clean the completed system, inside and out, promptly after installation, exercising care to avoid damage to coatings.
- B. Clean glass surfaces after installation, complying with requirements contained in the "Glazing" section for cleaning and maintenance. Remove excess glazing and sealant compounds, dirt and other substances from aluminum surfaces.

3.4 PROTECTION:

- A. Institute protective measures required throughout the remainder of the construction period to ensure that aluminum entrances and storefronts will be without damage or deterioration, other than normal weathering, at time of acceptance.

**\*\*END OF SECTION\*\***

ALUMINUM WINDOWS

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 types of aluminum-framed windows:
  - 1. Single-hung windows.
  - 2. Fixed windows.
  - 3. Horizontal-sliding windows.
- B. Related Sections include the following:
  - 1. Division 08 Section "Aluminum-Framed Entrances and Storefronts" for coordinating finish among aluminum fenestration units.
  - 2. Division 26 Sections for electrical service and connections for motor operators, controls, limit switches, and other powered devices and for system disconnect switches for motorized window operators.

1.3 DEFINITIONS

- A. AW: Architectural Windows
- B. Performance grade number, included as part of the AAMA/NWWDA product designation code, is actual design pressure in pounds force per square foot (pascals) used to determine structural test pressure and water test pressure.
- C. Structural test pressure, for uniform load structural test, is equivalent to 150 percent of design pressure.
- D. Minimum test size is smallest size permitted for performance class (gateway test size). Products must be tested at minimum test size or at a size larger than minimum test size to comply with requirements for performance class.

1.4 PERFORMANCE REQUIREMENTS

- A. General: Provide aluminum windows capable of complying with performance requirements indicated, based on testing manufacturer's windows that are representative of those specified and that are of test size indicated below:
  - 1. Minimum size required by gateway performance requirements for determining compliance with AAMA/NWWDA 101/I.S.2 for both gateway performance requirements and optional performance grades.
- B. AAMA/NWWDA Performance Requirements: Provide aluminum windows of the performance class and grade indicated that comply with AAMA/NWWDA 101/I.S.2.
  - 1. Performance Class: AW.
  - 2. Performance Grade: 50.
- C. Condensation-Resistance Factor: Provide aluminum windows tested for thermal performance according to AAMA 1503, showing a CRF of 52, where windows are indicated to be "thermally improved."
- D. Thermal Transmittance: Provide aluminum windows with a whole-window U-value maximum indicated at 15-mph (24-km/h) exterior wind velocity and winter condition temperatures when tested according to AAMA 1503, ASTM E 1423, or NFRC 100.
  - 1. U-Value: 0.50 Btu/sq. ft. x h x deg F (W/sq. m x K).
- E. Thermal Movements: Provide aluminum windows, including anchorage, that accommodate thermal movements of units resulting from the following maximum change (range) in ambient and surface temperatures without buckling, distortion, opening of joints, failure of joint sealants, damaging loads and stresses on glazing and connections, and other detrimental effects. Base engineering calculation on actual surface temperatures of materials due to solar heat gain and nighttime-sky heat loss.
  - 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C) material surfaces.

1.5 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, fabrication methods, dimensions of individual components and profiles, hardware, finishes, and operating instructions for each type of aluminum window indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, hardware, attachments to other Work, operational clearances, and the following:
  - 1. Mullion details, including reinforcement and stiffeners.
  - 2. Joinery details.
  - 3. Expansion provisions.
  - 4. Flashing and drainage details.

5. Weather-stripping details.
  6. Thermal-break details.
  7. Glazing details.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: For aluminum window components required, prepared on Samples of size indicated below.
1. Main Framing Member: 12-inch- (300-mm-) long, full-size sections of extrusions with factory-applied color finish.
  2. Hardware: Full-size units with factory-applied finish.
  3. Weather Stripping: 12-inch- (300-mm-) long sections.
  4. Architect reserves the right to require additional samples that show fabrication techniques, workmanship, and design of hardware and accessories.
- E. Qualification Data: For Installer.
- F. Product Test Reports: Based on evaluation of comprehensive tests performed within the last four years by a qualified testing agency, for each type, grade, and size of aluminum window. Test results based on use of down-sized test units will not be accepted.
- G. Maintenance Data: For operable window sash, operating hardware, weather stripping and finishes to include in maintenance manuals.

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An installer acceptable to aluminum window manufacturer for installation of units required for this Project.
- B. Source Limitations: Obtain aluminum windows through one source from a single manufacturer.
- C. Product Options: Drawings indicate size, profiles, and dimensional requirements of aluminum windows and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
- D. Fenestration Standard: Comply with AAMA/NWWDA 101/I.S.2, "Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors," for minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
1. Provide AAMA-certified aluminum windows with an attached label.
- E. Glazing Publications: Comply with published recommendations of glass manufacturers and GANA's "Glazing Manual" unless more stringent requirements are indicated.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify aluminum window openings by field measurements before fabrication and indicate measurements on Shop Drawings.
  - 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating aluminum windows without field measurements. Coordinate wall construction to ensure that actual opening dimensions correspond to established dimensions.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:
  - 1. Failure to meet performance requirements.
  - 2. Structural failures including excessive deflection.
  - 3. Water leakage, air infiltration, or condensation.
  - 4. Faulty operation of movable sash and hardware.
  - 5. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - 6. Insulating glass failure.
- B. Warranty Period: Three years from date of Substantial Completion.
- C. Warranty Period for Metal Finishes: 15 years from date of Substantial Completion.
- D. Warranty Period for Glass: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of design products by EFCO Corporation
  - 1. Fixed windows: 2700 Series, exterior glazed, 2" frame depth, thermally broken
  - 2. Fixed windows: 6600 Series, 3 7/8" frame depth, thermally broken
  - 3. Single Hung Windows: 660 Series, 3 7/8" frame depth, thermally broken
  - 4. Horizontal Sliding Windows: 3500 Series, 3 1/4" frame depth, thermally broken, medium height sill
- B. Acceptable Manufacturers
  - 1. EFCO Corporation

2. Kawneer Company, Inc.
3. Custom Window Company.
4. Graham Architectural Products Corp.
5. Heritage Window and Door, Inc.
6. TRACO.
7. Litex

## 2.2 MATERIALS, GENERAL

- A. Aluminum Extrusions: Alloy and temper recommended by aluminum window manufacturer for strength, corrosion resistance, and application of required finish, but not less than 22,000-psi (150-MPa) ultimate tensile strength, not less than 16,000-psi (110-MPa) minimum yield strength, and not less than 0.062-inch (1.6-mm) thickness at any location for the main frame and sash members.
- B. Fasteners: Aluminum, nonmagnetic stainless steel, epoxy adhesive, or other materials warranted by manufacturer to be noncorrosive and compatible with aluminum window members, trim, hardware, anchors, and other components. Cadmium-plated steel fasteners are not permitted.
  1. Reinforcement: Where fasteners screw-anchor into aluminum less than 0.125 inch (3.2 mm) thick, reinforce interior with aluminum or nonmagnetic stainless steel to receive screw threads, or provide standard, noncorrosive, pressed-in, splined grommet nuts.
  2. Exposed Fasteners: Unless unavoidable for applying hardware, do not use exposed fasteners. For application of hardware, use fasteners that match finish of member or hardware being fastened, as appropriate.
- C. Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated. Cadmium-plated steel anchors, clips, and accessories are not permitted.
- D. Reinforcing Members: Aluminum, nonmagnetic stainless steel, nickel/chrome-plated steel complying with ASTM B 456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated. Cadmium-plated steel reinforcing members are not permitted.
- E. Compression-Type Weather Stripping: Provide compressible weather stripping designed for permanently resilient sealing under bumper or wiper action, and completely concealed when aluminum window is closed.
  1. Weather-Stripping Material: Manufacturer's standard system and materials complying with AAMA/NWWDA 101/I.S.2.
- F. Sliding-Type Weather Stripping: Provide woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric. Comply with AAMA 701/702.
  1. Weather Seals: Provide weather stripping with integral barrier fin or fins of semirigid, polypropylene sheet or polypropylene-coated material.
- G. Replaceable Weather Seals: Comply with AAMA 701/702.



- H. Sealant: For sealants required within fabricated windows, provide window manufacturer's standard, permanently elastic, nonshrinking, and nonmigrating type recommended by sealant manufacturer for joint size and movement.

## 2.3 GLAZING

- A. Glass and Glazing Materials: Refer to Division 8 Section "Glazing" for glass units and glazing requirements applicable to glazed aluminum window units.

## 2.4 HARDWARE

- A. General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with aluminum; designed to smoothly operate, tightly close, and securely lock aluminum windows and sized to accommodate sash or ventilator weight and dimensions. Cadmium-plated hardware is not permitted. Do not use aluminum in frictional contact with other metals. Where exposed, provide cast white bronze, extruded, cast, or wrought aluminum or nonmagnetic stainless steel.
- B. Counterbalancing Mechanism: Comply with AAMA 902.
  - 1. Sash Balance: Concealed ultra-lift spring type capable of lifting 70 percent of sash weight of size and capacity to hold sash stationary at any open position.
    - a. Provide Ultra-Lift sash balances.
- C. Sill Cap/Track: Extruded-aluminum with natural anodized finish track of thickness, dimensions, and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior.
- D. Locks and Latches: Designed to allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.
  - 1. Provide auto sill locking on hung windows
  - 2. Provide auto plunger lock on horizontal sliding windows
- E. Roller Assemblies: Low-friction design.
- F. Push-Bar Operators: Provide telescoping-type, push-bar operator designed to open and close ventilators with fixed screens.
- G. Gear-Type Rotary Operators: Comply with AAMA 901 when tested according to ASTM E 405, Method A.
  - 1. Operation Function: All ventilators move simultaneously and securely close at both jambs without using additional manually controlled locking devices.
- H. Four- or Six-Bar Friction Hinges: Comply with AAMA 904.
  - 1. Locking mechanism and handles for manual operation.
  - 2. Friction Shoes: Provide friction shoes of nylon or other nonabrasive, nonstaining, noncorrosive, durable material.

- I. Limit Devices: Provide limit devices designed to restrict sash or ventilator opening.
  - 1. Safety Devices: Limit clear opening to 6 inches (150 mm) for ventilation; with custodial key release.
- J. Single-Hung Windows: Provide the following operating hardware:
  - 1. Sash Balances: Two per sash.
  - 2. Handle: Continuous, integral, sash lift bar on bottom rail of operating sash.
  - 3. Sash Lock: Auto sill lock mechanism
  - 4. Limit Device: Sash stop limit device; for each operable sash located at jamb; two per sash.
  - 5. Removable Lift-Out Sash: Design windows and provide with tamperproof, key-operated hardware to permit removal of sash from inside for cleaning.
- K. Horizontal-Sliding Windows: Provide the following operating hardware:
  - 1. Sash Rollers: Stainless-steel, lubricated ball-bearing rollers with nylon tires.
  - 2. Sash Lock: Auto Plunger locking mechanism.
  - 3. Limit Device: Sash stop limit device; mounted in bottom of pull stile.
  - 4. Removable Lift-Out Sash: Design windows and provide with tamperproof, key-operated hardware to permit removal of sash from inside for cleaning.

2.5 INSECT SCREENS – Not required

2.6 FABRICATION

- A. General: Fabricate aluminum windows, in sizes indicated, that comply with AAMA/NWWDA 101/I.S.2 for performance class and performance grade indicated. Include a complete system for assembling components and anchoring windows.
- B. Fabricate aluminum windows that are reglazable without dismantling sash or ventilator framing.
- C. Thermally Improved Construction: Fabricate aluminum windows with an integral, concealed, low-conductance thermal barrier; located between exterior materials and window members exposed on interior side; in a manner that eliminates direct metal-to-metal contact.
  - 1. Provide thermal-break construction that has been in use for not less than three years and has been tested to demonstrate resistance to thermal conductance and condensation and to show adequate strength and security of glass retention.
- D. Weather Stripping: Provide full-perimeter weather stripping for each operable sash and ventilator.
  - 1. Horizontal-Sliding Windows: Provide operable sash with a double row of sliding weather stripping in horizontal rails and single- or double-row weather stripping in meeting or jamb stiles, as required to meet specified performance requirements. Provide compression-

type weather stripping at perimeter of each movable panel where sliding-type weather stripping is not appropriate.

- E. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.
- F. Provide water-shed members above side-hinged ventilators and similar lines of natural water penetration.
- G. Mullions: Provide mullions and cover plates as shown, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections, as indicated. Provide mullions and cover plates capable of withstanding design loads of window units.
- H. Subframes: Provide subframes with anchors for all window units as shown, of profile and dimensions indicated but not less than 0.062-inch- (1.6-mm-) thick extruded aluminum. Miter or cope corners, and weld and dress smooth with concealed mechanical joint fasteners. Finish to match window units. Provide subframes capable of withstanding design loads of window units.
  - 1. Provide at all windows unless otherwise indicated.
- I. Factory-Glazed Fabrication: Glaze aluminum windows in the factory where practical and possible for applications indicated. Comply with requirements in Division 8 Section "Glazing" and with AAMA/NWWDA 101/I.S.2.
- J. Glazing Stops: Provide snap-on glazing stops coordinated with Division 8 Section "Glazing" and glazing system indicated. Provide glazing stops to match sash and ventilator frames.

## 2.7 FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- C. High-Performance Organic Finish: AA-M12-C42-R1X (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  - 1. Fluorocarbon 2-Coat Coating System: Manufacturer's standard 2-coat thermo-cured system, composed of specially formulated inhibitive primer and fluorocarbon color coat, with color coat containing not less than 70 percent polyvinylidene fluoride resin by weight; comply with AAMA 2605-98.
    - a. Color: PVDF/ Kynar 500 MICA – Warm Silver.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances; rough opening dimensions;

levelness of sill plate; coordination with wall flashings, vapor retarders, and other built-in components; operational clearances; and other conditions affecting performance of work.

1. Masonry Surfaces: Visibly dry and free of excess mortar, sand, and other construction debris.
  2. Wood Frame Walls: Dry, clean, sound, well nailed, free of voids, and without offsets at joints. Ensure that nail heads are driven flush with surfaces in opening and within 3 inches (76 mm) of opening.
  3. Metal Surfaces: Dry; clean; free of grease, oil, dirt, rust, corrosion, and welding slag; without sharp edges or offsets at joints.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. General: Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components; Drawings; and Shop Drawings.
- B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction. Do not bridge thermal breaks.
1. Windows are to be insulated by the erector with fiberglass batt insulation.
- C. Set sill members in bed of sealant or with gaskets, as indicated, for weathertight construction.
1. Comply with requirements of Division 7 Section "Joint Sealants."
- D. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.
- E. Metal Protection: Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials by complying with requirements specified in "Dissimilar Materials" Paragraph in Appendix B in AAMA/NWWDA 101/I.S.2.

### 3.3 ADJUSTING

- A. Adjust operating sashes and ventilators, screens, hardware, and accessories for a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts.

### 3.4 PROTECTION AND CLEANING

- A. Protect window surfaces from contact with contaminating substances resulting from construction operations. In addition, monitor window surfaces adjacent to and below exterior concrete and masonry surfaces during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written recommendations.
- B. Clean aluminum surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

- C. Clean factory-glazed glass immediately after installing windows. Comply with manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels and clean surfaces.
- D. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

3.5 DEMONSTRATION

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

**\*\*END OF SECTION\*\***

DOOR HARDWARE

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 commercial door hardware for the following:
  - 1. Swinging doors.
  - 2. Sliding doors.
  - 3. Other doors to the extent indicated.
- B. Door hardware includes, but is not necessarily limited to, the following:
  - 1. Mechanical door hardware.
  - 2. Electromechanical door hardware, power supplies, back-ups and surge protection.
  - 3. Cylinders specified for doors in other sections.
- C. Related Sections:
  - 1. Division 08 Section "Door Hardware Schedule".
  - 2. Division 08 Section "Hollow Metal Doors and Frames".
  - 3. Division 08 Section "Fiberglass Reinforced Plastic Doors".
  - 4. Division 08 Section "Flush Wood Doors".
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
  - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
  - 2. ICC/IBC - International Building Code.
  - 3. NFPA 80 - Fire Doors and Windows.
  - 4. NFPA 101 - Life Safety Code.
  - 5. NFPA 105 - Installation of Smoke Door Assemblies.
  - 6. Michigan Building Code, Local Amendments.

E. Standards: All hardware specified herein shall comply with the following industry standards:

1. ANSI/BHMA Certified Product Standards - A156 Series
2. UL10C – Positive Pressure Fire Tests of Door Assemblies

### 1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
  2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
  3. Content: Include the following information:
    - a. Type, style, function, size, label, hand, and finish of each door hardware item.
    - b. Manufacturer of each item.
    - c. Fastenings and other pertinent information.
    - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
    - e. Explanation of abbreviations, symbols, and codes contained in schedule.
    - f. Mounting locations for door hardware.
    - g. Door and frame sizes and materials.
  4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Shop Drawings: Details of electrified access control hardware indicating the following:
1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access

control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

- a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
  - b. Complete (risers, point-to-point) access control system block wiring diagrams.
2. Electrical Coordination: Coordinate with related Division 26 Electrical Sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Keying Schedule: Prepared under the supervision of the Owner, separate schedule detailing final keying instructions for locksets and cylinders in writing. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner to approve submitted keying schedule prior to the ordering of permanent cylinders.
- E. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Submittals. The manual to include the name, address, and contact information of the manufacturers providing the hardware and their nearest service representatives. The final copies delivered after completion of the installation test to include "as built" modifications made during installation, checkout, and acceptance.
- F. Warranties and Maintenance: Special warranties and maintenance agreements specified in this Section.

#### 1.4 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
- B. Installer Qualifications: Installers, trained by the primary product manufacturers, with a minimum 3 years documented experience installing both standard and electrified builders hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- C. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor in good standing by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.
  1. Scheduling Responsibility: Preparation of door hardware and keying schedules.
- D. Source Limitations: Obtain each type and variety of Door Hardware specified in this Section from a single source, qualified supplier unless otherwise indicated.



1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
  2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.
- E. Regulatory Requirements: Comply with NFPA 70, NFPA 80, NFPA 101 and ANSI A117.1 requirements and guidelines as directed in the model building code including, but not limited to, the following:
1. NFPA 70 "National Electrical Code", including electrical components, devices, and accessories listed and labeled as defined in Article 100 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
  2. Where indicated to comply with accessibility requirements, comply with Americans with Disabilities Act (ADA), "Accessibility Guidelines for Buildings and Facilities (ADAAG)," ANSI A117.1 as follows:
    - a. Handles, Pulls, Latches, Locks, and other Operating Devices: Shape that is easy to grasp with one hand and does not require tight grasping, tight pinching, or twisting of the wrist.
    - b. Door Closers: Comply with the following maximum opening-force requirements indicated:
      - 1) Interior Hinged Doors: 5 lbf applied perpendicular to door.
      - 2) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
    - c. Thresholds: Not more than 1/2 inch high. Bevel raised thresholds with a slope of not more than 1:2.
  3. NFPA 101: Comply with the following for means of egress doors:
    - a. Latches, Locks, and Exit Devices: Not more than 15 lbf to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation.
    - b. Thresholds: Not more than 1/2 inch high.
  4. Fire-Rated Door Assemblies: Provide door hardware for assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252 (neutral pressure at 40" above sill) or UL-10C.
    - a. Test Pressure: Positive pressure labeling.
- F. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.
- G. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:

1. Function of building, purpose of each area and degree of security required.
  2. Plans for existing and future key system expansion.
  3. Requirements for key control storage and software.
  4. Installation of permanent keys, cylinder cores and software.
  5. Address and requirements for delivery of keys.
- H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
  2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
  3. Review sequence of operation narratives for each unique access controlled opening.
  4. Review and finalize construction schedule and verify availability of materials.
  5. Review the required inspecting, testing, commissioning, and demonstration procedures
- I. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.
- 1.5 DELIVERY, STORAGE, AND HANDLING
- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
  - B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
  - C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".
- 1.6 COORDINATION
- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

- B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.
- C. Door and Frame Preparation: Related Division 08 Sections (Steel, Aluminum and Wood) doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

#### 1.7 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
  - 1. Structural failures including excessive deflection, cracking, or breakage.
  - 2. Faulty operation of the hardware.
  - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - 4. Electrical component defects and failures within the systems operation.
- C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.
- D. Special Warranty Periods:
  - 1. Ten years for mortise locks and latches.
  - 2. Five years for exit hardware.
  - 3. Twenty five years for manual surface door closers.
  - 4. Two years for electromechanical door hardware.

#### 1.8 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.
- B. Continuing Service: Beginning at Substantial Completion, and running concurrent with the specified warranty period, provide continuous (6) months full maintenance including repair and replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door opening operation. Provide parts and supplies as used in the manufacture and installation of original products.

## PART 2 - PRODUCTS

### 2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.
  - 1. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
    - a. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.
- B. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

### 2.2 HANGING DEVICES

- A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles as specified in the Door Hardware Sets.
  - 1. Quantity: Provide the following hinge quantity, unless otherwise indicated:
    - a. Two Hinges: For doors with heights up to 60 inches.
    - b. Three Hinges: For doors with heights 61 to 90 inches.
    - c. Four Hinges: For doors with heights 91 to 120 inches.
    - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
  - 2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
    - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
    - b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
  - 3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
    - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
    - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.

4. Hinge Options: Comply with the following where indicated in the Hardware Sets or on Drawings:
    - a. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the following applications:
      - 1) Out-swinging exterior doors.
      - 2) Out-swinging access controlled doors.
      - 3) Out-swinging lockable doors.
  5. Acceptable Manufacturers:
    - a. Hager Companies (HA).
    - b. McKinney Products (MK).
    - c. Stanley Hardware (ST).
- B. Continuous Geared Hinges: ANSI/BHMA A156.26 certified continuous geared hinge with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Provide concealed flush mount (with or without inset), full surface, or half surface, in standard and heavy duty models, as specified in the Hardware Sets. Concealed continuous hinges to be U.L. listed for use on up to and including 90 minute rated door installations and U.L. listed for windstorm components where applicable. Factory cut hinges for door size and provide with removable service power transfer panel where indicated at electrified openings.
1. Acceptable Manufacturers:
    - a. Pemko Manufacturing (PE).
    - b. Select Hinge (SE).
    - c. Stanley Hardware (ST).

## 2.3 POWER TRANSFER DEVICES

- A. Concealed Quick Connect Electric Power Transfers: Provide concealed wiring pathway housing mortised into the door and frame for low voltage electrified door hardware. Furnish with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.
  1. Acceptable Manufacturers:
    - a. Securitron (SU) - EL-CEPT Series.
- B. Electric Door Hardware Cords: Provide electric transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door

wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.

1. Acceptable Manufacturers:
  - a. McKinney Products (MK) - Inner Door Cord 3 inches: QC-C003P.
  - b. McKinney Products (MK) - Inner Door Cord 3 foot door: QC-C206P.
  - c. McKinney Products (MK) - Inner Door Cord 4 foot door: QC-C306P.
  - d. McKinney Products (MK) - Inner Door Cord 15 feet: QC-C1500P.
  - e. McKinney Products (MK) - Hinge to Junction Panel 15 feet: QC-C1500P.
2. Provide one each of the following tools as part of the base bid contract:
  - a. McKinney Products (MK) - Electrical Connecting Kit: QC-R001.
  - b. McKinney Products (MK) - Connector Hand Tool: QC-R003.

#### 2.4 DOOR OPERATING TRIM

- A. Door Push Plates and Pulls: ANS/BHMA A156.6 certified door pushes and pulls of type and design specified below or in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.
  1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
  2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
  3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
  4. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
    - a. Acceptable Manufacturers:
      - 1) Any member of Builders Hardware Manufacturers Association (BHMA).

#### 2.5 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.

- B. Source Limitations: Obtain each type of keyed cylinder and keys from the same source manufacturer as locksets and exit devices, unless otherwise indicated.
- C. Cylinders: Original manufacturer cylinders complying with the following:
  - 1. Mortise Type: Fixed core, threaded cylinders with rings and straight- or clover-type cam.
  - 2. Rim Type: Fixed core, cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
  - 3. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
  - 4. Keyway: Corbin Russwin 67 and 77 keyway families.
- D. Keying System: Each type of lock and cylinders to be keyed to keys provided by Owner. Conduct specified "Keying Conference" to define and document keying system instructions and requirements. Furnish nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner. Incorporate decisions made in keying conference, and as follows:
  - 1. Master Key System: Cylinders are operated by a change key and a master key.
  - 2. Grand Master Key System: Cylinders are operated by a change key, a master key, and a grand master key.
  - 3. Great-Grand Master Key System: Cylinders are operated by a change key, a master key, a grand master key, and a great-grand master key.
  - 4. Existing System: Master key or grand master key locks to Owner's existing system.
  - 5. Keyed Alike: Key all cylinders to same change key.
- E. Key Quantity: Provide the following minimum number of keys:
  - 1. Change Keys per Cylinder: Two (2)
- F. Owner shall provide keys for pinning purposes only. Cylinders shall be pinned to suit Owner provided bitting numbers and shall not be pinned using an existing key. Owner provided keys shall not be duplicated and shall be returned directly to Owner's representative when keying of cylinders is complete.

## 2.6 MECHANICAL LOCKS AND LATCHING DEVICES

- A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 certified mortise locksets furnished in the functions as specified in the Hardware Sets. Locksets to be manufactured with a corrosion resistant, stamped 12 gauge minimum formed steel case and be field-reversible for handing without disassembly of the lock body. Lockset trim (including knobs, levers, escutcheons, roses) to be the product of a single manufacturer. Furnish with standard 2 3/4" backset, 3/4" throw anti-friction stainless steel latchbolt, and a full 1" throw stainless steel bolt for deadbolt functions.
  - 1. Acceptable Manufacturers:

- a. Corbin Russwin Hardware (RU) – ML2000 Series.
- b. No Substitution – Facility Standard.

B. Lock Trim Design: As specified in Hardware Sets.

## 2.7 LOCK AND LATCH STRIKES

- A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
  - 1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
  - 2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
  - 3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
- B. Standards: Comply with the following:
  - 1. Strikes for Mortise Locks and Latches: BHMA A156.13.

## 2.8 CONVENTIONAL EXIT DEVICES

- A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:
  - 1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
  - 2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.
    - a. Fire Exit Removable Mullions: Provide keyed removable mullions for use with fire exit devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252. Mullions to be used only with exit devices for which they have been tested.
  - 3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
  - 4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is not acceptable except in any case where the door light extends behind the device as in a full glass configuration.



5. Flush End Caps: Provide heavy weight impact resistant flush end caps made of architectural metal in the same finish as the devices as in the Hardware Sets. Plastic end caps will not be acceptable.
  6. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty trim with cold forged escutcheons, beveled edges, and four threaded studs for thru-bolts.
    - a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets. Provided free-wheeling type trim where indicated.
    - b. Where function of exit device requires a cylinder, provide an interchangeable core type keyed cylinder (Rim or Mortise) as specified in Hardware Sets.
  7. Vertical Rod Exit Devices: Provide and install interior surface and concealed vertical rod exit devices as Less Bottom Rod (LBR) unless otherwise indicated.
  8. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
  9. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
  10. Rail Sizing: Provide exit device rails factory sized for proper door width application.
  11. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.
  12. Install exit devices at centerline from floor as specified in Part 3.3.B.1 of this Section to suit door designs and ADA requirements.
- B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Mounting rails to be formed from smooth stainless steel, brass or bronze architectural materials no less than 0.072" thick, with push rails a minimum of 0.062" thickness. Painted or aluminum metal rails are not acceptable. Exit device latch to be investment cast stainless steel, pullman type, with deadlock feature.
1. Acceptable Manufacturers:
    - a. Von Duprin (VD) – 98XP Series.
    - b. No Substitution.
- C. Tube Steel Removable Mullions: ANSI/BHMA A156.3 removable steel mullions with malleable-iron top and bottom retainers and a primed paint finish. Provide keyed removable feature, stabilizers, and mounting brackets as specified in the Hardware Sets. At openings designed for severe wind load conditions due to hurricanes or tornadoes, provide manufacturers approved mullion and accessories to meet applicable state and local windstorm codes.
1. Acceptable Manufacturers:
    - a. Von Duprin (VD) – 4950 / 9950 Series.

- b. No substitution.

## 2.9 DOOR CLOSERS

- A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers including installation and adjusting information on inside of cover.
  2. Standards: Closers to comply with UL-10C and UBC 7-2 for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
  3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the physically handicapped, provide units complying with ANSI ICC/A117.1.
  4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
    - a. Where closers are indicated to have mechanical dead-stop, provide heavy duty arms and brackets with an integral positive stop.
    - b. Where closers are indicated to have mechanical hold open, provide heavy duty units with an additional built-in mechanical holder assembly designed to hold open against normal wind and traffic conditions. Holder to be manually selectable to on-off position.
    - c. Where closers are indicated to have a cushion-type stop, provide heavy duty arms and brackets with spring stop mechanism to cushion door when opened to maximum degree.
    - d. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics. Provide drop plates or other accessories as required for proper mounting.
  5. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates, and through-bolt or security type fasteners as specified in the door Hardware Sets.
- B. Door Closers, Surface Mounted (Large Body Cast Iron): ANSI/BHMA A156.4, Grade 1 surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control.

1. Acceptable Manufacturers:
  - a. LCN Closers (LC) – 4011 / 4111 Series.
  - b. No Substitution – Facility Standard.

2.10 AUTOMATIC DOOR OPERATORS - GENERAL

- A. General: Provide operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for compliance with UL 325. Coordinate operator mechanisms with door operation, hinges, and activation devices.
  - 1. Fire-Rated Doors: Provide door operators for fire-rated door assemblies that comply with NFPA 80 for fire-rated door components and are listed and labeled by a qualified testing agency.
- B. Electrohydraulic Door Operators: Self-contained low-pressure units with rack and pinion design contained within a cast aluminum housing. Door closing speed controlled by independent hydraulic adjustment valves in the sweep and latch range of the closing cycle. Operator is to provide conventional door closer opening and closing forces unless the power operator motor is activated. Unit is to include an adjustable hydraulic backcheck valve to cushion the door speed if opened violently. Non-handed units for both push and pull side applications.
- C. Brackets and Reinforcements: Manufacturer's standard, fabricated from aluminum with nonferrous shims for aligning system components.

2.11 LOW ENERGY DOOR OPERATORS (ALTERNATE PRICE NO. 2)

- A. Standard: Certified ANSI/BHMA A156.19.
  - 1. Performance Requirements:
    - a. Opening and Closing Force if Power Fails: Door operator shall provide conventional door closer opening and closing forces unless the power operator motor is activated.
    - b. Entrapment Protection: Not more than 15 lbf required to prevent stopped door from closing or opening.
- B. Configuration: Surface mounted. Door operators to control single swinging and pair of swinging doors.
- C. Operation: Power opening and spring closing operation capable of meeting ANSI A117.1 accessibility guideline. Provide time delay for door to remain open before initiating closing cycle as required by ANSI/BHMA A156.19. When not in automatic mode, door operator to function as manual door closer with fully adjustable opening and closing forces, with or without electrical power.
  - 1. On-off switch to control power to be key switch operated.
- D. Features: Operator units to have full feature adjustments for door opening and closing force and speed, backcheck, motor assist acceleration from 0 to 30 seconds, time delay, vestibule interface delay, obstruction recycle, and hold open time from 0 up to 30 seconds.
  - 1. Provide outputs and relays on board the operator to allow for coordination of exit device latch retraction, electric strikes, magnetic locks, card readers, safety and motion sensors and specified auxiliary contacts.
- E. Acceptable Manufacturer and model:

- a. Norton Door Controls – 6020 Series.

## 2.12 ACTIVATION DEVICES

- A. General: Provide activation devices in accordance with ANSI/BHMA A156.19 standard, for condition of exposure indicated and for long term, maintenance free operation under normal traffic load operation. Coordinate activation control with electrified hardware and access control interfaces. Activation switches are standard SPST, with optional DPDT availability.
- B. Push-Plate Switch: Momentary contact door control switch with push-plate actuator.
  - 1. Configuration: Square or round push-plate control switch with single or double gang junction box mounting. Provide narrow profile face plate where indicated for jamb or mullion mounting.
    - a. Mounting Location: As indicated on Drawings.
  - 2. Push-Plate Material: Stainless steel.
  - 3. Message: International symbol of accessibility with "Push (Press) to Open (Operate)" text.
- C. Wireless or Remote Radio-Control Switch: Manufacturer's standard radio control system consisting of header mounted receiver and remote transmitter activation device.
- D. Signage: As required by cited ANSI/BHMA A156.19 standard for the type of operator.
- E. Finishes: Designations used to indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- F. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware. Units will be sprayed with a combination of waterborne acrylic and polyester powder coat.
- G. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

## 2.13 ARCHITECTURAL TRIM

- A. Door Protective Trim
  - 1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
  - 2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.

3. Metal Protection Plates: ANSI/BHMA A156.6 certified metal protection plates (kick, armor, or mop), beveled on four edges (B4E), fabricated from the following:
  - a. Stainless Steel: 300 series, .050-inch thick, with countersunk screw holes (CSK).
4. Fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets.
5. Acceptable Manufacturers:
  - 1) Any member of Builders Hardware Manufacturers Association (BHMA).

#### 2.14 DOOR STOPS AND HOLDERS

- A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.
- B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
  1. Acceptable Manufacturers:
    - 1) Any member of Builders Hardware Manufacturers Association (BHMA).
- C. Overhead Door Stops and Holders: ANSI/BHMA A156.6, Grade 1 certified overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.
  1. Acceptable Manufacturers:
    - 1) Any member of Builders Hardware Manufacturers Association (BHMA).

#### 2.15 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
- B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
  1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
- C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.

1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and UBC 7-2, Fire Tests of Door Assemblies.
- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated, based on testing according to ASTM E 1408.
- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- F. Acceptable Manufacturers:
  1. Pemko Manufacturing (PE).
  2. Reese Enterprises, Inc. (RS).
  3. Zero International (ZE).

2.16 ELECTRIC STRIKES

- A. Standard Electric Strikes: Heavy duty, cylindrical and mortise lock electric strikes conforming to ANSI/BHMA A156.31, Grade 1, UL listed for both Burglary Resistance and for use on fire rated door assemblies. Stainless steel construction with dual interlocking plunger design tested to exceed 3000 lbs. of static strength and 350 ft-lbs. of dynamic strength. Strikes tested for a minimum 1 million operating cycles. Provide strikes with 12 or 24 VDC capability and supplied standard as fail-secure unless otherwise specified. Option available for latchbolt and latchbolt strike monitoring indicating both the position of the latchbolt and locked condition of the strike.
  1. Acceptable Manufacturers:
    - a. Folger Adam EDC (FO).
    - b. HES (HE).
    - c. Von Duprin (VD).
- B. Surface Mounted Rim Electric Strikes: Surface mounted rim exit device electric strikes conforming to ANSI/BHMA A156.31, Grade 1, and UL Listed for both Burglary Resistance and for use on fire rated door assemblies. Construction includes internally mounted solenoid with two heavy-duty, stainless steel locking mechanisms operating independently to provide tamper resistance. Strikes tested for a minimum of 500,000 operating cycles. Provide strikes with 12 or 24 VDC capability supplied standard as fail-secure unless otherwise specified. Option available for latchbolt and latchbolt strike monitoring indicating both the position of the latchbolt and locked condition of the strike. Strike requires no cutting to the jamb prior to installation.
  1. Acceptable Manufacturers:
    - a. HES (HE) - 9500/9600 Series.
- C. Provide electric strikes with in-line power controller and surge suppressor by the same manufacturer as the strike with the combined products having a five year warranty.

2.17 ELECTRONIC ACCESSORIES

- A. Door Position Switches: Door position magnetic reed contact switches specifically designed for use in commercial door applications. On recessed models the contact and magnetic housing snap-lock into a 1" diameter hole. Surface mounted models include wide gap distance design complete with armored flex cabling. Provide SPDT, N/O switches with optional Rare Earth Magnet installation on steel doors with flush top channels.

1. Acceptable Manufacturers:

- a. Securitron (SU) - DPS Series.

- B. Switching Power Supplies: Provide UL listed or recognized filtered and regulated power supplies. Provide single, dual, or multi-voltage units as shown in the hardware sets. Units must be expandable up to eight Class 2 power limited outputs. Units must include the capability to incorporate a battery backup option with integral battery charging capability in addition to operating the DC load in event of line voltage failure. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw for the specified electrified hardware and access control equipment.

1. Acceptable Manufacturers:

- a. Securitron (SU) - AQ Series.

2.18 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.19 FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

### 3.2 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

### 3.3 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
  - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
  - 1. Exit devices shall be installed at 38 – 7/16 inches from floor to centerline of push rail.
  - 2. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
  - 3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
  - 4. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
  - 5. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."
- E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.



3.4 FIELD QUALITY CONTROL

- A. Field Inspection: Supplier will perform a final inspection of installed door hardware and state in report whether work complies with or deviates from requirements, including whether door hardware is properly installed, operating and adjusted.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.
- C. Clean operating items as necessary to restore proper finish. and provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SCHEDULE

- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

B. Manufacturer's Abbreviations:

- 1. MK - McKinney
- 2. PE - Pemko
- 3. RF - Rixson
- 4. RO - Rockwood
- 5. RU - Corbin Russwin
- 6. SA - Sargent

8. HS - HES

10. LC - LCN Closers

12. SU - Securitron

**Hardware Schedule**

**Set: 15**

Description: Exterior from Corridor

2 Continuous Hinge	CFM SLF-HD1		PE
2 Exit Device (exit only)	CD XP98EO	US32D	VD
2 Cylinder	As required	626	RU
2 Flush Pull	By Door Manufacturer		00
2 Surface Closer	4111 SHCUSH x 4110-30 x 4110-61	AL	LC
1 Threshold	1715AK MSES25SS		PE
1 Weatherstrip	By Door Manufacturer		00
2 Sweep	18100CNB TKSP8		PE
1 Position Switch	DPS-M-BK		SU

**Set: 1B**

Description: Exterior from Vestibule / Corridor

1 Continuous Hinge	CFM SLF-HD1		PE
1 Exit Device (exit only)	CD XP98EO	US32D	VD
1 Cylinder	As required	626	RU
1 Flush Pull	By Door Manufacturer		00
1 Surface Closer	4111 SHCUSH x 4110-30 x 4110-61	AL	LC
1 Threshold	1715AK MSES25SS		PE
1 Weatherstrip	By Door Manufacturer		00
1 Sweep	18100CNB TKSP8		PE
1 Position Switch	DPS-M-BK		SU

**Set: 1C**

Description: Card Reader - Exterior from Vestibule

1 Continuous Hinge	CFM SLF-HD1		PE
1 Exit Device (rim, nightlatch)	CD XP98NL	US32D	SA
2 Cylinder	As required	626	RU
1 Electric Strike	9600	630	HS
1 SMART Pac Bridge Rectifier	2005M3		HS
1 ElectroLynx Adaptor	2004M		HS
1 Flush Pull	By Door Manufacturer		00
1 Surface Closer	4111 SHCUSH x 4110-30 x 4110-61	AL	LC
1 Threshold	1715AK MSES25SS		PE
1 Weatherstrip	By Door Manufacturer		00
1 Sweep	18100CNB TKSP8		PE
1 eLynx Frame Harness	QC-C1500P		MK
1 Position Switch	DPS-M-BK		SU

Notes: Valid use of card reader outside unlocks electric strike to gain access. Key override outside retracts latch bolt.  
Free egress always permitted.

**Set: 1D**

Description: Exterior from Vestibule - night latch function

1 Continuous Hinge	CFM SLF-HD1		PE
1 Exit Device (rim, nightlatch)	CD XPNL	US32D	VD
1 Cylinder	As required	626	RU
1 Flush Pull	By Door Manufacturer		00
1 Surface Closer	4111 SHCUSH x 4110-30 x 4110-61	AL	LC
1 Threshold	1715AK MSES25SS		PE
1 Weatherstrip	By Door Manufacturer		00
1 Sweep	18100CNB TKSP8		PE

Notes: Key outside retracts latch bolt.  
Free egress always permitted.

**Set: 17.1**

Description: Electrical

2 Continuous Hinge	CFM HD1		PE
2 Exit Device	9827L-NL x 996L-NL x 03 x LBR	US32D	VD
2 Cylinder	As required	626	RU
2 Surface Closer	4111 SCUSH	AL	LC
2 Kickplate	K1050 10" high 4BE	US32D	RO
1 Smoke Seal	S88D (Head & Jambs)		PE
1 Astragal	S771C x Door Height		PE

**Set: 23.0**

Description: Courtyard to Corridor

1 Continuous Hinge	CFM SLF-HD1		PE
1 Exit Device	CD XP98L x 03	US32D	VD
2 Cylinder	As required	626	RU
1 Concealed Overhead Stop	6-036	630	RF
1 Surface Closer	4011 REG	AL	LC
1 Threshold	1715AK MSES25SS		PE
1 Weatherstrip	By Door Manufacturer		00
1 Sweep	18100CNB TKSP8		PE
1 Position Switch	DPS-M-BK		SU

Notes: Keyed cylinder locks and unlocks trim. Keyed cylinder controls dogging of latch bolt.  
Free egress always permitted.  
Header stop shall cover and weather cut out for overhead stop.

**Set: 30.0**

Description: Classroom

3 Hinge	TA2714 NRP	US26D	MK
1 Classroom Lock	ML2055 LWA LC	626	RU
1 Cylinder	As required	626	RU
1 Surface Closer	4111 HEDA	AL	LC
1 Kickplate	K1050 10" high 4BE	US32D	RO
1 Door Stop	400	US26D	RO
1 Smoke Seal	S88D (Head & Jambs)		PE

**Set: EX31**

1 Continuous Hinge	CFS CP-HD1 Torx		PE
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Notes: - Remove existing pivot sets  
- Install new full surface continuous hinges  
- Re-use existing doors, frames, and balance of existing door hardware.

**\*\*END OF SECTION\*\***

GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
  - 1. Windows.
  - 2. Doors.
  - 3. Glazed curtain walls.
  - 4. Storefront framing.
  - 5. Glazed entrances.
  - 6. Interior borrowed lites.
- B. Safety Glass Where Required: Meet or exceed applicable current requirements of ANSI Z97.1 "Safety Glazing" and CPSC 16 CFR, Category II.

1.3 DEFINITIONS

- A. Manufacturers of Glass Products: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations according to ASTM C 1036.
- C. Interspace: Space between lites of an insulating-glass unit that contains dehydrated air or a specified gas.
- D. Deterioration of Coated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.
- E. Deterioration of Insulating Glass: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
- F. Deterioration of Laminated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.



1.4 PERFORMANCE REQUIREMENTS

- A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Glass Design: Glass thickness designations indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:
  - 1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:
    - a. Specified Design Wind Loads: Not less than wind loads applicable to Project as required by ASCE 7 "Minimum Design Loads for Buildings and Other Structures": Section 6.0 "Wind Loads."
    - b. Specified Design Snow Loads: Not less than snow loads applicable to Project as required by ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 7.0, "Snow Loads."
    - c. Maximum Lateral Deflection: For the following types of glass supported on all 4 edges, provide thickness required that limits center deflection at design wind pressure to 1/50 times the short side length or 1 inch (25 mm), whichever is less.
      - 1) For monolithic-glass lites heat treated to resist wind loads.
      - 2) For insulating glass.
      - 3) For laminated-glass lites.
- C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
  - 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- D. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data, as determined according to procedures indicated below:
  - 1. For monolithic-glass lites, properties are based on units with lites 1/4 inch thick.
  - 2. For laminated-glass lites, properties are based on products of construction indicated.
  - 3. For insulating-glass units, properties are based on units with lites 1/4 inch thick and a nominal 1/2-inch- (12.7-mm-) wide interspace.
  - 4. Center-of-Glass Values: Based on using LBL-44789 WINDOW 5.0 computer program for the following methodologies:
    - a. U-Factors: NFRC 100 expressed as Btu/ sq. ft. x h x deg F (W/sq. m x K).

- b. Solar Heat Gain Coefficient: NFRC 200.
- c. Solar Optical Properties: NFRC 300.

1.5 SUBMITTALS

- A. Product Data: For each glass product and glazing material indicated.
  - 1. Samples:
    - 2. Each type and thickness of glass: three (3) samples, 12 inches square.
    - 3. Gaskets and Tapes: Three (3) samples, 6 inches long; each type and shape; molded corners for each type of gasket.
- B. LEED Submittals:
  - 1. Product Data for Credit EQ 4.1: For glazing sealants used inside of the weatherproofing system, including printed statement of VOC content.
- C. Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.
- D. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.
- E. Qualification Data: For installers.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance; and who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
- B. Source Limitations for Glass: Obtain glass through one source from a single manufacturer for each glass type.
- C. Source Limitations for Glazing Accessories: Obtain glazing accessories through one source from a single manufacturer for each product and installation method indicated.
- D. Glazing for Fire-Rated Door Assemblies: Glazing for assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252.
- E. Glazing for Fire-Rated Window Assemblies: Glazing for assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 257.
- F. Safety Glazing Products including wired glass: Comply with testing requirements in CPSC 16 CFR 1201, Category II and ANSI Z97.1.
  - 1. Subject to compliance with requirements, obtain safety glazing products permanently marked with certification label of the Safety Glazing Certification Council or another certification agency or manufacturer acceptable to authorities having jurisdiction.
  - 2. Where glazing units, including Kind FT glass and laminated glass, are specified in Part 2 articles for glazing lites more than 9 sq. ft. (0.84 sq. m) in exposed surface area of one

side, provide glazing products that comply with Category II materials, for lites 9 sq. ft. (0.84 sq. m) or less in exposed surface area of one side, provide glazing products that comply with Category I or II materials, except for hazardous locations where Category II materials are required by 16 CFR 1201 and regulations of authorities having jurisdiction.

- G. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
1. GANA Publications: GANA Laminated Division's "Laminated Glass Design Guide" and GANA's "Glazing Manual."
  2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR-A7, "Sloped Glazing Guidelines."
  3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Sloped Glazing Guidelines."
  4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "Glazing Guidelines for Sealed Insulating Glass Units."
- H. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the following testing and inspecting agency:
1. Insulating Glass Certification Council.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. For insulating-glass units that will be exposed to substantial altitude changes, comply with insulating-glass manufacturer's written recommendations for venting and sealing to avoid hermetic seal ruptures.

#### 1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Primary Glass Manufacturers:
    - a. AFG Industries, Inc.
    - b. Guardian Industries, Inc.
    - c. Pilkington Building Products North America
    - d. PPG Industries, Inc.
    - e. Viracon
    - f. Visteon Corp.

2.2 GLASS PRODUCTS

- A. Annealed Float Glass: ASTM C 1036, Type I (transparent flat glass), Quality-Q3; of class indicated.
- B. Heat-Treated Float Glass: ASTM C 1048; Type I (transparent flat glass); Quality-Q3; of class, kind, and condition indicated.
  - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed, unless otherwise indicated.
  - 2. Heat Strengthened: Provide Kind HS (heat-strengthened) float glass in place of annealed float glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.
  - 3. Tempered: Provide Kind FT (fully tempered) float glass in place of annealed or Kind HS (heat-strengthened) float glass where safety glass is indicated.
- C. Tinted Glass:
  - 1. Product: Subject to compliance with requirements, provide Solarban 60 SOLARGRAY as manufactured by PPG Industries, Inc. or equal by one of the above listed primary glass manufacturers
  - 2. Color: Gray
  - 3. Comply with the following properties for one-inch insulating glass with Low-E Coating:
    - a. Visible Light Transmittance: 35%
    - b. Summer U-Value: 0.27
    - c. Winter U-Value: 0.29
    - d. Solar Heat Gain Coefficient: 0.25
    - e. Shading Coefficient: 0.29
- D. Laminated Glass: ASTM C 1172, and complying with other requirements specified and with the following:
  - 1. Interlayer: Polyvinyl butyral of 0.060 inch thickness unless indicated otherwise with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass lites and installation.
    - a. For polyvinyl butyral interlayers, laminate lites in autoclave with heat plus pressure.
  - 2. Laminating Process: Fabricate laminated glass to produce glass free of foreign substances and air or glass pockets.
- E. Wired Glass: ASTM C 1036, Type II (patterned and wired flat glass), Class 1 (clear), Quality-Q-6; and of form and mesh pattern specified.
  - 1. UL label required on all lites.
  - 2. Comply with testing requirements in CPSC 16 CFR 1201, Category II.
- F. Insulating-Glass Units, General: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, and complying with ASTM E 774 for Class CBA units and with requirements specified in this Article.

1. Provide Kind HS (heat-strengthened) float glass in place of annealed glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.
  2. Provide Kind FT (fully tempered) glass lites where safety glass is indicated.
  3. Overall Unit Thickness and Thickness of Each Lite: Dimensions indicated for insulating-glass units are nominal and the overall thicknesses of units are measured perpendicularly from outer surfaces of glass lites at unit's edge.
  4. Sealing System: Dual seal, with primary and secondary sealants as follows:
    - a. Polyisobutylene and polysulfide or silicone.
      - 1) Silicone seal is required for all four sided or two sided structural glazing.
  5. Spacer Specifications: Manufacturer's standard spacer material and construction complying with the following requirements:
    - a. Spacer Material:
      - 1) Aluminum with mill or clear anodic finish for non-structurally glazed applications
      - 2) Aluminum with black, color anodic finish for structurally glazed applications.
    - b. Desiccant: Molecular sieve, silica gel, or blend of both.
    - c. Corner Construction: Manufacturer's standard corner construction.
- G. Low Emissivity-Coated Insulating Glass Units (Low-E): Manufacturer's standard unit with one pane coated with pyrolytic or sputtered, neutral colored, Low-E coating, on third surface of tinted insulating unit or second surface of clear insulating unit. See glass schedule for types and thicknesses.
1. Pyrolytic-Coated Float Glass: ASTM C 1376, float glass with metallic-oxide coating applied by pyrolytic deposition process during initial manufacture, and complying with other requirements specified.
  2. Sputter-Coated Float Glass: ASTM C 1376, float glass with metallic-oxide or -nitride coating deposited by vacuum deposition process after manufacture and heat treatment (if any), and complying with other requirements specified.
- H. Spandrel Glass:
1. All glass will be fully tempered.
  2. Fallout Resistance: Provide spandrel units identical to those passing the fallout-resistance test for spandrel glass specified in ASTM C 1048.
  3. Opacifier material will be either a ceramic frit or silicone opacicoat.
    - a. Ceramic-Coated Spandrel Glass: ASTM C 1048, Condition B (spandrel glass, one surface ceramic coated), Type I (transparent flat glass), Quality-Q3, and complying with other requirements specified.
    - b. Coated Spandrel Float Glass: Float glass complying with other requirements specified and with the following:

- 1) Factory apply manufacturer's standard opacifier of the following material to coated second surface of lites, with resulting products complying with Specification No. 89-1-6 in GANA Tempering Division's "Engineering Standards Manual."
  - a) Silicone opacifier material.
- I. One-way Vision Glass: Observation glass shall conform to pyrolytic-coated float glass, ASTM C 1376, with metallic-oxide coating applied by pyrolytic deposition process during initial manufacture. Comply with the following:
  1. Ideal lighting ratio: 7:1
  2. Color by Reflection: Silver
  3. Surface Reflection: 38%
  4. Type: 1/4" Laminated
  5. Subject to compliance with requirements provide the following product or approved equal:
    - a. Laminated Mirrorpane as manufactured by Pilkington.

## 2.3 FIRE-RATED GLAZING PRODUCTS

- A. Film-Faced Ceramic Glazing Material: Proprietary Category II safety glazing product in the form of a 3/16-inch- (5-mm-) thick, ceramic glazing material polished on both surfaces, faced on one surface with a clear glazing film, and as follows:
  1. Fire-Protection Rating: As indicated for the assembly in which glazing material is installed, and permanently labeled by a testing and inspecting agency acceptable to authorities having jurisdiction.
  2. Product: "FireLite NT" by Nippon Electric Glass Co., Ltd., and distributed by Technical Glass Products.or SuperlitCSP
- B. Specially Tempered Monolithic Glass: Proprietary Category II safety glazing product in the form of a specially tempered 1/4-inch- (6.4-mm-) thick monolithic lite, and as follows:
  1. Fire-Protection Rating: As indicated for the assembly in which glazing material is installed, and permanently labeled by a testing and inspecting agency acceptable to authorities having jurisdiction.
  2. Product: Subject to compliance with requirements, "SuperLite 1" by SAFTI; a Division of O'Keeffe's Inc.
- C. Gel-Filled, Dual-Glazed Units: Proprietary Category II safety glazing product in the form of two lites of Condition A (uncoated surfaces), Type I (transparent flat glass), Class 1 (clear), Kind FT (fully tempered) float glass; with a perimeter metal spacer separating lites and dual-edge seal enclosing a cavity completely filled with clear, fully transparent, heat-absorbing gel.
  1. Fire-Protection Rating: As indicated for the assembly in which glazing material is installed, and permanently labeled by a testing and inspecting agency acceptable to authorities having jurisdiction.

2. Product: Subject to compliance with requirements, "SuperLite II XL" by SAFTI; a Division of O'Keeffe's Inc.

## 2.4 LAMINATED AND INSULATED METAL PANELS

- A. 1/4" Laminated Metal Glazing Panels: Panels shall consist of a laminated sandwich of exterior grade plywood core substrate and stucco embossed aluminum skins 0.028" thick minimum. The entire sandwich shall be bonded under heat and pressure with permanently elastic neoprene contact adhesive.
  1. Panel Thickness: 1/4 inch unless indicated otherwise.
  2. Color: PVDF/Kynar 500 – Medium Bronze.
  3. Interior Finish: same as face sheet.
  4. Manufacturer: Subject to compliance with requirements, provide Laminators Inc. "Omega-Ply" System or approved equal.
- B. 1" Insulated Metal Glazing Panels: Panels shall consist of a laminated sandwich of polyisocyanurate insulation core, 0.060 Polyallomer substrate and smooth aluminum skins 0.021" thick minimum. The entire sandwich shall be bonded under heat and pressure with permanently elastic neoprene contact adhesive.
  1. Panel Thickness: 1 inch unless indicated otherwise.
  2. Color: PVDF/Kynar 500 MICA – to match Laminators Incorporated Bright Silver.
  3. Interior Finish: same as face sheet.
  4. Manufacturer: Subject to compliance with requirements, provide Laminators Inc. "Thermo Lite" System or approved equal.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum units.
  1. Brackets not exposed to weather or abrasion may be hot-dip galvanized steel complying with ASTM A 386.
  2. Provide non-staining, nonferrous shims for installation and alignment of curtain wall work.
- D. Fasteners and Accessories: Provide manufacturer's standard non-corrosive fasteners and accessories compatible with materials used in the framing system and with exposed portions.

## 2.5 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based elastomeric tape with a solids content of 100 percent; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; packaged on rolls with a release paper backing; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
  1. AAMA 804.3 Glazing Tape: Tremco #440; Shore A hardness of 10 at installation and not exceeding 20 upon aging.

2.6 GLAZING GASKETS

- A. Dense Compression Gaskets: Molded or extruded gaskets of material indicated below, complying with standards referenced with name of elastomer indicated below, black, and of profile and hardness required to maintain watertight seal:
  - 1. Silicone, ASTM C 1115.
- B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned gaskets of material indicated below; complying with ASTM C 509, Type II, black; and of profile and hardness required to maintain watertight seal:
  - 1. Silicone.

2.7 GLAZING SEALANTS

- A. Sealant for Glazing: Meet requirements for materials and workmanship specified under Division 7 Section "Joint Sealants."
  - 1. Compatibility: Select glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
  - 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
  - 3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
- B. Glazing Sealants for Fire-Resistive Glazing Products: Identical to products used in test assemblies to obtain fire-protection rating.

2.8 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Neoprene or EPDM 70 to 90 Shore A Hardness as recommended by manufacturer; certified non-staining and compatible with sealant. Use EPDM for units set with silicone glazing sealant.
- D. Spacers: Elastomeric blocks or continuous extrusions with a Shore, Type A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- F. Perimeter Insulation for Fire-Resistive Glazing: Identical to product used in test assembly to obtain fire-resistance rating.



2.9 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
- B. Grind smooth and polish exposed glass edges and corners.
- C. Glazing Contractor, Glass Fabricator and Glass Manufacturer shall determine which areas require heat strengthening. The glazing contractor shall include in his bid and shall install heat strengthened glass where it is required by manufacturer and/or fabricator.

2.10 GLASS SCHEDULE

A. Schedule of Glass Types:

- GL-1 Annealed Monolithic Glass:  
Tint: Clear  
Thickness: 1/4"
- GL-2 Tempered Monolithic Glass:  
Tint: Clear  
Thickness: 1/4"
- GL-3 Laminated Glass consisting of:  
1/8" heat strengthened glass; clear  
PVB interlayer; clear  
1/8" heat strengthened glass; clear.
- GL-4 Translucent Laminated Glass consisting of:  
1/8" float glass; clear  
Interlayer: 0.030 PVB; white hue  
1/8" float glass; clear.
- GL-5 Wire Glass:  
1/4" polished wired glass with 1 (M1) (Diamond) pattern.  
1/4" polished wired glass with 2 (M2) (Square) pattern.
- GL-6a 20-minute fire rated glass  
For use in 20 minute rated doors only. Basis of design is Superlite I as manufactured by SAFTI First, a division of O'Keeffe's Inc., (888) 653-3333/(415) 822-5222 fax. Or approved equals.
- GL-6b 45-minute fire rated glass  
For use in 45 minute door and window applications. Basis of design is Superlite II-XL-45 as manufactured by SAFTI First, a division of O'Keeffe's Inc. (888) 653-3333/(415) 822-5222 fax. Or approved equals.
- GL-6c 60 & 90 minute fire rated door glazing  
For use in 60 & 90 minute door applications. Must comply with CPSC Category II. Nominal 1/4" thick polished ceramic glazing with impact film applied to one side. Basis of design is Superlite CSP as manufactured by SAFTI First, a division of O'Keeffe's Inc. (888)653-3333/(415)822-5222 fax. Or approved equal.

- GL-6d    60, 90 or 120 minute fire rated glass  
For use in 60& 90 wall/window applications or 120 minute wall/window applications. Must comply with ASTM E-119 requirements as a barrier to radiant heat. Basis of design is Superlite II-XL as manufactured by SAFTI First, a division of O'Keeffe's Inc. (888) 653-3333/(415) 822-5222 fax. For use in GPX radiant heat barrier frames only. Or approved equals.
- GL-10    Annealed Insulating Glass consisting of:  
Exterior Lite: 1/4"  
Tint: Gray  
Airspace: 1/2"  
Interior Lite: 1/4"  
Tint: Clear  
Low-E Coating: #2 Surface.
- GL-11    Tempered Insulating Glass consisting of:  
Exterior Lite: 1/4"  
Tint: Gray  
Airspace: 1/2"  
Interior Lite: 1/4"  
Tint: Clear  
Low-E Coating: #2 Surface.
- GL-12    Tempered Insulating Translucent Glass consisting of:  
Exterior Lite: 1/4"  
Tint: Gray  
Airspace: 1/2"  
Interior Lite: 1/4"  
Tint: Clear  
Low-E Coating: #2 Surface.  
Acid Etch - Velour: #3 Surface.
- GL-13    Laminated Metal Panel  
Thickness: 1/4"  
Color: Medium Bronze
- GL-14    Insulated Metal Panel  
Thickness: 1"  
Color: MICA – Bright Silver.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine framing glazing, with Installer present, for compliance with the following:
1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
  2. Presence and functioning of weep system.
  3. Minimum required face or edge clearances.
  4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

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

3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
  - 1. Install glass in accordance with recommendations outlined in "Glazing Manual" and "Glazing Sealing Systems Manual" prepared by Flat Glass Marketing Association.
- B. Interior glazing shall be dryset with black glazing tape.
- C. Exterior glazing at entrance doors, sidelights, transoms, window wall frames, and similar members shall be installed with dryset gasket glazing.
- D. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.
- E. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
- F. Apply primers to joint surfaces where required for adhesion of sealants.
- G. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- H. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- I. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm) as follows:
  - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
  - 2. Provide 1/8-inch (3-mm) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- J. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- K. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until just before each glazing unit is installed.
- F. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

### 3.5 GASKET GLAZING

- A. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Install gaskets so they protrude past face of glazing stops.

### 3.6 CLEANING AND PROTECTION

- A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended by glass manufacturer.
- C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.
- D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.
- E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

**\*\*END OF SECTION\*\***

LOUVERS AND VENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK:

- A. Extent of louvers and vents is indicated on drawings, including indications of sizes and locations.
- B. Types of louvers and vents include the following:
  - 1. Extruded aluminum louvers
- C. Related Sections: The following Sections contain requirements that relate to this Section:
  - 1. Division 7 Section "Joint Sealants" for sealants.
  - 2. Division 15 for air-handling louvers connected to ductwork.

1.3 QUALITY ASSURANCE:

- A. Comply with SMACNA "Architectural Sheet Metal Manual" recommendations for fabrication, construction details and installation procedures, except as otherwise indicated.
- B. Field measurements: Verify size, location and placement of louver units prior to fabrication, wherever possible.
- C. Shop Assembly: Coordinate field measurements and shop drawings with fabrication and shop assembly to minimize field adjustments, splicing, mechanical joints and field assembly of units. Pre-assemble units in shop to greatest extent possible and disassemble as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

1.4 SUBMITTALS:

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
  - 1. Substitutions for products as specified MUST be submitted in accordance with Division 1 Substitute products not submitted in accordance with Division 1 Section "Product Requirements" will NOT be considered.
- B. Product Data: Submit manufacturer's specifications; certified test data, where applicable; and installation instructions for required products, including finishes.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Manufacturer: Subject to compliance with requirements, provide products equal to Ruskin Manufacturing Co. No. ELF 375DX drainable blade louver.

1. The Airolite Co.
2. American Warming and Ventilating Co.
3. Construction Specialties, Inc.

2.2 MATERIALS:

- A. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer to provide required finish.
- B. Aluminum Extrusions: ASTM B 221, Alloy 6063-T52.
- C. Fastenings: Use same material as items fastened, unless otherwise indicated. Fasteners for exterior applications may be hot-dip galvanized, stainless steel or aluminum. Provide types, gages and lengths to suit unit installation conditions. Use Phillips flat-head machine screws for exposed fasteners, unless otherwise indicated.
- D. Anchors and Inserts: Use non-ferrous metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use steel or lead expansion bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.
- E. Bituminous Paint: SSPC-Paint 12 (cold-applied asphalt mastic).

2.3 FABRICATION, GENERAL:

- A. Provide louvers and accessories of design, materials, sizes, depth, arrangement, and metal thicknesses indicated, or if not indicated, as required for optimum performance with respect to airflow; water penetration; air leakage, where applicable (for adjustable units, if any); strength; durability; and uniform appearance.
- B. Fabricate frames including integral sills to suit adjacent construction with tolerances for installation, including application of sealants in joints between louvers and adjoining work.
- C. Include supports, anchorages, and accessories required for complete assembly.
- D. Join frame members to one another and to stationary louver blades by welding, except where indicated otherwise or where field bolted connections between frame members are made necessary by size of louvers. Maintain equal blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

2.4 STATIONARY EXTRUDED ALUMINUM WALL LOUVERS:

- A. Horizontal Blade Louvers: Size and depth indicated, with blades of profile, slope and spacing indicated, or if not indicated, to meet performance requirements.
  1. Extrusion Thickness: Not less than 0.080" for blades and frames.
  2. Continuous Horizontal Blades: Conceal supporting framework from vision on outside face of louver by placing braces, mullions and brackets on inside face; with close fitting, field-made splice joints in blades designed to permit expansion and contraction without deforming blades or framework.
    - a. Exterior Corners: Shop miter and weld blades into prefabricated corner units to align with straight sections. Include concealed bracing.
    - b. Aluminum: Not less than 14 gage.

2.5 LOUVER SCREENS

- A. General: Provide louvers with screens at locations indicated.
  - 1. Screen Location for Fixed Louvers: Interior face, unless otherwise indicated.
  - 2. Screening Type: Bird screening, unless otherwise indicated.
- B. Secure screens to louver frames with stainless steel machine screws, spaced at each corner and at 12 inch o.c. between.
- C. Louver Screen Frames: Fabricate screen frames with mitered corners to louver sizes indicated and to comply with the following requirements:
  - 1. Metal: Same kind and form of metal as indicated for louver frames to which screens are attached.
    - a. Reinforce extruded aluminum screen frames at corners with clips.
    - b. Finish: Same finish as louver frames to which louver screens are attached.
    - c. Type: Non-rewireable U-shaped frames for permanently securing screen mesh.
- D. Louver Screening for Aluminum Louvers: Fit aluminum louver screen frames with screening covering louver openings and complying with the following requirements:
  - 1. Bird Screening: 1/2 inch square mesh formed with 0.063 inch diameter aluminum wire.

2.6 BLANK-OFF PANELS

- A. General: Fabricate blank-off panels from materials and to sizes indicated and to comply with the following requirements:
  - 1. Finish: Match finish applied to louver with respect to coating type, except for color which shall be as follows:
    - a. Black.
  - 2. Attach blank-off panels to back of louver frames with stainless steel sheet metal screws.
- B. Insulated Blank-Off Panels: Laminated metal-faced panels consisting of insulating core surfaced on back and front with metal sheets; complying with the following requirements:
  - 1. Thickness: 1 inch.
  - 2. Metal Facing Sheets: Aluminum sheet, 0.032 inch thick.
  - 3. Insulating Core: Extruded polystyrene insulation board insulation complying with ASTM C 578, Type VII (2.2 lb/cu. ft. density).
  - 4. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard extruded aluminum channel frames 0.081 inch thick, with corners mitered and with same finish as panels.
  - 5. Seal perimeter joints between panel faces and louver frames with polyvinyl chloride compression gaskets, 1/8 inch by 1 inch.

2.7 METAL FINISHES:

- A. GENERAL: Comply with NAAMM "Metal Finishes Manual" for finish designations and application recommendations, except as otherwise indicated. Apply finishes in factory after products are assembled. Protect finishes on exposed surfaces with protective covering, prior to shipment. Remove scratches and blemishes from exposed surfaces which will be visible after completing finishing process.
  - 1. Provide custom color as selected by Architect.
- B. Aluminum Finishes:
  - 1. High-Performance Coating: AA-M12-C42-R1X (cleaned with inhibitive chemicals, conversion coated with an acid-chromate-fluoride phosphate treatment and painted with organic coating specified below). Apply where high-performance coating is indicated in strict compliance with coating and resin manufacturer's instructions using a licensed applicator.
    - a. Fluorocarbon Coating: Inhibitive thermo-cured primer, 0.2 mil minimum dry film thickness, and thermo-cured fluorocarbon coating containing "Kynar 500" resin, 1.0 mil minimum dry film thickness.

PART 3 - EXECUTION

3.1 PREPARATION:

- A. Coordinate setting drawings, diagrams, templates, instructions and directions for installation of anchorages which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

3.2 INSTALLATION:

- A. Locate and place louver units plumb, level and in proper alignment with adjacent work.
- B. Use concealed anchorages wherever possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Repair finishes damaged by cutting, welding, soldering and grinding operations required for fitting and jointing. Restore finishes so there is no evidence of corrective work. Return items which cannot be refinished in field to shop, make required alterations, and refinish entire unit, or provide new units, at Contractor's option.
- D. Protect galvanized and non-ferrous metal surfaces from corrosion or galvanic action by application of a heavy coating of bituminous paint on surfaces which will be in contact with concrete, masonry or dissimilar metals.
- E. Refer to Division-7 sections for sealants in connection with installations of louvers.

**\*\*END OF SECTION\*\***



## GYPSUM WALLBOARD ASSEMBLIES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Interior gypsum wallboard.
  - 2. Tile backing panels.
  - 3. Non-load-bearing steel framing.
- B. Related Sections include the following:
  - 1. Division 05 Section "Cold-Formed Metal Framing" for load-bearing steel framing.
  - 2. Division 06 Section "Rough Carpentry" for wood framing and furring, exterior gypsum sheathing, and air infiltration barriers.
  - 3. Division 07 Section "Building Insulation" for insulation and vapor retarders installed in gypsum board assemblies.
  - 4. Division 07 Section "Interior/Exterior Finish System" for interior/exterior finish system.
  - 5. Division 09 Section "Painting" for painting.

#### 1.3 DEFINITIONS

- A. Gypsum Board Terminology: Refer to ASTM C 11 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

#### 1.4 SYSTEM DESCRIPTION

- A. In order to be acceptable, the appearance of all exposed wallboard surfaces in finished locations, after painting, shall be equivalent, in the judgment of the Architect, to the appearance of painted putty coat plaster surfaces and as follows:
  - 1. The finish shall be equal to a Level 4 Finish as described in the current edition of the "Gypsum Construction Handbook" of the United States Gypsum Company.
- B. Structural performance of fire rated shaft-wall assemblies:
  - 1. Provide gypsum board shaft-wall assemblies capable of withstanding the full air-pressure loads indicated for maximum heights of partitions without failing and while maintaining an airtight and smoke-tight seal. Evidence of failure includes deflections exceeding limits indicated, bending stresses causing studs to break or to distort, and end-reaction shear causing track (runners) to bend or to shear and studs to become crippled.

2. Provide gypsum board shaft-wall assemblies for horizontal duct enclosures capable of spanning distances indicated within deflection limits indicated.

#### 1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Coordination Drawings: Lay-out drawings indicating proposed location of all control joints in metal-framed gypsum board partitions, walls, ceilings, bulkheads, fasciae and soffits. Coordination drawings for this purpose may be annotated copies of Construction Documents architectural floor plans, reflected ceiling plans and interior elevations. Submit prior to commencement of framing installation.

#### 1.6 QUALITY ASSURANCE

- A. Comply with the provisions and recommendations of the United States Gypsum Company - "Gypsum Construction Handbook" (current edition) except where otherwise specified.
- B. Single-Source Responsibility: Obtain each type of gypsum board and related joint treatment materials from a single manufacturer.
- C. Fire-Test-Response Characteristics: For gypsum board assemblies with fire-resistance ratings and fire rated shaft-wall assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
  1. Fire-Resistance-Rated Assemblies: Indicated by design designations from UL's "Fire Resistance Directory," GA-600, "Fire Resistance Design Manual," or of other testing agency acceptable to authorities having jurisdiction.
- D. Sound Transmission Characteristics: For gypsum board assemblies and fire rated shaft-wall assemblies with STC ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by a qualified independent testing agency.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.
- B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Stack gypsum panels flat to prevent sagging.
- C. Handle gypsum boards to prevent damage to edges, ends and surfaces. Do not bend or otherwise damage metal corner beads and trim.

#### 1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Minimum Room Temperatures: For non-adhesive attachment of gypsum board to framing, maintain not less than 40°F (4°C). For adhesive attachment and finishing of gypsum board maintain not less than 50°F (10°C) for 48 hours prior to application and continuously thereafter until drying is complete.

- C. Ventilate building spaces to remove water not required for drying joint treatment materials. Avoid drafts during dry, hot weather to prevent materials from drying too rapidly.

1.9 SCAFFOLDING

- A. Provide necessary scaffolding and staging required for proper execution of wallboard work.
- B. Allow access and use of scaffolding by other trades whose work must be coordinated with wallboard work at no additional cost or back-charge and during regular working hours.

1.10 COORDINATION

- A. Make detailed inspection of all areas and surfaces to be covered.
- B. Verify dimensions, details, partition schedule and relationship to other work.
- C. Observe benchmarks and thickness of materials. Where diffusers or other accessories are mis-located notify installing trade with copy to the Architect.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 STEEL PARTITION AND SOFFIT FRAMING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Steel Framing and Furring:
    - a. ClarkDietrich Building Systems.
    - b. Marino\Ware.
    - c. Steel Stud Solutions, LLC.
    - d. MBA Metal Framing.
- B. Components, General: As follows:
  - 1. Comply with ASTM C 754 for conditions indicated.
  - 2. Steel Sheet Components: Complying with ASTM C 645 requirements for metal and with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
- C. Steel Studs and Runners: ASTM C 645.
  - 1. Minimum Base Metal Thickness: 0.0454 inch (1.15 mm).
  - 2. Depth: As indicated.

- D. Deep-Leg Deflection Track: ASTM C 645 top runner with 2-inch- (50.8-mm-) deep flanges.
- E. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
  - 1. Minimum Base Metal Thickness: 0.0312 inch (0.79 mm).
- F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
  - 1. Minimum Base Metal Thickness: 0.0312 inch (0.79 mm).
  - 2. Depth: As indicated.
- G. Resilient Furring Channels: 1/2-inch- (12.7-mm-) deep, steel sheet members designed to reduce sound transmission.
  - 1. Configuration: Asymmetrical, with face attached to single flange by a slotted leg (web).
    - a. Product: U.S. Gypsum No. RC-1 or equal.
- H. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (31.8 mm), wall attachment flange of 7/8 inch (22.2 mm), minimum bare metal thickness of 0.0179 inch (0.45 mm), and depth required to fit insulation thickness indicated.
- I. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

## 2.3 STEEL SUSPENDED CEILING AND SOFFIT FRAMING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Steel Framing and Furring:
    - a. Clark Steel Framing Systems.
    - b. Dale Industries, Inc. - Dale/Incor.
    - c. Dietrich Industries, Inc.
    - d. National Gypsum Company.
    - e. Unimast, Inc.
    - f. Western Metal Lath & Steel Framing Systems.
- B. Components, General: Comply with ASTM C 754 for conditions indicated.
- C. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- (1.59-mm-) diameter wire, or double strand of 0.0475-inch- (1.21-mm-) diameter wire.
- D. Hanger Attachments to Concrete: As follows:
  - 1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching hanger wires and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by a qualified independent testing agency.
    - a. Type: Cast-in-place anchor, designed for attachment to concrete forms, postinstalled, chemical anchor, or postinstalled, expansion anchor.

2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by a qualified independent testing agency.
- E. Hangers: As follows:
1. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch (4.12-mm) diameter.
- F. Carrying Channels: Cold-rolled, commercial-steel sheet with a base metal thickness of 0.0538 inch (1.37 mm), a minimum 1/2-inch- (12.7-mm-) wide flange, with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
1. Depth: Minimum 2 inches (50.8 mm) unless otherwise indicated.
- G. Furring Channels (Furring Members): Commercial-steel sheet with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
1. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch (22.2 mm) deep.
    - a. Minimum Base Metal Thickness: 0.0312 inch (0.79 mm).
  2. Resilient Furring Channels: 1/2-inch- (12.7-mm-) deep members designed to reduce sound transmission.
    - a. Configuration: Asymmetrical or hat shaped, with face attached to single flange by a slotted leg (web) or attached to two flanges by slotted or expanded metal legs.

## 2.4 WALLBOARD

- A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system indicated.
- B. Gypsum Wallboard: Gypsum core wall panel surfaced with a natural-finish face paper on front and a liner paper on back. Comply with ASTM C36 and the following:
1. Type X:
    - a. Thickness: 5/8 inch (15.9 mm).
    - b. Long Edges: Tapered.
    - c. Location: As indicated and where required for fire-resistance-rated assembly.
  2. Products: Subject to compliance with requirements, provide one of the following:
    - a. CertainTeed., ProRoc products.
    - b. Georgia-Pacific Corp., ToughRock Gypsum Board products.
    - c. National Gypsum Company, Gold Bond Brand products.
    - d. United States Gypsum Co., Sheetrock Brand Gypsum products.

## 2.5 TILE BACKING PANELS

- A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system indicated.

- B. Cementitious Backer Units (Cement Board): ANSI A118.9.
  - 1. Thickness: As indicated.
  - 2. Products: Subject to compliance with requirements, provide one of the following:
    - a. National Gypsum Co., PermaBase Cement Board.
    - b. United States Gypsum Co., Durock Cement Board

2.6 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
  - 1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
  - 2. Shapes:
    - a. Cornerbead: Use at outside corners.
      - 1) Product: U.S. Gypsum No. 103 Dur-A-Bead or equal.
    - b. LC-Bead (Casing Bead): J-shaped; exposed long flange receives joint compound; use at exposed panel edges and where indicated.
      - 1) Product: U.S. Gypsum No. 200-A Metal Trim or equal.
    - c. L-Bead (Casing Bead): L-shaped; exposed long leg receives joint compound; use where indicated.
      - 1) Product: U.S. Gypsum No. 200-B Metal Trim or equal.
    - d. Control Joint: Use at control joint locations in walls, ceilings, bulkheads, fasciae and soffits:
    - e.
      - 1) Product: U.S. Gypsum No. 093 Control Joint, or equal.
      - 2) Back to back casing beads may be used in lieu of prefabricated control joint trim. Provide backer and sealant to finish opening between beads as with materials appropriate to conditions of installation.
    - f. Curved-Edge Cornerbead: With notched or flexible flanges for use at curved openings.
      - 1) Product: U.S. Gypsum Sheetrock Flexible Metal Corner Tape or equal.

2.7 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475.
- B. Joint Tape:
  - 1. Interior Gypsum Wallboard: Paper.
  - 2. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound or drying-type, all-purpose compound.
3. Fill Coat: For second coat, use setting-type, sandable topping compound or drying-type, all-purpose compound.
4. Finish Coat: For third coat, use setting-type, sandable topping compound or drying-type, all-purpose compound.

D. Joint Compound for Tile Backing Panels:

1. Cementitious Backer Units: As recommended by manufacturer.

2.8 ACOUSTICAL SEALANT

- A. Acoustical Sealant for Concealed Joints: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), recommended for sealing interior concealed joints to reduce airborne sound transmission.
- B. Products: Subject to compliance with requirements, provide the following:
  1. Acoustical Sealant for Concealed Joints:
    - a. Tremco, Inc.; Tremco Acoustical Sealant.

2.9 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate and for adhering second layer of wallboard to first layer.
  1. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
  1. Use screws complying with ASTM C 954 for fastening panels to cold formed metal framing and steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
  2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Isolation Strip at Exterior Walls:
  1. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.

- E. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
  - 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
  - 2. Density: 2.5 pounds per cubic foot.
  - 3. Thickness: 3 inches unless indicated otherwise on the drawings
  - 4. Products: Subject to compliance with requirements, provide the following:
    - a. Thermafiber Sound Attenuation Fire Blankets as manufactured by United States Gypsum Co.
- F. Thermal Insulation: As specified in Division 7 Section "Building Insulation."
- G. Polyethylene Vapor Retarder: As specified in Division 7 Section "Building Insulation."

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Suspended Ceilings: Coordinate installation of ceiling suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive ceiling hangers at spacing required to support ceilings and that hangers will develop their full strength.
  - 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.
- B. Coordination with Sprayed Fire-Resistive Materials:
  - 1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed-on fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches (600 mm) o.c.
  - 2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of gypsum board assemblies and without reducing the fire-resistive material thickness below that which is required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.
- C. Control Joint Layout: Prior to commencement of framing installation submit coordination drawings indicating proposed control joint locations in metal-framed gypsum board partitions, walls, ceilings, bulkheads, fasciae and soffits, for review and acceptance of Architect.



3.3 INSTALLING STEEL FRAMING, GENERAL

- A. Installation Standards: ASTM C 754, and ASTM C 840 requirements that apply to framing installation.
- B. Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction. Comply with details indicated and with gypsum board manufacturer's written recommendations or, if none available, with United States Gypsum's "Gypsum Construction Handbook."
- C. Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement.
  - 1. Isolate ceiling assemblies where they abut or are penetrated by building structure.
  - 2. Isolate partition framing and wall furring where it abuts structure, except at floor. Install slip-type joints at head of assemblies that avoid axial loading of assembly and laterally support assembly.
    - a. Use deep-leg deflection track where indicated.
- D. Do not bridge building control and expansion joints with steel framing or furring members. Frame both sides of joints independently.
- E. General requirements and locations of control joints in metal-framed gypsum board construction:
  - 1. General: Comply with requirements of ASTM C840, and as noted below:
  - 2. Control joints shall be constructed with manufactured control joint trim, or field fabricated from materials as specified.
  - 3. Control joints will be installed where a partition, wall, or ceiling traverses and construction joint (expansion, or building control element) in the base building structure.
  - 4. Control joints will be installed where a wall or partition extends in an uninterrupted straight plane exceeding 30 linear feet. Door and/or window frames that extend full height of partitions will be considered equivalent to control joint construction.
  - 5. Control joints in interior ceilings, bulkheads, fasciae and soffits will be installed so that linear dimensions between control joints do not exceed 30 linear feet and total area between control joints does not exceed 900 square feet. Control joints will be installed to isolate wings of "L", "U: and "T" shaped ceiling and soffit areas.
  - 6. A control joint will be installed where ceiling, bulkhead, fascia and soffit framing members change direction.
  - 7. Provide appropriate backing material, fire-safing insulation, and sealant for control joints installed in acoustical or fire-rated construction, as required to maintain fire-rating and/or acoustical separation.
- F. All mechanical heating and cooling system components shall be independently supported; not supported by gypsum board framing system.
- G. Provide gypsum panel bulkheads and closures where ducts penetrate fire separations.

3.4 INSTALLING STEEL PARTITION AND SOFFIT FRAMING

- A. Install tracks (runners) at floors, ceilings, and structural walls and columns where gypsum board assemblies abut other construction.
  - 1. Where studs are installed directly against exterior walls, install foam-gasket isolation strip between studs and wall.
  - 2. Anchor tracks 24 inches o.c. with not less than two fasteners per section.
    - a. Review electrical conduit layout in slab, avoid penetration of conduits running directly below walls.
  - 3. Secure studs to top and bottom runner tracks by either welding or screw fastening at both inside and outside flanges.
  - 4. Allow for differential movement between floors and at roofs by use of nested runners unless otherwise noted.
- B. Installation Tolerance: Install each steel framing and furring member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by the faces of adjacent framing.
- C. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.
  - 1. For fire-resistance-rated and STC-rated partitions that extend to the underside of floor/roof slabs and decks or other continuous solid-structure surfaces to obtain ratings, install framing around structural and other members extending below floor/roof slabs and decks, as needed to support gypsum board closures and to make partitions continuous from floor to underside of solid structure.
  - 2. Metal studs which cannot extend full height to structure above, due to interference with ductwork and the like, shall be tied to cross stiffening, or diagonal bracing to structure above.
  - 3. Terminate partition framing at suspended ceilings where indicated.
  - 4. Interrupt metal framing (including top and bottom tracks) with a 1/2-inch gap at all control joint locations. Provide back to back studs and or framing for each control joint flange. Provide appropriate backing material, fire-safing insulation, and sealant for control joints installed in acoustical or fire-rated construction, as required to maintain fire-rating and/or acoustical separation.
- D. Install supplementary framing, blocking, backing plates and bracing in metal framing system wherever walls or partitions are indicated to support fixtures, equipment, services, casework, heavy trim and furnishings, and similar work.
- E. Install steel studs and furring at the following spacings:
  - 1. Single-Layer Construction: 16 inches (406 mm) o.c., unless otherwise indicated.
  - 2. Multilayer Construction: 16 inches (406 mm) o.c., unless otherwise indicated.
  - 3. Cementitious Backer Units: 16 inches (406 mm) o.c., unless otherwise indicated.

- F. Install horizontal stiffeners in stud system, spaced (vertical distance) not more than 4'-6" o.c. Weld at each intersection.
- G. Install steel studs so flanges point in the same direction and leading edge or end of each panel can be attached to open (unsupported) edges of stud flanges first.
- H. Acoustical Partition:
  - 1. Typical Partition: Steel channel studs with one or two layers of wallboard each side, with or without blanket insulation between the studs.
  - 2. Lay all runners in mastic or caulk between wallboard and floor.
  - 3. Caulk all top and bottom joints between the wallboard and structure.
  - 4. Tape other joints and spackle partition thoroughly airtight.
- I. Sound Insulation (where indicated): Install in accordance with manufacturer's recommendations.
- J. Frame door openings to comply with GA-600 and with gypsum board manufacturer's applicable written recommendations, unless otherwise indicated. Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
  - 1. Install two studs at each jamb, unless otherwise indicated.
  - 2. Extend jamb studs through suspended ceilings and attach to underside of floor or roof structure above.
- K. Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
- L. Z-Furring Members:
  - 1. Erect insulation vertically and hold in place with Z-furring members spaced 24 inches (610 mm) o.c.
  - 2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (600 mm) o.c.
  - 3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches (300 mm) from corner and cut insulation to fit.
- M. Polyethylene Vapor Retarder: Where indicated install to comply with requirements specified in Division 7 Section "Building Insulation."

### 3.5 INSTALLING STEEL SUSPENDED CEILING AND SOFFIT FRAMING

- A. All ceiling construction shall be fully "unrestrained". Interrupt main runners, furring, or wallboard ceilings at walls of all full sized rooms as required to accommodate building movement. Use appropriate trim pieces to accomplish the work.

1. Cut furring, reinforce, support, and fit for electric outlet boxes, recessed fixtures, grilles and similar items.
  2. Provide allowance for anticipated building movement between floors and ceilings or soffits.
- B. Suspend ceiling hangers from building structure as follows:
1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
    - a. Do not support ceilings directly from permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
    - b. Do not attach hangers to steel deck tabs.
    - c. Do not attach hangers to steel roof deck. Attach hangers to structural members.
    - d. Do not connect or suspend steel framing from ducts, pipes, or conduit.
  2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
  3. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail.
- C. Tie carrying channels to hangers with single (only) wrap of wire to avoid lifting channel.
- D. Installation Tolerances: Install steel framing components for suspended ceilings so members for panel attachment are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member and transversely between parallel members.
- E. Wire-tie furring channels to supports, as required to comply with requirements for assemblies indicated.
1. Saddle tie furring channels to carrying channels with double strand tie wires.
  2. Screw furring to wood framing.
- F. Install suspended steel framing components in sizes and spacings indicated, but not less than that required by the referenced steel framing and installation standards.
1. Hangers: 48 inches (1219 mm) o.c.
  2. Carrying Channels (Main Runners): 48 inches (1219 mm o.c.
  3. Furring Channels (Furring Members): 16 inches (406 mm) o.c.

### 3.6 APPLYING AND FINISHING PANELS, GENERAL

- A. Gypsum Board Application and Finishing Standards: ASTM C 840 and GA-216.

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- B. Install sound attenuation blankets before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.
- C. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- D. Install gypsum panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.
- E. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- F. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- G. Attach gypsum panels to framing provided at openings and cutouts.
- H. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members using resilient channels, or provide control joints to counteract wood shrinkage.
- I. Form control and expansion joints with space between edges of adjoining gypsum panels.
- J. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
  - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
  - 2. Fit gypsum panels around ducts, pipes, and conduits.
  - 3. Where partitions intersect open concrete coffers, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by coffers, joists, and other structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.
- K. Isolate perimeter of non-load-bearing gypsum board partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations, and trim edges with U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- L. Hold gypsum panels free from all surfaces subject to condensation or moisture.
- M. Floating Construction: Where feasible, including where recommended in writing by manufacturer, install gypsum panels over wood framing, with floating internal corner construction.
- N. STC-Rated Assemblies: Seal construction at perimeters, behind control and expansion joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and manufacturer's written recommendations for locating edge trim and

closing off sound-flanking paths around or through gypsum board assemblies, including sealing partitions above acoustical ceilings.

- O. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's written recommendations.
- P. Space fasteners in panels that are tile substrates a maximum of 8 inches (203.2 mm) o.c.

### 3.7 PANEL APPLICATION METHODS

#### A. General:

1. Plenum wall, ceiling drops, skirts or baffles that are beyond reach of user or occupant are to be constructed to meet L/120 deflection criteria.
2. Partitions, ceiling drops, baffles or other assemblies within user or occupant contact or with painted or vinyl finishes or that some vibration or movement is not detrimental to perceived structural integrity shall be constructed to meet L/240 deflection criteria.
3. Partitions, or assemblies where finish is a rigid veneer, such as plaster, skim coat, tile or stone work or mounted mirror or any use that would be compromised by vibration or deflection shall be constructed to meet L/360 deflection criteria.
4. Do not proceed with work until temperature and humidity of building meet requirements of manufacturer's standard specifications.
5. Fastening system shall be power driven drywall screws. Where hand driven fasteners are used, double nailing will be required.
6. Set all nails and screws to slightly dimple, but not break surface of board. Space nails 6 to 8 inches, 3/8 inch from edges, staggered at joints; double spacing for screws.
7. Repair areas scarified or otherwise damaged by cutting out damaged areas, back blocking set with adhesive, and patching with patching plaster.
8. Grout anchors for door frames. Jamb board into door frame to provide rigidity. Full grout frames at label doors, shaftwall, and elsewhere as indicated.
9. Metal studs with finish one side are to receive stiffener channels at no more than 4'-6" maximum spacing.

#### B. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated.
2. On partitions/walls, apply gypsum panels vertically (parallel to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
  - a. Stagger abutting end joints not less than one framing member in alternate courses of board.
  - b. At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.
3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.

- C. Single-Layer Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- D. Tile Backing Panels:
  - 1. Cementitious Backer Units: ANSI A108.11, at locations indicated to receive tile.
    - a. Where indicated install standard gypsum wallboard panels to produce a flat surface at tiled areas not subject to wetting.
  - 2. Examine framing; verify that framing and furring members to receive cement board has a maximum spacing of 16" o.c. and is minimum 20 gauge with a maximum deflection of L/360.
  - 3. Install cement board in accordance with manufacturer's instructions.
    - a. Install cement board with rough side out.
    - b. Use maximum lengths possible to minimize number of joints.
  - 4. Attach cement board to framing with screws spaced 8" o. c. at perimeter where there are framing supports, and 8" o. c. along intermediate framing in field.
    - a. Drive fasteners to bear tight against and flush with surface of cement board. Do not countersink. Locate fasteners minimum 3/8" from edges and ends of cement board.
  - 5. Where tile backing panels abut other types of panels in the same plane, shim surfaces to produce a uniform plane across panel surfaces.

### 3.8 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints at locations specified and per reviewed Coordination Drawings, subject to Architect's approval. Install control joint trim in accordance with manufacturer's recommendations.
- C. All aluminum in contact with joint compound shall have contact faces treated with zinc chromate primer.

### 3.9 FINISHING GYPSUM BOARD ASSEMBLIES

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
  - 1. Apply perforated tape and compound at all joints, at inside corner and as required to conceal all fasteners and finish off all trim. Protect outside corners with corner beads.
  - 2. Finished appearance shall be perfectly smooth so that, after painting, there shall be no evidence of taping or patching. Areas where the location of joints or fasteners may be determined by visual inspection due to bulges, irregularities in surface of variations in texture, will be considered defective.

3. If dry-out or over-sanding of finish coat of compound leaves surface requiring special treatment or sealing, provide such sealer or treatment and leave entire surface acceptable to the finishing trades as specified under Division 9 Section "Painting."
  4. Repair all nail pops, wrinkles, buckles and other defects occurring during the Guarantee period and make good all damage to other work resulting from such repairs.
- B. Prefill open joints and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below, according to ASTM C 840, for locations indicated:
1. Level 4: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges.
- E. Cementitious Backer Units: Finish according to manufacturer's written instructions.
- 3.10 ACOUSTICAL BULKHEADS IN PLENUM SPACE
- A. Provide acoustical separation by bulkhead in ceiling plenum space where indicated.
- B. Bulkhead: Tight assembly of screw studs and wallboard with all cracks sealed or gasketed. Bulkheads between adjacent rooms require wallboard on one side only (where so indicated.).
- C. Coordinate with acoustical ceiling work.
- D. Where bulkheads are built to enclose and shield noisy ducts, no part of the bulkhead structure may touch the duct.
- 3.11 PATCHING AND REPAIRS
- A. Prior to start of painting or installation of wall covering, neatly and accurately patch and repair all damaged wallboard to match finish of adjoining work. Cut out cracks, damaged areas, blemished, defective portions and re-work to match adjacent area.
- B. Apply chemical treatment where required to remedy defects.
- C. After sizing and seal coats have been applied, as specified under Division 9 Section "Painting," patch and repair any hair cracks or fine cracks which become visible, as necessary to render finish painting free from visible cracks.
- 3.12 CLEAN UP
- A. Upon completion of the work, in each area, brush all surfaces clean including floors, ledges and other areas carrying droppings or debris resulting from the work.
- B. Upon completion of work in any area or as often as directed, remove from the premises and legally dispose of all surplus materials, and construction debris.
- C. Do not bury lime or gypsum materials on the site.

**\*\*END OF SECTION\*\***



TILE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of 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. Unglazed porcelain mosaic tile.
  - 2. Anti-fracture membrane.
- B. Related Sections: The following sections contain requirements that relate to this Section:
  - 1. Division 3 Section "Cast-in-Place Concrete" for monolithic slab finishes specified for tile substrates.
  - 2. Division 7 Section "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
  - 3. Division 9 Section "Gypsum Wallboard Assemblies" for cementitious backer units installed as part of gypsum wallboard systems.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each type of product specified.
- C. Samples for initial selection purposes in form of manufacturer's color charts consisting of actual tiles or sections of tile showing full range of colors, textures, and patterns available for each type and composition of tile indicated. Include samples of grout and accessories involving color selection.
- D. Samples for verification purposes of each item listed below, prepared on samples of size and construction indicated, products involve color and texture variations, in sets showing full range of variations expected.
  - 1. Each type and composition of tile and for each color and texture required, at least 12 inches square, mounted on plywood or hardboard backing and grouted.
  - 2. Full-size units of each type of trim and accessory for each color required.

1.4 QUALITY ASSURANCE

- A. Single-Source Responsibility for Tile: Obtain each color, grade, finish, type, composition, and variety of tile from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.

- B. Single-Source Responsibility for Setting and Grouting Materials: Obtain ingredients of a uniform quality from one manufacturer for each cementitious and admixture component and from one source or producer for each aggregate.
- C. Installer Qualifications: Engage an experienced Installer who has successfully completed tile installations similar in material, design, and extent to that indicated for Project.
- D. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 1.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirement of ANSI A137.1 for labeling sealed tile packages.
- B. Prevent damage or contamination to materials by water, freezing, foreign matter, and other causes.
- C. Handle tile with temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If despite these precautions coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.6 PROJECT CONDITIONS

- A. Maintain environmental conditions and protect work during and after installation to comply with referenced standards and manufacturer's printed recommendations.
- B. Vent temporary heaters to exterior to prevent damage to tile work from carbon dioxide buildup.
- C. Maintain temperatures at 50°F (10°C) or more in tiled areas during installation and for 7 days after completion, unless higher temperatures are required by referenced installation standard or manufacturer's instructions.

1.7 EXTRA MATERIALS

- A. Deliver extra materials to Owner. Furnish extra materials that match products installed as described below, packaged with protective covering for storage and identified with labels clearly describing contents.
  - 1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed, for each type, composition, color, pattern, and size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Tile: Subject to compliance with requirements, provide products as follows:

1. CT1: Virginia Tile  
American Olean  
Shadow Bay Colorbody Porcelain  
Size: 18" x 18"  
Thickness: 5/16"  
Recommended Grout Joint: 3/16"  
Finish: Matte  
Installation: Straight set  
Color: Architect shall select one (1) color from manufacturer's full range of colors.  
  
Cove Base:  
S-36C9T  
Size: 6" x 12"  
Finish: Matte  
Color: Architect shall select one (1) color from manufacturer's full range of colors.  
Note: Provide all necessary inside and outside corner pieces to complete installation.  
  
Cove Base Outercorner:  
SC-36C9T  
Size: 6" x 1"  
Finish: Matte  
Color: Architect shall select one (1) color from manufacturer's full range of colors.  
Note: Provide all necessary inside and outside corner pieces to complete installation.

Manufacturer's Representative: Kathleen Somervell (248) 467-4362

2.2 PRODUCTS, GENERAL

- A. ANSI Standard for Ceramic Tile: Comply with ANSI A137.1 "American National Standard Specifications for Ceramic Tile" for types, compositions, and grades of tile indicated.
  1. Furnish tile complying with "Standard Grade" requirements unless otherwise indicated.
- B. ANSI Standard for Tile Installation Materials: Comply with ANSI standard referenced with products and materials indicated for setting and grouting.
- C. Colors, Textures, and Patterns: Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics, provide specific products or materials complying with the following requirements:
  1. Provide selections made by Architect from manufacturer's full range of colors, textures, and patterns as indicated for each product.
  2. Provide tile trim and accessories that match color and finish of adjoining flat tile.

- D. Factory Blending: For tile exhibiting color variations within the ranges selected during sample submittals, blend tile in factory and package accordingly so that tile units taken from one package show the same range in colors as those taken from other packages and match approved samples.
- E. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating them with a continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

2.3 TRIM UNITS:

- A. Trim Units: Provide tile trim units to match characteristics of adjoining flat tile and to comply with following requirements:
  - 1. Size: As indicated, coordinated with sizes and coursing of adjoining flat tile where applicable.
  - 2. Shapes: As selected by Architect from manufacturer's standard shapes, and as necessary for a complete installation.

2.4 ANTI-FRACTURE MATERIALS

- A. Anti-fracture Membrane: ANSI A118.12, composition as follows:
- B. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
  - 1. Products: Subject to compliance with requirements, provide the following:
    - a. Laticrete: Blue 92 Anti-Fracture Membrane.
    - b. MAPEI Corporation; Mapelastic AquaDefense Waterproofing and Crack-Isolation Membrane.
    - c. TEC; a subsidiary of H. B. Fuller Company; HydraFlex Waterproofing Crack Isolation Membrane.
  - 2. Location: At all locations unless indicated otherwise.

2.5 SETTING MATERIALS

- A. Latex-Portland Cement Mortar: ANSI A118.4, composition as follows:
  - 1. Latex additive (water emulsion) of type described below, serving as replacement for part or all of gauging water, combined at job site with prepackaged dry mortar mix supplied or specified by latex additive manufacturer.
    - a. Latex Type: Manufacturer's standard.

2.6 GROUTING MATERIALS

- A. Latex-Portland Cement Grout: ANSI A118.6, color as indicated, composition as follows:
  - 1. Latex additive (water emulsion) serving as replacement for part or all of gauging water, added at job site with dry grout mixture, with type of latex and dry grout mix as follows:
    - a. Latex Type: Manufacturer's standard.

- b. Dry Grout Mixture: Grout shall be as manufactured by one of the following:
  - 1) Custom Building Products.
  - 2) H. B. Fuller Co.
  - 3) LATICRETE International Inc.
  - 4) MAPEI Corporation.
  - 5) Summitville Tiles, Inc.
  - 6) TEC Specialty Products Inc. "AccuColor Premium Unsanded Grout"
- c. Grout shall be colored as selected by Architect from manufacturer's full line of colors.

## 2.7 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with requirements of referenced standards and manufacturers including those for accurate proportioning of materials, water, or additive content; type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortars and grouts of uniform quality with optimum performance characteristics for application indicated.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and areas where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
  - 1. Verify that substrates for setting tile are firm, dry, clean, and free from oil or waxy films and curing compounds.
  - 2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed before installing tile.
- B. Do not proceed with installation until unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Blending: For tile exhibiting color variations within the ranges selected during sample submittals, verify that tile has been blended in factory and packaged accordingly so that tile units taken from one package show the same range in colors as those taken from other packages and match approved samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

### 3.3 INSTALLATION, GENERAL

- A. ANSI Tile Installation Standard: Comply with parts of ANSI 108 series of tile installation standards included under "American National Standard Specifications for the Installation of Ceramic Tile" that apply to type of setting and grouting materials and methods indicated.
- B. TCA Installation Guidelines: TCA "Handbook for Ceramic Tile Installation"; comply with TCA installation methods indicated.
- C. Where indicated, install anti-fracture membrane to comply with manufacturer's written instructions to produce a membrane of uniform thickness bonded securely to substrate.

- D. Extend tile work into recesses and under or behind equipment and fixtures to form a complete covering without interruptions except as otherwise shown. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- E. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so that plates, collars, or covers overlap tile.
- F. Jointing Pattern: Unless otherwise shown, lay tile in grid pattern. Align joints when adjoining tiles on floor, base, walls, and trim are same size. Lay out tile work and center tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths unless otherwise shown.
- G. Lay out tile wainscots to dimensions indicated.
- H. Expansion Joints: Locate expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated during installation of setting materials, mortar beds, and tile. Do not saw cut joints after installation of tiles.
  - 1. Locate joints in tile surfaces directly above joints in concrete substrates.
- I. Grout tile to comply with the requirements of the following installation standards:
  - 1. For ceramic tile grouts (and latex-portland cement grouts), comply with ANSI A108.10.
  - 2. For chemical-resistant epoxy grouts, comply with ANSI A108.6.

### 3.4 FLOOR INSTALLATION METHODS

- A. Porcelain Mosaic Tile: Install tile to comply with requirements indicated below for setting bed methods, TCA installation methods related to types of subfloor construction, and grout types:
  - 1. Latex-Portland Cement Mortar: ANSI A108.5.
    - a. Concrete Subfloors, Interior: TCA F112, F113 and 125A as indicated on Drawings.
      - 1) Install anti-fracture membrane at all locations unless indicated otherwise.
    - b. Grout: Latex-portland cement.
      - 1) Provide epoxy grout where noted in specifications and where indicated on Drawings.

### 3.5 CRACK ISOLATION MEMBRANE INSTALLATION

- A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness and bonded securely to substrate.

### 3.6 CLEANING AND PROTECTION

- A. Cleaning: Upon completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
  - 1. Remove latex-portland cement grout residue from tile as soon as possible.

2. Unglazed tile may be cleaned with acid solutions only when permitted by tile and grout manufacturer's printed instructions, but no sooner than 14 days after installation. Protect metal surfaces, cast iron, and vitreous plumbing fixtures from effects of acid cleaning. Flush surface with clean water before and after cleaning.
  3. Remove temporary protective coating by method recommended by coating manufacturer that is acceptable to brick and grout manufacturer. Trap and remove coating to prevent it from clogging drains.
- B. Finished Tile Work: Leave finished installation clean and free of cracked, chipped, broken, unbonded, and otherwise defective tile work.
- C. Provide final protection and maintain conditions in a manner acceptable to manufacturer and installer that ensures that tile is without damage or deterioration at time of Substantial Completion.
1. When recommended by tile manufacturer, apply a protective coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear.
  2. Prohibit foot and wheel traffic from tiled floors for at least 7 days after grouting is completed.
- D. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

**\*\*END OF SECTION\*\***

ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following types of acoustical ceilings.
  - 1. Acoustical panel ceilings installed with exposed suspension systems.
- B. Related Sections: The following sections contain requirements that relate to this section:
  - 1. Division 9 Section "Gypsum Wallboard Assemblies" for gypsum board substrate for adhered acoustical tile.
  - 2. Division 15 for grilles, registers, and diffusers and sprinkler heads in acoustical ceilings.
  - 3. Division 16 for lighting fixtures in acoustical ceilings.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each type of product specified.
- C. Samples for initial selection purposes in form of manufacturer's color charts consisting of actual acoustical units or sections of units showing full range of colors, textures, and patterns available for each type of unit indicated.
- D. Samples for verification purposes of each type of exposed finish required, prepared on samples of size indicated below and of same thickness and material indicated for final unit of Work. Where finishes involve normal color and texture variations, include sample sets showing full range of variations expected.
  - 1. 6-inch-square samples of each acoustical panel type, pattern, and color.
  - 2. Set of 12-inch-long samples of exposed suspension system members, including moldings, for each color and system type required.
- E. Qualification data for firms and persons specified in "Quality Assurance" article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of Architects and Owners, and other information specified.
- F. Product test reports from qualified independent testing laboratory that are based on its testing of current products for compliance of acoustical ceiling systems and components with requirements.



1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has successfully completed acoustical ceilings similar in material, design, and extent to those indicated for Project.
- B. Fire-Performance Characteristics: Provide acoustical ceilings that are identical to those tested for the following fire-performance characteristics, per ASTM test method indicated below, by UL or other testing and inspecting organizations acceptable to authorities having jurisdiction. Identify acoustical ceiling components with appropriate markings of applicable testing and inspecting organization.
  - 1. Surface Burning Characteristics: As follows, tested per ASTM E 84 and complying with ASTM E 1264 for Class A products.
    - a. Flame Spread: 25 or less.
    - b. Smoke Developed: 50 or less.
  - 2. Fire-Resistance Ratings: As indicated by reference to design designations in UL "Fire Resistance Directory," for types of assemblies in which acoustical ceilings function as a fire-protective membrane and tested per ASTM E 119.
    - a. Protect lighting fixtures and air ducts to comply with requirements indicated for rated assembly.
- C. Single-Source Responsibility for Ceiling Units: Obtain each type of acoustical ceiling unit from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.
- D. Single-Source Responsibility for Suspension System: Obtain each type of suspension system from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.
- E. Coordination of Work: Coordinate layout and installation of acoustical ceiling units and suspension system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system components (if any), and partition system (if any).

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 PROJECT CONDITIONS

- A. Space Enclosure: Do not install interior acoustical ceilings until space is enclosed and weatherproof, wet-work in space is completed and nominally dry, work above ceilings is complete, and ambient conditions of temperature and humidity will be continuously maintained at values near those indicated for final occupancy.

1.7 EXTRA MATERIALS

- A. Deliver extra materials to Owner. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with appropriate labels.
1. Acoustical Ceiling Units: Furnish quantity of full-size units equal to 2.0 percent of amount installed.
  2. Exposed Suspension System Components: Furnish quantity of each exposed component equal to 2.0 percent of amount installed.

PART 2 - PRODUCTS

2.1 ACOUSTICAL PANELS

- A. Manufacturer: Subject to compliance with requirements provide products as follows:
1. ACT1      USG Interiors  
                 "F" Fissured  
                 Item No. : 131  
                 Size: 24" x 24" x 3/4"  
                 Edge: SQ  
                 Color: White  
                 Or Equal By: Armstrong, CertainTeed

2.2 METAL SUSPENSION SYSTEMS

- A. Suspension systems shall conform to ASTM C-635 for "intermediate duty" classification, except that where quantity or weight of ceiling fixtures would create deflection of greater than 1/360 of the span length, "heavy duty" system shall be used or ceiling grid shall be reinforced in a manner to maintain deflection of less than 1/360 of the span length. The General and Supplementary Conditions shall take precedence over Section 6 (Inspection) of ASTM C-635. All recessed light fixtures shall be supported by main runners on not less than two opposite sides.
1. Exposed portions shall receive a factory applied matte white baked enamel finish.
- B. Manufacturer: Subject to compliance with requirements provide products as follows:
1. Grid at ACT1
    - a. USG Interiors  
Donn DX Suspension System with 15/16" Exposed Face  
Color: White  
Or Equal By: Armstrong, CertainTeed

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and structural framing to which ceiling system attaches or abuts, with Installer present, for compliance with requirements specified in this and other sections that affect installation and anchorage of ceiling system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less-than-half-width units at borders, and comply with reflected ceiling plans.

3.3 INSTALLATION

- A. General: Install acoustical ceiling systems to comply with installation standard referenced below, per manufacturer's instructions and CISCA "Ceiling Systems Handbook."
  - 1. Standard for Installation of Ceiling Suspension Systems: Comply with ASTM C 636.
- B. Arrange acoustical units and orient directionally patterned units (if any) in a manner shown by reflected ceiling plans.
- C. Suspend ceiling hangers from building structural members and as follows:
  - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, counter-splaying, or other equally effective means.
  - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
  - 3. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eyescrews, or other devices that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
  - 4. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eyescrews, or other devices that are secure and appropriate for structure to which hangers are attached as well as for type of hanger involved, and in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
  - 5. Do not support ceilings directly from permanent metal forms; furnish cast-in-place hanger inserts that extend through forms.
  - 6. Do not attach hangers to steel deck tabs.
  - 7. Do not attach hangers to steel roof deck. Attach hangers to structural members.
  - 8. Space hangers not more than 4'-0" o.c. along each member supported directly from hangers, unless otherwise shown, and provide hangers not more than 8 inches from ends of each member.
- D. Install edge moldings of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical units.

1. Sealant Bed: Apply continuous ribbon of acoustical sealant, concealed on back of vertical leg before installing moldings.
  2. Screw-attach moldings to substrate at intervals not over 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to tolerance of 1/8 inch in 12'-0". Miter corners accurately and connect securely.
- E. Install acoustical panels in coordination with suspension system, with edges concealed by support of suspension members. Scribe and cut panels to fit accurately at borders and at penetrations.
1. Install hold-down clips in areas indicated and in areas where required by governing regulations or for fire-resistance ratings; space as recommended by panel manufacturer, unless otherwise indicated or required.

3.4 CLEANING

- A. Clean exposed surfaces of acoustical ceilings, including trim, edge moldings, and suspension members. Comply with manufacturer's instructions for cleaning and touch-up of minor finish damage. Remove and replace work that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

**\*\*END OF SECTION\*\***

RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK:

- A. Extent of resilient tile flooring and accessories is shown on drawings and in schedules.

1.3 QUALITY ASSURANCE

- A. Manufacturer: Provide each type of resilient tile flooring and accessories as produced by a single manufacturer, including recommended primers, adhesives, sealants, and leveling compounds.
- B. Fire Test Performance: Provide resilient tile flooring which complies with the following fire test performance criteria as determined by an independent testing laboratory acceptable to authorities having jurisdiction.
  - 1. Flame Spread: Not more than 75 per ASTM E 84.
  - 2. Smoke Developed: Not more than 450 per ASTM E 84.
  - 3. Smoke Density: Not more than 450 per NFPA 258.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data for each type of resilient flooring and accessory.
- B. Samples for Initial Selection Purposes: Submit manufacturer's standard color charts in form of actual sections of resilient flooring, including accessories, showing full range of colors and patterns available, for each type of resilient tile flooring required.
- C. Samples for Verification Purposes: Submit the following samples of each type, color, and pattern of resilient tile flooring required, showing full-range of color and pattern variations.
  - 1. Full size tile samples.
  - 2. 2-1/2 long samples of resilient flooring accessories.
  - 3. Other materials as requested.
- D. Certification for Fire Test Performance: Submit certification from an independent testing laboratory acceptable to authorities having jurisdiction that resilient tile flooring complies with fire test performance requirements.
- E. Maintenance Instructions: Submit 2 copies of manufacturer's recommended maintenance practices for each type of resilient tile flooring and accessory required.

1.5 PROJECT CONDITIONS

- A. Maintain minimum temperature of 65°F (18°C) in spaces to receive resilient tile flooring for at least 48 hours prior to installation, during installation, and for not less than 48 hours after installation. Store resilient flooring materials in spaces where they will be installed for at least 48 hours before beginning installation. Subsequently, maintain minimum temperature of 55°F (13°C) in areas where work is completed.
- B. Install resilient tile flooring and accessories after other finishing operations, including painting, have been completed. Do not install resilient flooring over concrete slabs until the latter have been cured and are sufficiently dry to achieve bond with adhesive as determined by resilient flooring manufacturer's recommended bond and moisture test.

1.6 EXTRA STOCK:

- A. Deliver stock of maintenance materials to Owner. Furnish maintenance materials from same manufactured lot as materials installed and enclosed in protective packaging with appropriate identifying labels.
  - 1. Tile Flooring: Furnish not less than one box for each 50 boxes or fraction thereof, for each type, color, pattern and size installed.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Vinyl Composition Tile: Subject to compliance with requirements, provide products as follows:
  - 1. VCT1      Armstrong  
                 Imperial Texture Standard Excelon  
                 Size: 12" x 12"  
                 Color: Classic White 51911.
- B. Resilient Wall Base: Subject to compliance with requirements provide products as follows:
  - 1. RB1      Provide one of the following:
    - a. Roppe  
         Rubber Wall Base  
         Height: 4"  
         Color: Architect to select one (1) color from manufacturer's standard offering.
  - 2. RB2      Provide one of the following:
    - b. Roppe  
         Rubber Wall Base  
         Height: 6"  
         Color: Architect to select one (1) color from manufacturer's standard offering.  
         Note: Height of base may have to be trimmed to fit at base of cabinets

2.2 RESILIENT FLOORING COLORS AND PATTERNS

- A. Color shall be as selected by the Architect from manufacturer's full line.

2.3 TILE FLOORING

- A. Vinyl Composition Tile: FS SS-T-312, Type IV; 12" x 12" unless otherwise indicated, and as follows:
  - 1. Composition 1 - asbestos-free.
  - 2. Gage: 1/8".

2.4 ACCESSORIES

- A. Rubber Wall Base: Provide rubber base complying with FS SS-W-40, Type I, with matching end stops and preformed or molded corner units, and as follows:
  - 1. Height: 4" & 6".
  - 2. Thickness: 1/8" gage.
  - 3. Style: Standard top set cove.
  - 4. Finish: Matte.
- B. Resilient Edge Strips: 1/8" thick, homogeneous vinyl or rubber composition, tapered or bullnose edge, color to match flooring, or as selected by Architect from standard colors available; not less than 1" wide.
- C. Adhesives (Cements): Waterproof, stabilized type as recommended by flooring manufacturer to suit material and substrate conditions.
- D. Concrete Slab Primer: Non-staining type as recommended by flooring manufacturer.
- E. Leveling and Patching Compounds: Latex type as recommended by flooring manufacturer.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Require Installer to inspect subfloor surfaces to determine that they are satisfactory. A satisfactory subfloor surface is defined as one that is smooth and free from cracks, holes, ridges, coatings preventing adhesive bond, and other defects impairing performance or appearance.
- B. Perform bond and moisture tests on concrete subfloors to determine if surfaces are sufficiently cured and dry as well as to ascertain presence of curing compounds.
- C. Do not allow resilient flooring work to proceed until subfloor surfaces are satisfactory.

3.2 PREPARATION

- A. Prepare subfloor surfaces as follows:
  - 1. Use leveling and patching compounds as recommended by resilient flooring manufacturer for filling small cracks, holes and depressions in subfloors.

2. Remove coatings from subfloor surfaces that would prevent adhesive bond, including curing compounds incompatible with resilient flooring adhesives, paint, oils, waxes and sealers.
3. For existing floors, skim coat **entire** floor for smooth, even surface. If necessary, grind floor to achieve smooth surface.

- B. Broom clean or vacuum surfaces to be covered, and inspect subfloor.
- C. Apply concrete slab primer, if recommended by flooring manufacturer, prior to application of adhesive. Apply in compliance with manufacturer's directions.

### 3.3 INSTALLATION, GENERAL:

- A. Where movable partitions are shown, install resilient flooring before partitions are erected.
- B. Install resilient flooring using method indicated in strict compliance with manufacturer's printed instructions. Extend resilient flooring into toe spaces, door reveals, and into closets and similar openings.
- C. Scribe, cut, and fit resilient flooring to permanent fixtures, built-in furniture and cabinets, pipes, outlets and permanent columns, walls and partitions.
- D. Maintain reference markers, holes, or openings that are in place or plainly marked for future cutting by repeating on finish flooring as marked on subfloor. Use chalk or other non-permanent marking device.
- E. Install resilient flooring on covers for telephone and electrical ducts, and similar items occurring within finished floor areas. Maintain overall continuity of color and pattern with pieces of flooring installed on these covers. Tightly cement edges to perimeter of floor around covers and to covers.
- F. Tightly cement resilient flooring to subbase without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, or other surface imperfections. Hand roll resilient flooring at perimeter of each covered area to assure adhesion.

### 3.4 INSTALLATION OF TILE FLOORS:

- A. Lay tile from center marks established with principal walls, discounting minor offsets, so that tile at opposite edges of room area of equal width. Adjust as necessary to avoid use of cut widths less than 1/2 tile at room perimeters. Lay tile square to room axis, unless otherwise shown.
- B. Match tiles for color and pattern by using tile from cartons in same sequence as manufactured and packaged if so numbered. Cut tile neatly around all fixtures. Broken, cracked, chipped, or deformed tiles are not acceptable.
  1. Lay tile with grain running in one direction.
- C. Adhere tile flooring to substrates using full spread of adhesive applied in compliance with flooring manufacturer's directions.

### 3.5 INSTALLATION OF ACCESSORIES:

- A. Apply wall base to walls, columns, pilasters, casework and other permanent fixtures in rooms or areas where base is required. Install base in lengths as long as practical, with preformed outside corner units, and fabricated with mitered or coped inside corners. Tightly bond base to



substrate throughout length of each piece, with continuous contact at horizontal and vertical surfaces.

1. On masonry surfaces, or other similar irregular substrates, fill voids along top edge of resilient wall base with manufacturer's recommended adhesive filler material.
- B. Place resilient edge strips tightly butted to flooring and secure with adhesive. Install edging strips at edges of flooring which would otherwise be exposed.

3.6 CLEANING AND PROTECTION:

- A. Perform following operations immediately upon completion of resilient flooring:
  1. Sweep or vacuum floor thoroughly.
  2. Do not wash floor until time period recommended by resilient flooring manufacturer has elapsed to allow resilient flooring to become well-sealed in adhesive.
  3. Damp-mop floor being careful to remove black marks and excessive soil.
  4. Remove any excess adhesive or other surface blemishes, using appropriate cleaner recommended by resilient flooring manufacturers.
- B. Protect flooring against damage during construction period to comply with resilient flooring manufacturer's directions.
  1. Apply protective floor polish to resilient flooring surfaces free from soil, excess adhesive or surface blemishes. Use commercial available metal cross-linked acrylic product acceptable to resilient flooring manufacturer.
  2. Protect resilient flooring against damage from rolling loads for initial period following installation by covering with plywood or hardboard. Use dollies to move stationary equipment or furnishings across floors.
  3. Cover resilient flooring with undyed, untreated building paper until inspection for substantial completion.
- C. Clean resilient flooring not more than 4 days prior to date scheduled for inspections intended to establish date of substantial completion in each area of project. Clean resilient flooring by method recommended by resilient flooring manufacturer.
  1. Strip protective floor polish, which was applied after completion of installation, prior to cleaning.
  2. Reapply floor polish after cleaning.

**\*\*END OF SECTION\*\***

CARPET TILE

PART 1 - GENERAL

1.1 RELATED SECTIONS

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

1.2 SUMMARY

- A. This Section includes carpet tile, installation, and accessories.
- B. Related Sections: The following sections contain requirements that relate to this Section:
  - 1. Division 09 Section "Resilient Tile Flooring" for resilient wall base, resilient stair nosings, and accessories installed with carpet.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product Data: Submit manufacturer's technical product data for each type of carpet tile specified to verify compliance with specifications.
- C. Shop Drawings: Provide shop drawings showing layout and placement of cut tiles. Indicate pile or pattern direction, start points, and locations and types of edge strips. Indicate columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tile. Show installation details at special conditions.
- D. SAMPLES:
  - 1. For verification purposes of each carpet tile specified.
  - 2. For verification purposes of any edge strips to be used.

1.4 QUALITY ASSURANCE

- A. Carpet Tile Surface Burning Characteristics: Provide written data, if requested, for the following fire performance characteristics, per test method indicated below, by UL or other testing and inspecting organizations acceptable to authorities having jurisdiction. Identify carpet tile with appropriate markings of applicable testing and inspecting organization.
  - 1. Test Method: DOC FF 1-70. Pill Test
  - 2. Rating: Pass.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to project site in original factory wrappings and containers, labeled with identification of manufacturer, brand name, and lot number.
- B. Store materials in original undamaged packages and containers, inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity. Lay flat, blocked off ground. Maintain minimum temperature of 68 deg F (20 deg C) at least three days prior to and during installation in area where materials are stored.

1.6 PROJECT CONDITIONS

- A. Substrate Conditions: No condensation on underside of 4-foot by 4-foot polyethylene sheet within 48 hours, fully taped at perimeter to substrate.
- B. Substrate Conditions: pH of 9 or less when substrate wetted with potable water and pHydron paper applied.

1.7 CONTRACTOR TURNOVER REQUIREMENTS

- A. Warranty: Provide copies of manufacturer's warranty for each product used.
- B. Maintenance: Provide maintenance data consisting of manufacturer's printed instructions for each carpet tile used. Include methods and frequency of recommended cleaning as well as any precautions.
- C. Replacement Materials: Before installation begins, provide to Owner a quantity of material in full size units equal to 2 percent of the amount installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Provide the following Carpet Tile:
  - 1. CPT1 (13175)  
Manufacturer: Shaw Contract Group  
Style: Chroma Tile 59583  
Construction: Multi-Level Pattern Loop  
Fiber: Solution Q Extreme Nylon  
Dye Method: 100% Solution Dyed  
Gauge: 1/12  
Total Thickness: 0.254 inches  
Size: 24" x 24"  
Backing: Ecoworx Tile  
Installation Method: Random  
Color: Infinite 83515

2.2 ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Carpet Edge Guard: Extruded or molded heavy-duty vinyl or rubber of size and profile indicated; minimum 2-inch-wide anchorage flange; manufacturer's standard colors.
- C. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider, and protrusions more than 1/32

inch (0.8 mm) unless more stringent requirements are required by manufacturer's written instructions.

- B. If substrate is new concrete, clear away debris and scrape up cementitious deposits from concrete surfaces to receive carpet tile; apply sealer to prevent dusting.
- C. If the substrate is existing concrete, patch holes and level to a smooth surface. If previous finish was chemically stripped, reseal concrete. Seal powdery or porous surfaces with sealer recommended by carpet tile manufacturer.
- D. If the substrate is wood, patch holes and cracks. Sand to level. Remove wax. Seal surface with sealer recommended by carpet tile manufacturer.
- E. If the substrate is resilient flooring, replace missing pieces of existing resilient flooring or patch to level. Cut out peaked sheet goods seams and fill with latex underlayment.
- F. If the substrate is terrazzo, remove chemical finish on terrazzo; patch grout lines and cracks to level with latex underlayment.

### 3.2 INSTALLATION

- A. Comply with manufacturer's recommendations for a "Glue down" installation of carpet tile; maintain uniformity of carpet direction and lay of pile, unless otherwise indicated.
- B. Installation Method: Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive.
- C. Extend carpet tile under removable flanges and furnishings and into alcoves and closets of each space.
- D. Install carpet edge guard where edge of carpet tile is exposed; anchor guards to substrate.
- E. Install with pattern parallel to walls and borders. Perimeter modules shall be half-size or larger.

### 3.3 CLEANING

- A. Remove any tape or adhesive from carpet tile surface with manufacturer's recommended cleaning agent.
- B. Remove and dispose of debris and unusable scraps. Vacuum using commercial machine with face-beater element. Remove soil. Replace carpet tiles where soil cannot be removed. Remove protruding face yarn.
- C. Vacuum carpet tile.

### 3.4 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer, to ensure carpet tile is not damaged or deteriorated at time of Substantial Completion.

**\*\*END OF SECTION\*\***

PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes, labor, materials and equipment for Painting and Finishing.
- B. The following sections contain requirements that relate to this Section:
  - 1. Division 6 Section "Interior Architectural Woodwork" for factory finished millwork.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Verification: For each type of paint system and in each color and gloss of topcoat indicated.
  - 1. Submit 8-1/2 x 11 color downs on heavy paper to match Architect's color chips for each color and type of paint specified for Architect's approval.
    - a. Architect will furnish a schedule after beginning of construction. The schedule will include color chips for matching.
  - 2. Step coats on Samples to show each coat required for system.
  - 3. Label each coat of each Sample.
  - 4. Label each Sample for location and application area.
- C. Material Certificates: For scrub resistance and washability, signed by manufacturers.

1.4 QUALITY ASSURANCE

- A. Architect has the option of requesting test patches in place for Architect's approval of final color and finish.
  - 1. Notify Architect 48 hours in advance of the time the test patches will be ready for inspection.
- B. Manufacturer shall certify that tests have been performed on semi-gloss wall finish and others as selected by the Architect. Acceptance of materials is conditional upon demonstration of washability and abrasion resistance of test patches. Testing shall include the following:
  - 1. Scrub resistance per ASTM D2486-79: Value as specified in approved finish schedule but not less than 1200.
  - 2. Washability per ASTM D3450-80: Value as specified in approved finish schedule but not less than 80% for sponge and 90% for brush.

1.5 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.
    - a. Do not store oil or paint soaked rags inside the building.
  - 3. Do not store materials in any room containing a direct-fired heating unit.
- B. Mix and thin paints in strict accordance with recommendations of the manufacturer.
  - 1. Mix paints only in areas designated, and provided proper protection for walls and floors.

1.6 PROJECT 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 interior 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.
- C. Do not apply exterior paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 PAINT, GENERAL

- A. 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.

2.3 COLORS

- A. The Architect has the option of accenting certain building elements different colors; (i.e.: doors, frames, columns, ceilings, walls) to be defined in a Schedule.
- B. The Architect reserves the right to select colors from manufacturer's standard or premium price groups, including deep tone colors for both interior and exterior products.

- C. Furnish an equal product by the same manufacturer only in those instances where a deep tone color specified by the Architect is not available in the specified product. This is subject to Architect's approval.
- D. Tinted primer shall be used whenever deep tone colors are specified.

## 2.4 EXTERIOR FINISHES

- A. Ferrous Metals (i.e. doors, railings, fences, lintels, etc.):
  - 1. First Coat: (If flash rusting occurs, use two coats)
    - a. Benjamin Moore: MO4 Acrylic Metal Primer
    - b. Glidden Professional: Devoe Coatings Devflex 4020PF Direct to Metal Primer & Flat Finish.
    - c. PPG Industries: 90-708 Series, Pitt-Tech One-Pack Interior/Exterior Industrial Primer
    - d. Pratt & Lambert: Universal Acrylic Primer Z6631 or Steeltech Acrylic Prime & Finish Z190.
    - e. Sherwin Williams: ProCryl Universal Metal Primer B66-310 Series
  - 2. Second and Third Coats:
    - a. Benjamin Moore: Moorcraft Latex House and Trim Paint 170 except at railings which shall be Impervex Enamel 309
    - b. Glidden Professional: Devoe Coatings Devflex 4216HP High Performance Waterborne Acrylic Semi-Gloss Enamel.
    - c. PPG Industries: 6-2000 Series, Speedhide Exterior Satin Latex except at railings which shall receive 90-474 Series, Pitt-Tech One Pack Interior/Exterior Satin High Performance Industrial Enamel.
    - d. Pratt & Lambert: DTM Acrylic Gloss Z6841 or Semi-Gloss Z6761 or Satin Z6671.
    - e. Sherwin Williams: DTM Acrylic Gloss Coating (Water Reducible), B66-100
- B. Exterior Structural Steel exposed to view.
  - 1. For warranty purposes, the Contractor shall insure that the specified primer in Division 5 "Structural Steel" and the intermediate and finish coats specified below are from the same manufacturer.
    - a. No coatings shall be applied until approved by the Architect and Owner's Representative.
  - 2. Prime Coat: Refer to Division 5, "Structural Steel."
  - 3. Intermediate Coat:
    - a. Tnemec: One (1) coat TNEMEC Series 161 TNEME - Fascure @ 4.0 to 6.0 mils DFT.
    - b. Wasser: One (1) component MC-CR @ 3.0-4.0 mils DFT.
    - c. Sherwin Williams: One (1) coat Macropoxy 646 FC @ 5-10 mils DFT.
  - 4. Finish Coat:
    - a. Tnemec: One (1) coat TNEMEC Series 74 Endura-Shield @ 2.0 to 5.0 mil DFT.

- b. Glidden Professional: One (1) Coat Devco Coatings DETHANE 379H Aliphatic Urethane Enamel @ 2.0 to 3.0 mils DFT.
- c. Wasser: One (1) component MC-Luster @ 2.0-4.0 mils DFT.
- d. Sherwin Williams: One (1) coat Acrolon 218 HS @ 3-6 mils DFT.

2.5 INTERIOR FINISHES

A. Plaster and Gypsum Board Ceilings and Ceiling Drops

1. First Coat:

- a. Benjamin Moore: Moorcraft Vinyl Latex Primer-Sealer 273.
- b. Glidden Professional: High Hide Interior Primer Sealer 1000-1200.
- c. Pittsburgh Paints: 4-603 Permacrete interior/exterior Acrylic Alkali Resistant Primer for plaster; 6-2 Interior Latex Sealer for gypsum board.
- d. Pratt & Lambert: Plaster: Pro Hide Gold Z1001 Gypsum: Pro Hide Gold High Holdout Latex Primer/Sealer Z8165
- e. Sherwin Williams: ProMar 200 Zero VOC Primer B28W2600

2. Second Coat:

- a. Benjamin Moore: Moorcraft Vinyl Latex Flat 275
- b. Glidden Professional: Ultra-Hide 150 Interior Flat Paint 1210V Series.
- c. Pittsburgh Paints: Speedhide Latex Flat 6-70 (for all colors)
- d. Pratt & Lambert: Pro Hide Gold Latex Flat Z8100, Eggshell Z8200, Satin Z9400 or Semi Z8300.
- e. Sherwin Williams: ProMar 200 Zero VOC Latex Flat B30 Series

3. Third Coat:

- a. Benjamin Moore: Moorcraft Vinyl Latex Flat 275
- b. Glidden Professional: Ultra-Hide 150 Interior Flat Paint 1210V Series.
- c. Pittsburgh Paints: Speedhide Latex Flat 6-70 (for all colors)
- d. Pratt & Lambert: Pro Hide Gold Latex Flat Z8100, Eggshell Z8200, Satin Z9400, or Semi Z8300.
- e. Sherwin Williams: ProMar 200 Zero VOC Latex Flat B30 Series

B. Plaster and Gypsum Board Walls and Columns – Non-epoxy:

1. First Coat:

- a. Benjamin Moore: Moorcraft Vinyl Latex Primer-Sealer 273
- b. Glidden Professional: High Hide Interior Primer Sealer 1000-1200.
- c. Pittsburgh Paints: 4-603 Permacrete interior/exterior Acrylic Alkali Resistant Primer for plaster; 6-2 Interior Latex Sealer for gypsum board.
- d. Pratt & Lambert: Plaster: Pro Hide Gold Z1001 Gypsum: Pro Hide Gold High Holdout Latex Primer/Sealer Z8165.
- e. Sherwin Williams: ProMar 200 Zero VOC Primer B28W2600

2. Second and Third Coats:

- a. Benjamin Moore: Moorcraft Latex Eggshell Enamel 274
- b. Glidden Professional: Ultra-Hide 150 Interior Eggshell Paint 1412V Series.
- c. Pittsburgh Paints: Speedhide Latex Eggshell 6-411 Pratt & Lambert: Pro Hide + Latex Eggshell Enamel



- d. Pratt & Lambert: Pro Hide Gold Latex Flat Z8100, Eggshell Z8200, Satin Z9400 or Semi Z8300.
- e. Sherwin Williams: ProMar 200 Zero VOC Latex Eg-Shel B20 Series

C. Plaster and Gypsum Board Walls and Columns - Epoxy:

1. First Coat:

- a. Benjamin Moore: M08/M09 Waterborne Epoxy Primer
- b. Glidden Professional: High Hide Interior Primer Sealer 1000-1200.
- c. Pittsburgh Paints: 4-603 Permacrete interior/exterior Acrylic Alkali Resistant Primer for plaster; 6-2 Interior Latex Sealer for gypsum board.
- d. Pratt & Lambert: Plaster: Pro Hide Gold Z1001 Gypsum: Pro Hide Gold High Holdout Latex Primer/Sealer Z8165.
- e. Sherwin Williams: ProMar 200 Zero VOC Primer B28W2600

2. Second and Third Coats:

- a. Benjamin Moore: M43/M44 Acrylic Epoxy Gloss Coating
- b. Glidden Professional: Devoe Coatings Tru-Glaze-WB Waterborne Epoxy Gloss Coating 4428.
- c. Pittsburgh Paints: 16-551 Series, Pitt-Glaze High Solids Acrylic-Epoxy.
- d. Pratt & Lambert: Acrylic Water-Based Epoxy Z7021.
- e. Sherwin Williams: Water Based Catalyzed Epoxy, B70/B60V25

D. Masonry Block

1. First Coat: Masonry block filler at rate not to exceed 100 sq. ft. per gal.

- a. Benjamin Moore: Interior and Exterior Block Filler 173
- b. Glidden Professional: Concrete Coatings Block Filler Interior/Exterior Primer 3010-1200.
- c. Pittsburgh Paints: Speedhide Latex Block Filler 6-15
- d. Pratt & Lambert: Pro Hide Silver Block Filler Z8485
- e. Sherwin Williams: Pro Mar Interior/Exterior Block Filler B25W25

2. Second and Third Coats – Non-epoxy.

- a. Semi-Gloss Latex Enamel Finish: Two (2) Coats over filled surface with total dry film thickness not less than 3.5 mils, excluding filler coat.
  - 1) Benjamin Moore: Moorcraft Latex Semi Gloss Enamel 276.
  - 2) Glidden Professional: Ultra-Hide 150 Interior Semi-Gloss Paint 1416V Series.
  - 3) Pittsburgh Paints: 6-512 Series, Speedhide Semi-Gloss Latex Enamel.
  - 4) Pratt & Lambert: Pro Hide Gold Latex, Satin Z9400 or Semi Z8300
  - 5) Sherwin Williams: ProMar 200 Zero VOC Latex Semi-Gloss B31 Series

3. Second and Third Coats - Epoxy.

- a. Benjamin Moore: M43/M44 Acrylic Epoxy Gloss Coating
- b. Glidden Professional: Devoe Coatings Tru-Glaze-WB Waterborne Epoxy Gloss Coating 4428.
- c. Pittsburgh Paints: 16-551 Series, Pitt-Glaze High Solids Acrylic-Epoxy.
- d. Pratt & Lambert: Acrylic Water-Based Epoxy Z7021
- e. Sherwin Williams: Water Based Catalyzed Epoxy, B70/B60V25

E. Existing Painted Masonry Block - Epoxy.

1. Sample Patch: Prepare a 36" x 36" minimum test area to see if a reaction occurs between existing and new finishes prior to proceeding with the specified work. If a reaction occurs, alert Architect and propose solution(s).
2. First Coat: Barrier Coat Primer
  - a. Benjamin Moore: M08/M09 Waterborne Epoxy Primer
  - b. Glidden Professional: Devoe Coatings Tru-Glaze-WB Waterborne Epoxy Primer 4030.
  - c. Pittsburgh Paints: 17-921 Seal Grip exterior/interior 100% acrylic Primer/Sealer
  - d. Pratt & Lambert: Acrylic Waterborne Bonding Primer Z6650
  - e. Sherwin Williams: Loxon Masonry Primer A24W8300 (patches and bare spots)
3. Second and Third Coats.
  - a. Benjamin Moore: M43/M44 Acrylic Epoxy Gloss Coating
  - b. Glidden Professional: Devoe Coatings Tru-Glaze-WB Waterborne Epoxy Gloss Coating 4428.
  - c. Pittsburgh Paints: 16-800 Series, Pitt-Glaze High Solids Acrylic-Epoxy.
  - d. Pratt & Lambert: Enducryl Water-Based Epoxy Z7021
  - e. Sherwin Williams: Water Based Catalyzed Epoxy, B70/B60V25

F. Exposed Ceiling Construction - Dry Fall Paint.

1. Preparation: Spot prime any welds, etc.
2. First Coat:
  - a. Benjamin Moore: M04 Acrylic Metal Primer
  - b. Glidden Professional: Devoe Coatings Devflex 4020PF Direct to Metal Primer & Flat Finish.
  - c. Pittsburgh Paints: 90-708 Series, Pitt-Tech One Pack Interior/Exterior Industrial Primer.
  - d. Pratt & Lambert: Steel Tech Arcylic Metal Primer, Z190
  - e. Sherwin Williams: ProCryl Universal Metal Primer B66-310 Series
3. Second and Third Coats: (if deep tone colors are specified, the products below shall be factory mixed)
  - a. Benjamin Moore: Moorcraft Dry Fog Sweep Up 272
  - b. Glidden Professional: Waterborne Interior Dryfall Flat 1280-1200.
  - c. Pittsburgh Paints: 6-715X, Speedhide Flat Latex Dry Fog
  - d. Pratt & Lambert: Enducryl Acrylic Dryfall, Flat Z5900 or Semi Z5910
  - e. Sherwin Williams: Low VOC Waterborne Acrylic Dryfall Flat B42W81

G. Ferrous, Galvanized Metals, Aluminum

1. Preparation:
  - a. See Divisions 5 and 8 for requirements for priming of ferrous metals.
  - b. Do all touch up and priming of unprimed metals in accordance with requirements of Divisions 5 and 8.

2. Apply paint in accordance with Steel Structure Painting Council Paint Application Specifications SSPC-PA1 to a dry film thickness as specified by the manufacturer.
  3. First Coat - Primer:
    - a. Ferrous metal (to be used even at shop primed items except as noted in Division 5):
      - 1) Benjamin Moore: M04 Acrylic Metal Primer
      - 2) Glidden Professional: Devco Coatings Devflex 4020PF Direct to Metal Primer & Flat Finish.
      - 3) Pittsburgh Paints: 90-708 Series, Pitt-Tech One Pack Interior/Exterior Industrial Primer.
      - 4) Pratt & Lambert: Steel Tech Acrylic Prime & Finish Z190
      - 5) Sherwin Williams: ProCryl Universal Metal Primer B66-310 Series
    - b. Galvanized metal after thorough cleaning per SSPC-SP1 with water soluble degreaser. No hydrocarbons.
      - 1) Benjamin Moore: M04 Acrylic Metal Primer
      - 2) Glidden Professional: Devco Coatings Devflex 4020PF Direct to Metal Primer & Flat Finish.
      - 3) Pittsburgh Paints: 90-708 Series, Pitt-Tech One Pack Interior/Exterior Industrial Primer.
      - 4) Pratt & Lambert: Steel Tech Acrylic Prime & Finish Z190
      - 5) Sherwin Williams: ProCryl Universal Metal Primer B660310 Series
    - c. Aluminum:
      - 1) Benjamin Moore: M04 Acrylic Metal Primer
      - 2) Glidden Professional: Devco Coatings Devflex 4020PF Direct to Metal Primer & Flat Finish.
      - 3) Pittsburgh Paints: 90-708 Series, Pitt-Tech One Pack Interior/Exterior Industrial Primer.
      - 4) Pratt & Lambert: Steel Tech Acrylic Prime & Finish Z190
      - 5) Sherwin Williams: ProCryl Universal Metal Primer B66-310 Series
  4. Second and Third Coats:
    - a. Benjamin Moore: Moorcraft Latex Semi Gloss Enamel 276
    - b. Glidden Professional: Ultra-Hide 150 Interior Latex Semi-Gloss Paint 1416V Series.
    - c. Pittsburgh Paint: 6-512 Series, Speedhide Semi-Gloss Latex Enamel.
    - d. Pratt & Lambert: Enducryl Acrylic Semi Gloss Z6621
    - e. Sherwin Williams: Pro Industrial Zero VOC Acrylic Semi-Gloss B66-600 Series.
- H. Structural Steel, Interior Wet or Severe - Exposed:
1. For warranty purposes, the Contractor shall insure that the specified primer in Division 5 "Structural Steel" and the intermediate and finish coats specified below are from the same manufacturer.
    - a. No coatings shall be applied until approved by the Architect and Owner's Representative.
  2. Prime Coat: Refer to Division 5, "Structural Steel."

3. Intermediate Coat:
  - a. Tnemec: One (1) coat TNEMEC Series 161 Tneme-fascure @ 4.0 to 6.0 mil DFT.
  - b. Glidden Professional: Devoe Coatings One (1) coat Bar-Rust 231 Multi-Purpose Epoxy Mastic @ 4.0-8.0 mils DFT.
  - c. Wasser: One (1) component MC-CR @ 3.0-4.0 mils DFT.
  - d. Sherwin Williams: One (1) coat Macropoxy 646 FC @ 5-10 mils DFT.
4. Finish Coat:
  - a. Tnemec: One (1) coat TNEMEC Series 74 Endura-Shield @ 2.0 to 5.0 mil DFT.
  - b. Glidden Professional: One (1) Coat Devoe Coatings DETHANE 379H Aliphatic Urethane Enamel @ 2.0 to 3.0 mils DFT.
  - c. Wasser: One (1) component MC-Luster @ 2.0-4.0 mils DFT.
  - d. Sherwin Williams: One (1) coat Acrolon 218 HS @ 3-6 mils DFT.

2.6 MECHANICAL

A. Apparatus, Equipment, and Equipment Supports

1. First Coat:
  - a. Benjamin Moore: M04 Acrylic Metal Primer
  - b. Glidden Professional: Devoe Coatings Devflex 4020PF Direct to Metal Primer & Flat Finish.
  - c. Pittsburgh Paints: 90-708 Series, Pitt-Tech One Pack Interior/ Exterior.
  - d. Pratt & Lambert: Steel Tech Acrylic Prime & Finish Z190
  - e. Sherwin Williams: ProCryl Universal Metal Primer B66-310 Series
2. Second Coat:
  - a. Benjamin Moore: Moorcraft Latex Semi Gloss Enamel 276
  - b. Glidden Professional: Devoe Coatings Devflex 4216HP High Performance Waterborne Acrylic Semi-Gloss Enamel.
  - c. Pittsburgh Paints: 90-474 Series, Pitt-Tech One Pack Interior/Exterior Satin High Performance Industrial Enamel.
  - d. Pratt & Lambert: Enducryl Acrylic Semi Gloss Z6621
  - e. Sherwin Williams: Pro Industrial Zero VOC Acrylic Semi-Gloss B66-600 Series.

B. Exposed Bare Piping, Valves, Fittings, and Hangers:

1. First Coat:
  - a. Benjamin Moore: M04 Acrylic Metal Primer
  - b. Glidden Professional: Devoe Coatings Devflex 4020PF Direct to Metal Primer & Flat Finish.
  - c. Pittsburgh Paints: 90-708 Series, Pitt-Tech One Pack Interior/Exterior Industrial Primer.
  - d. Pratt & Lambert: Steel Tech Acrylic Prime & Finish Z190
  - e. Sherwin Williams: ProCryl Universal Metal Primer B66-310 Series.
2. Second Coat:
  - a. Benjamin Moore: Moorcraft Latex Semi Gloss 276

- b. Glidden Professional: Devoe Coatings Devflex 4216HP High Performance Waterborne Acrylic Semi-Gloss Enamel.
  - c. Pittsburgh Paints: 90-474 Series, Pitt-Tech One Pack Interior/Exterior Satin High Performance Industrial Enamel.
  - d. Pratt & Lambert: Enducryl Acrylic Semi Gloss Z6621
  - e. Sherwin Williams: Pro Industrial Zero VOC Acrylic Semi-Gloss B66-600 Series.
- C. Exposed Insulation Piping, Valves, Fittings, and Hangers when canvas wrapped:
  - 1. First Coat:
    - a. Benjamin Moore: Moorcraft Vinyl Latex Primer-Sealer 273
    - b. Glidden Professional: High Hide Interior Primer Sealer 1000-1200.
    - c. Pittsburgh Paints: Speedhide Latex Primer-Sealer 6-2
    - d. Pratt & Lambert: Pro Hide Gold High Holdout Latex Primer Z8165
    - e. Sherwin Williams: ProMar 200 Zero VOC Primer B28W2600
  - 2. Second Coat:
    - a. Benjamin Moore: Moorcraft Vinyl Latex Flat 275
    - b. Glidden Professional: Ultra-Hide 150 Interior Flat Paint 1210V Series.
    - c. Pittsburgh Paints: Speedhide Latex Interior Flat 6-70
    - d. Pratt & Lambert: Pro Hide Gold Flat Z8100
    - e. Sherwin Williams: ProMar 200 Zero VOC Flat B30 Series.
- D. Insulated Ductwork and Piping with Canvas Covering Inc. Hangers for any kind of ductwork.
  - 1. One Brush Coat:
    - a. Pittsburgh Paints: 42-7, Speedhide Interior Fire Retardant Flat Latex.
- E. Grilles, Registers, and Diffusers
  - 1. First Coat:
    - a. Benjamin Moore: M04 Acrylic Metal Primer
    - b. Glidden Professional: Devoe Coatings Devflex 4020PF Direct to Metal Primer & Flat Finish.
    - c. Pittsburgh Paints: 90-708 Series, Pitt-Tech One Pack Interior/Exterior Industrial Primer.
    - d. Pratt & Lambert: Steel Tech Acrylic Prime & Finish Z190
    - e. Sherwin Williams: ProCryl Universal Metal Primer B66-310 Series.
  - 2. Second and Third Coats:
    - a. Benjamin Moore: Moorcraft Latex Semi Gloss Enamel 276
    - b. Glidden Professional: Devoe Coatings Devflex 4216HP High Performance Waterborne Acrylic Semi-Gloss Enamel.
    - c. Pittsburgh Paints: 90-474 Series, Pitt-Tech One Pack Interior/Exterior Satin High Performance Industrial Enamel.
    - d. Pratt & Lambert: Enducryl Acrylic Semi Gloss Z6621
    - e. Sherwin Williams: Pro Industrial Zero VOC Acrylic Semi-Gloss B66-600 Series.

F. Exterior Ductwork Exposed to Weather

1. First Coat (Heavy coat of one of the following):
  - a. Glidden Professional: Devoe Coatings Devran 201H Universal Epoxy Primer.
  - b. Koppers: Bitumastic-Super Service Black
  - c. Pittsburgh Paints: 95-240 Series, Pitt-Guard Rapid Coat D-T-R.
  - d. Sherwin Williams: Macropoxy 646 Fast Cure, B58-600/B58V600.
  - e. Wasser: MC Tar.
2. Second and Third Coats (allow 24 hours drying time after first coat):
  - a. Glidden Professional: One (1) Coat Devoe Coatings DETHANE 379H Aliphatic Urethane Enamel @ 2.0 to 3.0 mils DFT.
  - b. Koppers: Bituglas Aluminum
  - c. Pittsburgh Paints: 95-240 Series, Pitt-Guard Rapid Coat D-T-R.
  - d. Sherwin Williams: Hi-Solids Polyurethane B65-300.
  - e. Wasser: MC Tar.

2.7 ELECTRICAL

A. Exterior Exposed Electrical Conduit Fittings, Boxes, and other miscellaneous exterior electrical items.

1. First Coat - Galvanized:
  - a. Benjamin Moore: M04 Acrylic Metal Primer
  - b. Glidden Professional: Devoe Coatings Devflex 4020PF Direct to Metal Primer & Flat Finish.
  - c. Pittsburgh Paints: 90-708 Series, Pitt-Tech One Pack Interior/Exterior Industrial Primer.
  - d. Pratt & Lambert: Steel Tech Acrylic Prime & Finish Z190
  - e. Sherwin Williams: ProCryl Universal Metal Primer B66-310 Series.
2. First Coat - Ferrous Metal:
  - a. Benjamin Moore: M04 Acrylic Metal Primer
  - b. Glidden Professional: Devoe Coatings Devflex 4020PF Direct to Metal Primer & Flat Finish.
  - c. Pittsburgh Paints: 90-708 Series, Pitt-Tech One Pack Interior/Exterior Industrial Primer.
  - d. Pratt & Lambert: Steel Tech Acrylic Prime & Finish Z190
  - e. Sherwin Williams: ProCryl Universal Metal Primer B66-310 Series.
3. Second and Third Coats:
  - a. Benjamin Moore: Impervex Enamel 309
  - b. Glidden Professional: Devoe Coatings Devflex 4216HP High Performance Waterborne Acrylic Semi-Gloss Enamel.
  - c. Pittsburgh Paints: 90-374 Series, Pitt-Tech One Pack Interior/Exterior Gloss High Performance Industrial Enamel.
  - d. Pratt & Lambert: Enducryl Acrylic Gloss Z6611
  - e. Sherwin Williams: DTM Acrylic Gloss Coating (Water Reducible), B66 Series

- B. Interior Exposed Electrical Items in areas where walls and/or ceilings are painted including electrical panels, cabinets, exposed conduit, etc.
1. First Coat - Galvanized:
    - a. Benjamin Moore: M04 Acrylic Metal Primer
    - b. Glidden Professional: Devoe Coatings Devflex 4020PF Direct to Metal Primer & Flat Finish.
    - c. Pittsburgh Paints: 90-708 Series, Pitt-Tech One Pack Interior/Exterior Industrial Primer.
    - d. Pratt & Lambert: Steel Tech Acrylic Prime & Finish Z190
    - e. Sherwin Williams: ProCryl Universal Metal Primer B66-310 Series.
  2. First Coat - Ferrous Metal:
    - a. Benjamin Moore: M04 Acrylic Metal Primer
    - b. Glidden Professional: Devoe Coatings Devflex 4020PF Direct to Metal Primer & Flat Finish.
    - c. Pittsburgh Paints: 90-708 Series, Pitt-Tech One Pack Interior/Exterior Industrial Primer.
    - d. Pratt & Lambert: Steel Tech Acrylic Prime & Finish Z190
    - e. Sherwin Williams: ProCryl Universal Metal Primer B66-310 Series.
  3. Second and Third Coats:
    - a. Benjamin Moore: Moorcraft Latex Semi Gloss Enamel 276
    - b. Glidden Professional: Devoe Coatings Devflex 4216HP High Performance Waterborne Acrylic Semi-Gloss Enamel.
    - c. Pittsburgh Paint: 90-474 Series, Pitt-Tech One Pack Interior/Exterior Satin High Performance Industrial Enamel.
    - d. Pratt & Lambert: Enducryl Acrylic Gloss Z6611
    - e. Sherwin Williams: Pro Industrial Zero VOC Acrylic Semi-Gloss B66-600 Series.

### 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 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. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

- D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
  - 1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

### 3.2 PREPARATION OF NEW SUBSTRATES

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
  - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
  - 2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
  - 1. Remove incompatible primers and reprime substrate with compatible primers 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. Clay Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content of surfaces or alkalinity of mortar joints to be painted exceed that permitted in manufacturer's written instructions.
- F. Concrete Masonry Substrates: Remove 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.
- G. Ferrous Metals, Galvanized Metal, Aluminum: Clean surfaces according to the Steel Structure Painting Council Surface Preparation Specifications: SSPC-SP1 Solvent Cleaning, SSPC-SP2 Hand Tool Cleaning, or SSPC-SP3 Power Tool Cleaning, as appropriate.
  - 1. Steel Substrates: Remove any rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.
  - 2. 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.
    - a. Thoroughly clean galvanized metal per SSPC-SP1 with water soluble degreaser. No hydrocarbons.
  - 3. Aluminum Substrates: Remove surface oxidation.



H. Wood Substrates:

1. Refer to Division 6 Section "Finish Carpentry and Millwork" for preparation specified under other trades.
2. Countersink all nails and finish with putty or plastic wood filler. Sand smooth when dried.
3. Sand surfaces that will be exposed to view, and dust off.
4. Prime edges, ends, faces, undersides, and backsides of wood.
5. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

I. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.

J. Plaster Substrates: Do not begin paint application until plaster is fully cured and dry.

K. Plastic Trim Fabrication Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.3 PREPARATION OF EXISTING SUBSTRATES

A. Preparation of Previously Painted Surfaces: Comply with requirements as specified for preparation of new substrates as well as the following:

1. Scrub clean existing surfaces with a stiff brush and a solution of clean water and mild detergent.
2. Scuff sand surface to allow new finish to hold.
3. De-gloss painted surfaces in a manner appropriate to the substrate.
4. Fill cracks, holes, voids and defects, and leave a smooth surface ready for application of primer.
5. Remove loose paint and feather edges or patch as required to provide a smooth, seamless finish.
6. Prepare a 36" x 36" minimum test area to see if a reaction occurs between existing and new finishes prior to proceeding with the specified work. If a reaction occurs, alert Architect and propose solution(s).

3.4 PRIMING AND BACKPRIMING OF WOOD

- A. All wood, factory finished or otherwise, must be back-primed immediately upon delivery with interior trim primer specified for wood which is to be painted, or finish manufacturer's recommended protective pre-treatment for wood which is to have natural finish.
- B. Apply first coat to all wood scheduled to receive natural finish before material is handled at the site by other trades.
- C. Furnish sealer to other trades for touching up any bare wood caused by mortising or butting of surfaces, or any kind of assembly or installation.

- D. Avoid painting over or otherwise staining edges of wood where natural finish is scheduled.

3.5 APPLICATION

- A. General: Apply paints according to manufacturer's written instructions.

1. Use applicators and techniques suited for paint and substrate indicated.
  - a. Except where specifically authorized by the Architect to do otherwise: Apply flat or eggshell wall paint by brush or roller; apply gloss or semi-gloss with brush only.
2. Sanding: In addition to preparatory sanding, fine sand between succeeding coats of all varnish enamel or flat enamel, using sandpaper appropriate to the finish. Use fine production paper between coats.
3. 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.
4. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
5. Doors: Finish all edges, including tops and bottoms, of wood and metal doors same as faces. Fill edges of exposed plywood doors, panels, similar materials.
6. Finish interior of all closets and cabinets same as adjoining rooms, unless otherwise scheduled.
7. Apply one coat of sanding sealer and one coat of semi-gloss varnish to insides of all drawers unless otherwise specified.

- 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. The number of coats scheduled are minimums.

- 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.

1. Holidays and restrikes in painted surfaces shall be considered sufficient cause to require recoating of entire surface.

- E. Painting Mechanical and Electrical Work: Paint items exposed in equipment rooms and occupied spaces including, but not limited to, the following:

1. Mechanical Work:
  - a. Uninsulated metal piping.
  - b. Uninsulated plastic piping.
  - c. Pipe hangers and supports.
  - d. Tanks that do not have factory-applied final finishes.

- e. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
- f. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
- g. Mechanical equipment that is indicated to have a factory-primed finish for field painting.

2. Electrical Work:

- a. Switchgear.
- b. Panelboards.
- c. Electrical equipment that is indicated to have a factory-primed finish for field painting.

3.6 FIELD QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when paints are being applied:
  - 1. Owner will engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
  - 2. Testing agency will perform tests for compliance of paint materials with product requirements.
  - 3. Owner may direct Contractor to stop applying paints 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.

3.7 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\*\***

VISUAL DISPLAY BOARDS

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 types of visual display boards:
  - 1. Porcelain enamel markerboards.
  - 2. Fabric-faced tackboards.
- B. Related Sections: The following sections contain requirements that relate to this section:
  - 1. Division 06 Section "Rough Carpentry" for wood blocking and grounds.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data: Include individual panel weights for sliding units. Include manufacturer's data substantiating that tackboard materials comply with requirements indicated.
- C. Shop Drawings: Provide shop drawings for each type of chalkboard, markerboard, and tackboard required. Include sections of typical trim members and dimensioned elevations. Show anchors, grounds, reinforcement, accessories, layout, and installation details.
- D. Samples: Provide the following samples of each product for initial selection of colors, patterns, and textures, as required, and for verification of compliance with requirements indicated.
  - 1. Samples for initial selection of color, pattern, and texture:
    - a. Porcelain Enamel Markerboard: Manufacturer's color charts consisting of actual sections of porcelain enamel finish showing the full range of colors available for each type of markerboard required.
    - b. Fabric-faced Tackboards: Manufacturer's color charts consisting of actual sections of fabric, showing the full range of colors, textures, and patterns available for each type of fabric-faced tackboard indicated.
    - c. Aluminum Trim and Accessories: Samples of each finish type and color, on 6-inch-long sections of extrusions and not less than 4-inch squares of sheet or plate, showing the full range of colors available.
- E. Certificates: In lieu of laboratory test reports, when permitted by the Architect, submit the manufacturer's certification that vinyl-fabric-faced cork tackboard materials furnished comply with requirements specified for flame spread ratings.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who is an authorized representative of the visual display board manufacturer for both installation and maintenance.
  - 1. Maintenance Proximity: Not more than 4 hours' normal travel time from the Installer's place of business to the Project site.
- B. Fire Performance Characteristics: Provide fabric-faced tackboards with surface burning characteristics indicated below, as determined by testing assembled materials composed of facings and backings identical to those required in this section, in accordance with ASTM E 84, by a testing organization acceptable to authorities having jurisdiction.
  - 1. Flame Spread: 25 or less.
  - 2. Smoke Developed: 10 or less.
- C. Design Criteria: The drawings indicate size, profiles, and dimensional requirements of visual display boards and are based on the specific type and model indicated. Other visual display boards having equal performance characteristics by other manufacturers may be considered provided that deviations in dimensions and profiles are minor and do not change the design concept or intended performance as judged by the Architect. The burden of proof of equality is on the proposer.

1.5 PROJECT CONDITIONS

- A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication to ensure proper fitting. Show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay.
  - 1. Allow for trimming and fitting wherever taking field measurements before fabrication might delay the Work.

1.6 WARRANTY

- A. Porcelain Enamel Markerboard Warranty: Furnish the manufacturer's written warranty, agreeing to replace porcelain enamel chalkboards and markerboards that do not retain their original writing and erasing qualities, exhibit crazing, cracking, or flaking, provided the manufacturer's instructions with regard to handling, installation, protection, and maintenance have been followed.
  - 1. Warranty Period: Lifetime of the building.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products of one of the following:
  - 1. Aarco Products Inc.
  - 2. Best-Rite Chalkboard Co.
  - 3. Claridge Products and Equipment, Inc.

4. Marsh Industries, Inc.
5. Newline Corp.
6. PolyVision Corp.

## 2.2 MATERIALS

- A. Porcelain Enamel Markerboards: Provide balanced, high-pressure-laminated porcelain enamel chalkboards and markerboards of 3-ply construction consisting of face sheet, core material, and backing.
1. Face Sheet: Provide face sheet of 24-gage enameling grade steel especially processed for temperatures used in coating porcelain on steel. Coat the exposed face and exposed edges with a 3-coat process consisting of primer, ground coat, and color cover coat, and the concealed face with a 2-coat process consisting of primer and ground coat. Fuse cover and ground coats to steel at the manufacturer's standard firing temperatures, but not less than 1200 deg F (649 deg C).
    - a. Chalkboard Cover Coat: Provide the manufacturer's standard colored writing surface intended for use with chalk. Color shall be chosen by Architect from manufacturer's standard colors.
    - b. Markerboard Cover Coat: Provide the manufacturer's standard light-colored special writing surface with gloss finish intended for use with liquid felt-tipped markers. Color shall be chosen by Architect from manufacturer's standard colors.
  2. Core: Provide the manufacturer's standard 3/8-inch-thick particleboard core material complying with the requirements of ANSI A208.1, Grade 1-M-1.
  3. Backing Sheet: Provide the manufacturer's standard 0.015-inch-thick aluminum sheet backing.
  4. Laminating Adhesive: Provide the manufacturer's standard moisture-resistant thermoplastic-type adhesive.
- B. Fabric-Faced Fiberboard Tackboards: Fabric factory laminated to 1/2-inch- (13-mm-) thick fiberboard backing; ASTM E84 - Class A rating.
1. Fiberboard: ANSI A208.2, Grade MD.
  2. Vinyl Fabric: FS CCC-W-408, Type II, burlap weave; weighing not less than 13 oz./sq. yd. (440 g/sq. m); with flame-spread index of 25 or less when tested according to ASTM E 84.
    - a. Fabric: Provide Steppe 2VST from Source One, D.L. Couch, or equal. Architect to select from manufacturer's full range of colors. Manufacturer's representative: Christy Opalka (313) 550-1714.

## 2.3 ACCESSORIES

- A. Metal Trim and Accessories: Fabricate frames and trim of not less than 0.062-inch-thick aluminum of size and shape as indicated and to suit type of installation. Provide straight,

single-length units wherever possible; keep joints to a minimum. Miter corners to a neat, hairline closure.

1. Extruded Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063.
2. Where the size of boards or other conditions exist that require support in addition to the normal trim, provide structural supports or modify the trim as indicated or as selected by the Architect from the manufacturer's standard structural support accessories to suit the condition indicated.
3. Marker/Chalk Tray: Furnish the manufacturer's standard continuous, solid extrusion-type aluminum marker/chalk tray with ribbed section and smoothly curved exposed ends, for each markerboard and chalkboard.
4. Map Rail: Furnish map rail at the top of each unit, complete with the following accessories:
  - a. Display Rail: Provide continuous cork display rail approximately 1 or 2 inches wide, as indicated, integral with the map rail.
  - b. End Stops: Provide one end stop at each end of the map rail.
  - c. Map Hooks: Provide two (2) map hooks for each 4 feet of map rail or fraction thereof.
  - d. Map Hooks: Provide two (2) map hooks with flexible metal clips for each 4 feet of map rail or fraction thereof.
  - e. Flagholder: Provide one (1) flagholder for each room.

#### 2.4 FABRICATION

- A. Porcelain Enamel Markerboards: Laminate facing sheet and backing sheet to core material under pressure with manufacturer's recommended flexible, waterproof adhesive.
- B. Assembly: Provide factory-assembled chalkboard, markerboard and tackboard units, except where field-assembled units are required.
  1. Make joints only where total length exceeds maximum manufactured length. Fabricate with the minimum number of joints, balanced around the center of the board, as acceptable to the Architect.
  2. Provide the manufacturer's standard vertical joint system between abutting sections of chalkboard or markerboard.
  3. Provide manufacturer's standard mullion trim at joints between chalkboard, markerboard and tackboard.

#### 2.5 FINISHES

- A. General: Comply with NAAMM "Metal Finishes Manual" for recommendations relative to application and designations of finishes.
- B. Finish designations prefixed by "AA" conform to the system established by the Aluminum Association for designating aluminum finishes.
- C. Class II Clear Anodized Finish: AA-M12C22A31 (Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class II Architectural, clear film thicker than 0.4 mil).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Deliver factory-built chalkboard, markerboard and tackboard units completely assembled in one piece without joints, wherever possible. Where dimensions exceed panel size, provide 2 or more pieces of equal length as acceptable to the Architect. When overall dimensions require delivery in separate units, prefabricate components at the factory, disassemble for delivery, and make final joints at the site. Use splines at joints to maintain surface alignment.
- B. Install units in locations and at mounting heights indicated and in accordance with the manufacturer's instructions. Keep perimeter lines straight, plumb, and level. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for a complete installation.
- C. Coordinate job-site assembled units with grounds, trim, and accessories. Join parts with a neat, precision fit.

3.2 ADJUST AND CLEAN

- A. Verify that accessories required for each unit have been properly installed and that operating units function properly.
- B. Clean units in accordance with the manufacturer's instructions. Break in chalkboards only as recommended by the manufacturer.

\*\*END OF SECTION\*\*



METAL LOCKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
  - 1. Knocked-down, standard metal lockers.
- B. Related Sections include the following:
  - 1. Division 06 Section "Rough Carpentry" for furring, blocking, and shims required for installing metal lockers and concealed within other construction before metal locker installation.
- C. Uncoated Steel Sheet Thicknesses: Indicated as the minimum thicknesses.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of metal locker.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal locker.
- B. Shop Drawings: For metal lockers.
  - 1. Include plans, elevations, sections, details, and attachments to other work.
  - 2. Show locker trim and accessories.
  - 3. Include locker identification system and numbering sequence.
- C. Samples: For each color specified, in manufacturer's standard size.
- D. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available.
- E. Samples for Verification: For the following products, in manufacturer's standard size:
  - 1. Lockers and equipment.
- F. Product Schedule: For lockers.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative of metal locker manufacturer for installation and maintenance of units required for this Project.
- B. Source Limitations: Obtain metal lockers and accessories through one source from a single manufacturer.
- C. Product Options: Drawings indicate size, profiles, and dimensional requirements of metal lockers and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
  - 1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
- D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver metal lockers until spaces to receive them are clean, dry, and ready for metal locker installation.
- B. Deliver master and control keys and combination control charts to Owner.

1.8 PROJECT CONDITIONS

- A. Field Measurements: Verify the following by field measurements before fabrication and indicate measurements on Shop Drawings:
  - 1. Concealed framing, blocking, and reinforcements that support metal lockers before they are enclosed.
  - 2. Recessed openings.
  - 3. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish recessed opening dimensions and proceed with fabricating metal lockers without field measurements. Coordinate wall and floor construction to ensure that actual recessed opening dimensions correspond to established dimensions.

1.9 COORDINATION

- A. Coordinate size and location of concrete and concrete masonry bases for metal lockers.
- B. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that metal lockers can be supported and installed as indicated.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures.
    - b. Faulty operation of latches and other door hardware.
  - 2. Damage from deliberate destruction and vandalism is excluded.
  - 3. Warranty Period for Knocked-Down Metal Lockers: Two years from date of Substantial Completion.

1.11 EXTRA MATERIALS

- A. Furnish extra materials described below, before construction begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Full-size units of the following metal locker hardware items equal to 10 percent of amount installed for each type and finish installed, but no fewer than 5 units:
    - a. Locks.
    - b. Identification plates.
    - c. Hooks.

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. Basis-of-Design Product: The design for each metal locker specified is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008, Commercial Steel (CS) Type B, suitable for exposed applications.
- B. Fasteners: Zinc- or nickel-plated steel, slotless-type exposed bolt heads, and self-locking nuts or lock washers for nuts on moving parts.
- C. Anchors: Select material, type, size, and finish required for secure anchorage to each substrate.
  - 1. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance.
  - 2. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

2.3 KNOCKED-DOWN, STANDARD METAL LOCKERS

- A. Basis-of-Design Product: Standard Lockers as manufactured by Penco Products - Guardian lockers or a comparable product of one of the following:
1. DeBourgh Mfg. Co.
  2. List Industries Inc.
  3. Lyon Workspace Products.
  4. Newline Corp.
  5. Penco Products, Inc., Subsidiary of Vesper Corporation.
- B. Locker Arrangement:
1. Type L1 – single tier 12"w x 15"d x 30"h on top of single tier 12"w x 15"d x 42"h
  2. Type L2 – single tier 15"w x 15"d x 30"h on top of single tier 15"w x 15"d x 42"h
- C. Body: Assembled by riveting or bolting body components together. Fabricate from unperforated, cold-rolled steel sheet with thicknesses as follows:
1. Tops, Bottoms, and Intermediate Dividers: 0.0209 inch (0.55 mm), with single bend at sides.
  2. Bottoms: 0.0598 inch (1.34 mm), with single bend at sides.
  3. Backs and Sides: 0.0209 inch (0.55 mm) thick, with full-height, double-flanged connections.
  4. Shelves: None required
- D. Frames: Channel formed; fabricated from 0.0528-inch- (1.35-mm-) thick, cold-rolled steel sheet; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral door strike full height on vertical main frames.
1. Cross Frames between Tiers: Channel formed and fabricated from same material as main frames; welded to vertical frame members.
- E. Doors: One-piece; fabricated from 0.0528-inch- (1.35-mm-) thick, cold-rolled steel sheet; formed into channel shape with double bend at vertical edges, and with right-angle single bend at horizontal edges.
1. Doors less than 12 inches (305 mm) wide may be fabricated from 0.0428-inch- (1.1-mm-) thick, cold-rolled steel sheet.
  2. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than 15 inches (381 mm) wide; welded to inner face of doors.
  3. Door Style: Vented panel as follows:
    - a. Louvered Vents:

- 1) Not less than six louver openings at top and bottom for single-tier
- F. Hinges: Welded to door and attached to door frame with not less than 2 factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees.
1. Knuckle Hinges: Steel, full loop, 5 or 7 knuckles, tight pin; minimum 2 inches (51 mm) high. Provide not less than 3 hinges for each door more than 42 inches (1067 mm) high.
- G. Door Handle and Latch: Stainless-steel strike plate with integral pull; with steel padlock loop that projects through metal locker door matching existing.
- H. Built-in Combination Locks: Key-controlled, three-number dialing combination locks; capable of at least five combination changes made automatically with a control key.
1. Bolt Operation: Manually locking deadbolt or automatically locking spring bolt.
- I. Equipment: Equip each metal locker with identification plate and the following, unless otherwise indicated:
1. Single-Tier Units:
    - a. Two single-prong wall hooks.
- J. Accessories:
1. Continuous Base: Knocked down lockers shall be furnished with 4" high, 14 gauge zee base flanged outward at top for support of lockers and inward at bottom for anchoring to the floor. Provide end bases at ends of rows
  2. Continuous Sloping Tops: Fabricated from cold-rolled steel sheet, manufacturer's standard thickness, but not less than 0.0329 inch (0.85 mm) thick.
    - a. Closures: Vertical-end type.
    - b. Sloped top corner fillers, mitered.
  3. Recess Trim: Fabricated from 0.0428-inch- (1.1-mm-) thick, cold-rolled steel sheet.
  4. Filler Panels: Fabricated from cold-rolled steel sheet, manufacturer's standard thickness, but not less than 0.0329 inch (0.85 mm) thick.
  5. Finished End Panels: Fabricated from 0.0209-inch- (0.55-mm-) thick, cold-rolled steel sheet.
- K. Finish: Baked enamel or powder coat.
1. Color(s):
    - a. Custom color to match existing lockers.
- 2.4 FABRICATION
- A. General: Fabricate metal lockers square, rigid, and without warp; with metal faces flat and free of dents or distortion. Make exposed metal edges free of sharp edges and burrs, and safe to touch.

1. Form body panels, doors, and accessories from one-piece steel sheet, unless otherwise indicated.
  2. Provide fasteners, filler plates, supports, clips, and closures as required for a complete installation.
- B. Unit Principle: Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments.
- C. Knocked-Down Construction: Fabricate metal lockers for nominal assembly at Project site using nuts, bolts, screws, or rivets. Factory weld frame members together to form a rigid, one-piece assembly.
- D. Hooks: Manufacturer's standard ball-pointed type, aluminum or steel; zinc plated.
- E. Identification Plates: Manufacturer's standard etched, embossed, or stamped aluminum plates; with numbers and letters at least 3/8 inch (9 mm) high.
- F. Continuous Sloping Tops: Fabricated in lengths as long as practicable, without visible fasteners at splice locations; finished to match lockers.
1. Sloped top corner fillers, mitered.
- G. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip joint filler angle formed to receive filler panel.
- H. Finished End Panels: Designed for concealing unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.
1. Provide one-piece panels for double-row (back-to-back) locker ends.

## 2.5 STEEL SHEET FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Factory finish steel surfaces and accessories except stainless-steel and chrome-plated surfaces.
- C. Surface Preparation: Clean surfaces of dirt, oil, grease, mill scale, rust, and other contaminants that could impair paint bond. Use manufacturer's standard methods.
- D. Powder-Coat Finish: Immediately after cleaning and pretreating, electrostatically apply manufacturer's standard baked-polymer thermosetting powder finish. Comply with resin manufacturer's written instructions for application, baking, and minimum dry film thickness.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine walls, floors, and support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. General: Install level, plumb, and true; shim as required, using concealed shims.
  - 1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches (910 mm) o.c. Install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion, using concealed fasteners.
  - 2. Anchor single rows of metal lockers to walls near top of lockers and to floor.
  - 3. Anchor back-to-back metal lockers to floor.
- B. Knocked-Down Metal Lockers: Assemble knocked-down metal lockers with standard fasteners, with no exposed fasteners on door faces or face frames.
- C. Equipment and Accessories: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.
  - 1. Attach hooks with at least two fasteners.
  - 2. Attach door locks on doors using security-type fasteners.
  - 3. Identification Plates: Identify metal lockers with identification indicated on Drawings.
    - a. Attach plates to each locker door, near top, centered, with at least two aluminum rivets.
    - b. Attach plates to upper shelf of each open-front metal locker, centered, with a least two aluminum rivets.
  - 4. Attach recess trim to recessed metal lockers with concealed clips.
  - 5. Attach filler panels with concealed fasteners. Locate fillers panels where indicated on Drawings.
  - 6. Attach sloping top units to metal lockers, with closures at exposed ends.
  - 7. Attach finished end panels with fasteners only at perimeter to conceal exposed ends of nonrecessed metal lockers.

### 3.3 ADJUSTING, CLEANING, AND PROTECTION

- A. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding. Verify that integral locking devices operate properly.
- B. Protect metal lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit metal locker use during construction.
- C. Touch up marred finishes, or replace metal lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by metal locker manufacturer.

**\*\*END OF SECTION\*\***

ROLLER SHADES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes manual roller shades.
- B. Related Sections include the following:
  - 1. Division 06 Section "Rough Carpentry" for wood blocking and grounds.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions.
- B. Shop Drawings: Show location and extent of roller shades. Include elevations, sections, details, and dimensions not shown in Product Data. Show installation details, mountings, attachments to other Work, operational clearances, and relationship to adjoining work.
- C. Full size sample for verification purposes of each type of window shade showing all components, materials, and finishes to be exposed to view. Prepare samples from same materials to be used for fabricating units.
- D. Samples for Verification:
  - 1. Complete, full-size operating unit not less than 16 inches (400 mm) wide for each type of roller shade indicated.
  - 2. Shade Material: Not less than 3 inches (80 mm) square, with specified treatments applied. Mark face of material.
  - 3. Valance: Full-size unit, not less than 12 inches (300 mm) long.
- E. Window Treatment Schedule: Include roller shades in schedule using same room designations indicated on Drawings.
- F. Product Certificates: For each type of roller shade product, signed by product manufacturer.
- G. Product Test Reports: For each type of roller shade product.
- H. Qualification Data: For Installer.
- I. Maintenance Data: For roller shades to include in maintenance manuals. Include the following:
  - 1. Methods for maintaining roller shades and finishes.



2. Precautions about cleaning materials and methods that could be detrimental to fabrics, finishes, and performance.
  3. Operating hardware.
- J. Warranty: Furnish a twenty five year (25) guarantee against defects in material and workmanship from the date of substantial completion.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed installation of roller shades similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
1. Provide a list of three institutional-quality window shade projects successfully completed within the last five years. For each project include the following:
    - a. Project/building name and location.
    - b. Description of scope.
    - c. Representative's name and phone number.
- B. Source Limitations: Obtain roller shades through one source from a single manufacturer.
- C. Corded Window Covering Product Standard: Provide roller shades complying with WCMA A 100.1.
- D. Mockups: Build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution.
1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
  2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver shades in factory packages, marked with manufacturer and product name, and location of installation using same room designations indicated on Drawings and in a window treatment schedule.

#### 1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction and wet and dirty finish work in spaces, including painting, is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operable glazed units' operation hardware throughout the entire operating range. Notify Architect of discrepancies. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide MechoShades as manufactured by MechoShade Systems, Inc or equal products by one of the following:
1. Draper Shade and Screen Co., Inc.
  2. Solarfective Products, Ltd.
- B. Refer to roller shade schedule in Part 3.

2.2 ROLLER SHADES

- A. Shade Band Material - Translucent
1. Translucent Shades shall be light filtering, flame retardant, fade and soil resistant and washable.
    - a. Construction: 100% thermoplastic olefin
    - b. Openness Factor: 3 percent.
    - c. Meets Government Spec. #CCC-C-521-E.
    - d. Type I product
    - e. Weight: Must be a minimum of 6.4 oz. per square yard.
    - f. Color: As selected by Architect from manufacturer's full range.
  2. Provide EcoVeil 1550 Series ShadeCloth as manufactured by MechoShade Systems or equal products by one of the following:
    - a. Draper Shade and Screen Co., Inc.
    - b. Solarfective Products, Ltd.
- B. Rollers: Electrogalvanized or epoxy primed steel or extruded-aluminum tube of diameter and wall thickness required to support and fit internal components of operating system and the weight and width of shade band material without sagging; designed to be easily removable from support brackets; with removable spline fitting integral channel in tube Provide capacity for one roller shade band per roller, unless otherwise indicated on Drawings.
- C. Direction of Roll: Regular, from back of roller.
- D. Mounting Brackets: Galvanized or zinc-plated steel.
- E. Roller Shades, Non-Pocket-Style:
1. Fascia: L-shaped, formed-steel sheet or extruded aluminum; long edges returned or rolled; continuous panel concealing front and bottom of shade roller, brackets, and operating hardware and operators; length as indicated on Drawings or in a window treatment schedule; removable design for access.
  2. Top/Back Cover: L shaped; material and finish to match fascia; combining with fascia and end caps to form a six-sided headbox enclosure sized to fit shade roller and operating hardware inside.
- F. Bottom Bar: Steel or extruded aluminum, with plastic or metal capped ends. Provide exposed-to-view, external-type bottom bar with concealed weight bar as required for smooth, properly balanced shade operation.

G. Shade Operation:

1. Manual: Provide with spring roller continuous loop bead chain, clutch, and cord tensioner and bracket lift operator.
  - a. Position of Clutch Operator: Left or Right side of roller, as determined by hand of user facing shade from inside, unless otherwise indicated on Drawings or in a window treatment schedule.
  - b. Clutch: Capacity to lift size and weight of shade; sized to fit roller or provide adaptor.
  - c. Lift Assist Mechanism: Manufacturer's standard spring assist for balancing roller shade weight and lifting heavy roller shades.
  - d. Loop Length: Length required to make operation convenient from floor level.
  - e. Bead Chain: Nickel-plated metal or stainless steel.
  - f. Operating Function: Stop and hold shade at any position in ascending or descending travel.

H. Valance: Style matching hem; as indicated by manufacturer's designation color or as indicated in a window treatment schedule.

I. Mounting: As indicated on Drawings, mounting permitting easy removal and replacement without damaging roller shade or adjacent surfaces and finishes.

2.3 ROLLER SHADE FABRICATION

A. Product Description: Roller shade consisting of a roller, a means of supporting the roller, a flexible sheet or band of material carried by the roller, a means of attaching the material to the roller, a bottom bar, and an operating mechanism that lifts and lowers the shade.

B. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.

1. Lifting Mechanism: With permanently lubricated moving parts.

C. Unit Sizes: Obtain units fabricated in sizes to fill window and other openings as follows, measured at 74 deg F (23 deg C):

1. Shade Units Installed between (Inside) Jambs: Edge of shade not more than 1/4 inch (6 mm) from face of jamb. Length equal to head to sill dimension of opening in which each shade is installed.
2. Shade Units Installed Outside Jambs: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.

D. Installation Brackets: Designed for easy removal and reinstallation of shade, for supporting headbox, roller, and operating hardware and for hardware position and shade mounting method indicated.

E. Installation Fasteners: Not fewer than two fasteners per bracket, fabricated from metal noncorrosive to shade hardware and adjoining construction; type designed for securing to supporting substrate; and supporting shades and accessories under conditions of normal use.

F. Color-Coated Finish: For metal components exposed to view, apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

- G. Colors of Metal and Plastic Components Exposed to View: As selected by Architect from manufacturer's full range.

## 2.4 WARRANTY

- A. Furnish a twenty five year (25) guarantee against defects in material and workmanship from the date of substantial completion.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, accurate locations of connections to building electrical system, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 ROLLER SHADE INSTALLATION

- A. Install roller shades level, plumb, square, and true according to manufacturer's written instructions, and located so shade band is not closer than 2 inches (50 mm) to interior face of glass. Allow clearances for window operation hardware.
- B. Connections: Connect motorized operators to building electrical system.

### 3.3 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

### 3.4 CLEANING AND PROTECTION

- A. Clean roller shade surfaces after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

### 3.5 DEMONSTRATION

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

### 3.6 ROLLER SHADE SCHEDULE

- A. Type A Shade Band Material: Translucent  
Operation: Manual  
Installation: Non-pocket style

**\*\*END OF SECTION\*\***

PREFABRICATED CASEWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
  - 1. Prefabricated laminate clad casework and components.
  - 2. Countertops.
  - 3. Miscellaneous pieces including mobile storage units and tables.
- B. Related Sections include the following:
  - 1. Division 6 Section "Rough Carpentry" for blocking within walls.
  - 2. Division 6 Section "Finish Carpentry and Millwork" for custom cabinetry.
  - 3. Division 9 Section "Resilient Tile Flooring" for resilient base molding.
  - 4. Division 22 for sinks and service fixtures, service waste lines, connections, ducting within or adjacent to casework, and vents.
  - 5. Division 26 for electrical services.

1.3 DEFINITIONS

- A. Identification of casework components and related products by surface visibility.
  - 1. Exposed Surfaces:
    - a. Any storage unit exterior front, side, or rear surface that is visible after installation.
    - b. Faces of doors and drawers when closed.
    - c. Tops of cabinets less than 72 inches above furnished floor.
    - d. Any open interior of a storage unit without solid door or drawer fronts and units with glass insert doors.
  - 2. Semi-Exposed Surfaces:
    - a. Any interior surface of a storage unit that is behind solid doors, drawer fronts, or sliding solid doors.
    - b. Bottoms of wall cabinets.
    - c. Tops of cabinets 72 inches or more above finished floor.
  - 3. Concealed Surfaces: Any surface not visible after installation.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Indicate dimensions, description of materials and finishes, general construction, specific modifications, component connections, anchorage methods, hardware, and installation procedures.
  - 2. Indicate locations of plumbing and electrical service field connection by others.
- C. Samples for Initial Selection: Provide color charts for the following:
  - 1. Plastic laminates.
  - 2. PVC edging.
  - 3. Hardware finishes.
- D. Samples for Verification: Provide the following:
  - 1. Laminate clad panel products, 8-1/2 inches, by 11 inches for each type, color, pattern, and surface finish including edging, with separate samples of unfaced panel products used for core.
  - 2. Exposed cabinet hardware, one unit of each type and finish.
- E. Casework Samples: To be provided only upon request of the Architect.
  - 1. Base cabinet: Cabinet conforming to specifications, with drawer, door and countertop.
  - 2. Wall cabinet: Cabinet conforming to specifications, with door.
  - 3. Cabinet samples shall be complete with specified hardware for doors, drawers and shelves.
- F. Qualification Data: For Manufacturer and Installer.

1.5 QUALITY ASSURANCE

- A. Manufacturer: Minimum of ten (10) years experience in providing manufactured casework systems for similar types of projects.
- B. Installer Qualifications: An installer with not less than five (5) years of successful experience in installing prefabricated casework similar to that required for this project and which is approved by manufacturer.
- C. Comply with applicable provisions of the following specifications and documents:
  - 1. Michigan Building Code and Michigan Barrier Free requirements.
  - 2. ANSI A117.1 - 2003, Accessible and Usable Buildings and Facilities.
  - 3. ADA, Accessibility Guidelines for Buildings and Facilities, Federal Register Volume 56, Number 144, Rules and Regulations.

1.6 DELIVERY, STORAGE, AND PRODUCT HANDLING

- A. Do not deliver completed laminate clad casework, countertops, and related products until spaces to receive them are clean, dry, and ready for casework installation.
- B. Environmental Requirements:
  - 1. Do not deliver or install casework until interior concrete work, masonry, plastering and other wet operations are complete.
  - 2. Store casework in a ventilated place, protected from the weather, with relative humidity range of 20 percent to 50 percent.
- C. Protect finished surfaces from soiling and damage during handling and installation with a protective covering.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify the following by field measurements before fabrication and indicate measurements on Shop Drawings:
  - 1. Concealed framing, blocking, and reinforcements that support casework before they are enclosed.
  - 2. Cabinet layouts and locations.
  - 3. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish recessed opening dimensions and proceed with fabricating casework without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.8 COORDINATION

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

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of casework that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five (5) years from date of Substantial Completion.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. General Basis-of-Design: Products and catalog numbers specified on the Drawings are from the catalog of TMI Systems Design Corporation and shall be used as a basis for identification, configuration, size, and quality. The design for each unit is based on the product called out on the Drawings.
- B. Manufacturers: Subject to compliance with requirements, provide products by TMI Systems Design Corporation or equal by one of the following:

1. Case Systems, Inc.
2. LSI Corporation.
3. Wood-Metal Industries, a division of Wood-Mode, Inc.

## 2.2 MATERIALS

### A. Core Materials:

1. Particleboard up to 7/8 inch thick: Industrial Grade average 47-pound density particleboard, ANSI A 208.1-1999, M-3.
2. Particleboard 1 inch thick and thicker: Industrial Grade average 45-pound density particle-board, ANSI A 208.1-1999, M-2.
3. Moisture Resistant Particle Board, 1 inch thick: ANSI A208.1-1999 M-3 MR.
4. Medium Density Fiberboard 3/4 inch thick: Average 48-pound density grade, ANSI A208.2.

### B. Decorative Laminates:

1. High-pressure decorative laminate VGS (.028), NEMA Test LD 3-1995.
2. High-pressure decorative laminate HGS (.048), NEMA Test LD 3-1995.
3. High-pressure decorative laminate HGP (.039), NEMA Test LD 3-1995.
4. High-pressure cabinet liner CLS (.020), NEMA Test LD 3-1995.
5. High-pressure backer BKL (.020), NEMA Test LD3-1995.
6. Thermally fused melamine laminate, NEMA Test LD 3-1995.

### C. Edging Materials: Edging shall be a high impact, crack and chip resistant, rigid material, with integral color throughout.

1. 1mm PVC banding.
2. 3mm PVC banding.

## 2.3 CABINET HARDWARE

### A. Hinges: Five knuckle, steel, institutional grade, capable of 270 degree swing, hospital tipped with non-removable pin. 0.095 inch thick. ANSI-BHMA standard A156.9, Grade 1.

1. Doors 48 inches and over in height have 3 hinges per door.

### B. Door Catches: Door catches shall be heavy-duty spring loaded large diameter roller type. Each door shall have a single catch mounted at the bottom edge. All doors over 48" high shall have a catch at both the top and bottom of the door.



1. Catch strike plates shall be injection molded nylon, with an integral molded engagement ridge. Strike plate shall also provide a wide face bumper insuring a positive doorstop.
  - C. Pulls: Architect shall select from manufacturer's wire pulls and plastic molded pulls.
    1. Wire pulls shall be prefinished metal.
  - D. Drawer Slides:
    1. Kneespace, pencil drawers and all drawers 4" deep or less: Single extension, 100-pound load rated epoxy coated steel, bottom corner mounted with smooth and quiet nylon rollers. Positive stop both directions with self-closing feature.
    2. File and all drawers over 4" deep: Full extension, 150-pound load rated epoxy coated steel, bottom corner or side mounted with smooth and quiet nylon rollers. Positive stop both directions with self-closing feature.
  - E. Adjustable Shelf Supports: Injection molded clear polycarbonate clip with two (2) integral support pins, 5mm diameter, that shall friction fit into cabinet end panels and vertical dividers, adjustable on 32mm centers.
    1. Clips shall incorporate integrally molded lock tabs to retain shelf from tipping or inadvertently being lifted out.
    2. Each clip shall be capable of supporting a minimum of 200 pounds without failure.
    3. Clips shall be adjustable with the option of being permanently fixed.
  - F. Sliding Door Track: Anodized aluminum double channel.
  - G. Coat Rods: 1 inch diameter, 14-gauge chrome plated steel installed in captive mounting hardware.
  - H. Locks: Locks shall be die cast, cylinder type with a five-disc tumbler mechanism and a removeable core. Locks shall be cam style for drawers and doors. At other locations, use lock style required to suit application.
    1. Locks shall be provided on all casework.
    2. All locks within a room shall be keyed alike and different than adjacent rooms. All locks on the Project shall be master keyed.
      - a. Provide two (2) keys for each room and three (3) master keys.
- 2.4 MISCELLANEOUS ITEMS
- A. Provide all accessories and hardware for a complete installation including the following:
    1. Mounting hardware.
    2. Undercounter laminated support panels or undercounter metal support brackets as selected by the Architect.
    3. Metal leg supports and free-standing table hardware.
  - B. Grommets: Provide manufacturer's standard plastic grommets.

- C. Keyboard Tray: Manufacturer's standard articulating undercounter mount with slide, tilt, and rotation mechanism including pull-out mouse pad.

2.5 FABRICATION

- A. General: Fabricate casework, countertops and related products to dimensions, profiles, and details shown.
  - 1. Prefabricated casework shall comply with ANSI-A 161.1-1998.
- B. Tops and bottoms shall be glued and doweled to cabinet sides and internal cabinet components such as fixed horizontals, rails and verticals. Minimum 6 dowels each joint for 24 inch deep cabinets and a minimum of 4 dowels each joint for 12 inch deep cabinets.
  - 1. Dowels shall be fluted hardwood, minimum 8mm diameter.
  - 2. Assemble components with clamps under controlled conditions in order to maintain cabinet squareness and properly set joints.
  - 3. All joints shall be tight fitting and shall not rupture or loosen due to the following:
    - a. Dimensional changes in core materials.
    - b. Racking of casework during installation and shipping.
    - c. Normal use.
  - 4. Base and tall cabinets shall have one piece side panels continuous to floor.
- C. Back panels: Secure by one of the following methods:
  - 1. Set securely in grooved channel along entire perimeter and glued or screwed.
  - 2. Securely screwed or doweled in place and captured and supported by mounting rails.
- D. Mounting rails (stretchers) shall be fully concealed behind backs and sides. Rails shall be doweled into cabinet sides, sub-tops and/or bottoms.
  - 1. Wall and tall cabinets shall incorporate two mounting rails.
    - a. Wall cabinets shall have rails positioned at top and bottom.
    - b. Tall cabinets shall have rails positioned at top and intermediate location.
  - 2. Base units shall have rail positioned in the upper back area.
- E. Base units, except sink base units, shall have a full sub-top. Sink base units shall be manufacturer's standard reinforced open top with a removable split back panel.
- F. Side panels and vertical dividers shall be bored to receive adjustable shelf supports at 32mm on center.
- G. Drawers shall be full box design with a separate front, glued and doweled.
  - 1. Four sides shall be glued and doweled together.
  - 2. Bottom shall be screwed directly to bottom edges of the sides or set in grooves along all four sides and glued and screwed.
  - 3. Front face shall be screwed to subface of full box.

- H. Component minimum thicknesses shall be as follows:
1. Structural components shall be 3/4 inch thick core material.
  2. Tops, sides and bottoms shall be 3/4 inch thick core material.
  3. Back panels shall be 1/4 inch thick core material.
  4. Mounting rails (stretchers) shall be 3/4 inch thick structural components.
  5. Exposed cabinet backs shall be 3/4 inch decorative laminated backs in lieu of mounting stretchers.
  6. Doors and drawer faces shall be 3/4 inch thick core material.
  7. Drawer sides and bottom shall be 1/2 inch thick core material.
  8. Shelves shall be 3/4 inch thick up to 30 inches wide, 1 inch thick over 30 inches wide.
- I. Component finishes shall be as follows:
1. Decorative Laminates:
    - a. Exposed Surfaces: High-pressure decorative laminate VGS (.028)
    - b. Semi-Exposed Surfaces: Thermally fused melamine laminate.
  2. All laminated panels shall have balanced construction. Unfinished core stock surfaces, even on concealed surfaces (excluding edges), shall not be permitted.
    - a. Concealed Surfaces: High-pressure cabinet liner CLS (.020).
  3. PVC Banding: Exposed and semi-exposed edges shall be PVC banding applied with hot melt adhesive. Thicknesses shall be as follows:
    - a. Door and drawer fronts shall be edged with 3mm PVC.
    - b. All other edges including exposed exterior cabinet members, top edges of drawer boxes, adjustable shelves, and interior panels shall be edged with 1 mm PVC.

## 2.6 WORK SURFACES

- A. Countertop design shall be with 3mm PVC edge banding and separate rectangular backsplash.
1. Continuous tops shall be joined with minimum number of splice joints and aligned with tight joint fasteners as required to provide a uniform and gapless joint.
- B. Core: 1 inch thick moisture resistant material.
- C. Surface: High-pressure decorative laminate HGS (.048) and HGP (.039).
1. Exposed edges shall be covered with 3mm PVC edge banding.
  2. Backing sheet on underside shall be high-pressure backer BKL (.020).

2.7 FINISHES

A. Cabinet exteriors:

1. Decorative laminate colors at cabinet exteriors, including door and drawer fronts, shall be selected by the Architect from manufacturer's full line.
2. PVC edges shall be selected by Architect from manufacturer's full line of colors.
3. Exposed cabinet body edges shall be color matched to cabinet sides.
4. The underside of wall cabinets and the interior of open and glass door cabinets shall match the exterior cabinet colors.

B. Cabinet interiors:

1. The interior of closed-door cabinets and drawer boxes shall be manufacturer's standard almond or white color.
2. PVC edges on adjustable shelves, drawer boxes and interior panel components shall match the color of the interior cabinet.

C. Cabinet hardware: Cabinet hardware finishes, including those for drawer pulls, drawer slides and hinges, shall be selected by Architect from manufacturer's full lines.

D. Work surfaces: Colors shall be selected by Architect from any of the standard or premium solid color or pattern lines of Nevamar, WilsonArt, Formica and Pionite.

PART 3 - INSTALLATION

3.1 EXAMINATION

- A. Examine walls and floors with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install according to manufacturer's written instructions.
- B. Erect casework, plumb, level, true and straight with no distortions. Shim as required. Where laminate clad casework abuts other finished work, scribe and cut to accurate fit.

3.3 ADJUSTING, CLEANING, AND PROTECTION

- A. Adjust casework and hardware so that doors and drawers operate smoothly without warping or binding.
1. Verify that all locking devices operate properly.
- B. Repair minor damage per manufacturer's recommendations. Replace damaged items that cannot be restored to their original condition.

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PREFABRICATED  
CASEWORK

- C. Protect prefabricated casework from damage, abuse, dust, dirt, stain, or paint. Do not permit use of casework during construction.
- D. Clean Up: Remove all cartons, debris, sawdust, scraps, etc., and leave spaces clean and all prefabricated cabinets and countertops ready for Owner's use.

**\*\*END OF SECTION\*\***

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### PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS
  - A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to work of this Section.
- 1.2 SUMMARY
  - A. This Section includes mechanical general administrative and procedural requirements. The following requirements are included in this Section to supplement the requirements specified in Division 01 Specification Sections.
- 1.3 INDUSTRY STANDARDS
  - A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
    1. AABC – Associated Air Balance Council.
    2. ABMA - American Bearing Manufacturers Association.
    3. ABMA – American Boiler Manufacturers Association.

4. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The).
5. AMCA - Air Movement and Control Association International, Inc.
6. ANSI – American National Standards Institute.
7. ASHRAE – American Society of Heating, Refrigeration and Air Conditioning Engineers.
8. ASTM – American Society for Testing Materials.
9. CDA – Copper Development Association.
10. CGA – Compressed Gas Association.
11. CSA – CSA International.
12. HI – Hydraulic Institute.
13. Intertek – Intertek Group.
14. NAIMA – North American Insulation Manufacturers Association.
15. NEBB – National Environmental Balancing Bureau.
16. NEC – National Electrical Code.
17. NECA - National Electrical Contractors Association.
18. NEMA – National Electrical Manufacturer's Association.
19. NFPA – National Fire Protection Association.
20. SMACNA – Sheet Metal and Air Conditioning Contractors National Association.
21. UL – Underwriter's Laboratories, Inc.

- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
- C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
  1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Systems Components Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

1.5 QUALITY ASSURANCE

- A. Scope of Work: Furnish all labor, material, equipment, technical supervision, and incidental services required to complete, test and leave ready for operation the mechanical systems as specified and as indicated on Drawings.
  - 1. Contract Documents are complimentary, and what is required by one shall be as binding as if required by all. In the event of inconsistencies or disagreements within the Construction Documents bids shall be based on the most expensive combination of quality and quantity of the work indicated.
- B. Ordinances and Codes: Perform all Work in accordance with applicable Federal, State and local ordinances and regulations, the Rules and Regulations of ASHRAE, NFPA, SMACNA and UL, unless otherwise indicated.
  - 1. Notify the Architect/Engineer in writing before submitting a proposal should any changes in Drawings or Specifications be required to conform to the above codes, rules or regulations.
  - 2. If the Contractor performs any work knowing it to be contrary to such laws, ordinances, rules and regulations, and without notice to A/E, the Contractor shall bear all costs arising from corrective measures.
- C. Source Limitations: Obtain equipment and other components of the same or similar systems through one source from a single manufacturer.
- D. Tests and Inspections: Perform all tests required by state, city, county and/or other agencies having jurisdiction. Provide all materials, equipment, etc., and labor required for tests.
- E. Performance Requirements: Perform all work in a first class and workmanlike manner, in accordance with the latest accepted standards and practices for the trades involved.
- F. Sequence and Schedule: Perform work to avoid interference with the work of other trades. Remove and relocate work which in the opinion of the Owner's Representatives causes interference.
- G. Labeling Requirement for Packaged Equipment: Electrical panels on packaged mechanical equipment shall bear UL label or label of other Nationally Recognized Testing Laboratory (NRTL) (Intertek, CSA, etc.).

1.6 CODES, PERMITS AND FEES

- A. Unless otherwise indicated, all required permits, licenses, inspections, approvals and fees for Mechanical Work shall be secured and paid for by the Contractor. All Work shall conform to all applicable codes, rules and regulations.
- B. Rules of local utility companies shall be complied with. Check with each utility company supplying service to the installation and determine all devices including, but not limited to, all valves, meter boxes, and meters which will be required and include the cost of all such items in proposal.
- C. All work shall be executed in accordance with the rules and regulations set forth in local and state codes. Prepare any detailed drawings or diagrams which may be required by the governing authorities. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern.



- D. Refer to Division 22 Section "Domestic Water Piping" for purchase and installation of potable water meters.

#### 1.7 DRAWINGS

- A. The drawings show the location and general arrangement of equipment, piping and related items. They shall be followed as closely as elements of the construction will permit.
- B. Examine the drawings of other trades and verify the conditions governing the work on the job site. Arrange work accordingly. Provide fittings, valves, and accessories as required to meet actual conditions.
- C. Deviations from the drawings, with the exception of minor changes in routing and other such incidental changes that do not affect the functioning or serviceability of the systems, shall not be made without the written approval of the Architect/Engineer.
- D. The Architectural and Structural Drawings take precedence in all matters pertaining to the building structure, Mechanical Drawings in all matters pertaining to Mechanical Trades and Electrical Drawings in all matters pertaining to Electrical Trades. Where there are conflicts or differences between the drawings for the various trades, report such conflicts or differences to the Architect/Engineer for resolution.
- E. Drawings are not intended to be scaled for rough-in or to serve as shop drawings. Take all field measurements required to complete the Work.

#### 1.8 MATERIAL AND EQUIPMENT MANUFACTURERS

- A. Equipment: All items of equipment shall be furnished complete with all accessories normally supplied with the catalog items listed and all other accessories necessary for a complete and satisfactory operating system. All equipment and materials shall be new and shall be standard products of manufacturers regularly engaged in the production of plumbing, heating, ventilating and air conditioning equipment and shall be the manufacturer's latest design.
- B. If an approved manufacturer is other than the manufacturer used as the basis for design, the equipment or product provided shall be equal in size, quality, durability, appearance, capacity, and efficiency through all ranges of operation, shall conform with arrangements and space limitations of the equipment shown on the plans and/or specified, shall be compatible with the other components of the system and shall comply with the requirements for Items Requiring Prior Approval specified in this section of the Specifications. All costs to make these items of equipment comply with these requirements including, but not limited to, piping, sheet metal, electrical work, and building alterations shall be included in the original Bid.
- C. All package unit equipment and skid mounted mechanical components that are factory assembled shall meet, in detail, the products named and specified within each section of the Mechanical and Electrical Specifications.
- D. Changes Involving Electrical Work: The design of the mechanical systems is based on the equipment scheduled on the Drawings. Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified with no additional cost to project. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1. Where equipment changes are made that involve additional Electrical Work (larger size motor, additional wiring of equipment, etc.) the Mechanical Trades involved shall compensate the Electrical Trades for the cost of the additional Work required.

#### 1.9 INSPECTION OF SITE

- A. Visit the site, examine and verify the conditions under which the Work must be conducted before submitting Proposal. The submitting of a Proposal implies that the Contractor has visited the site and understands the conditions under which the Work must be conducted. No additional charges will be allowed because of failure to make this examination or to include all materials and labor to complete the Work.
- B. No contract sum adjustments or contract time extensions will be made for Contractor claims arising from conditions which were or could have been observable, ascertainable or reasonably foreseeable from a site visit or inquiry into local conditions affecting the execution of the work.

#### 1.10 ITEMS REQUIRING PRIOR APPROVAL

- A. Bids shall be based upon manufactured equipment specified. All items that the Contractor proposes to use in the Work that are not specifically named in the Contract Documents must be submitted for review prior to bids. Such items must be submitted in compliance with Division 01 specifications. Requests for prior approval must be accompanied by complete catalog information, including but not limited to, model, size, accessories, complete electrical information and performance data in the form given in the equipment schedule on the drawings at stated design conditions. Where items are referred to by symbolic designations on the drawings, all requests for prior approval shall bear the same designations.
  1. Equipment to be considered for prior approval shall be equal in quality, durability, appearance, capacity and efficiency through all ranges of operation, shall fulfill the requirements of equipment arrangement and space limitations of the equipment shown on the plans and/or specified and shall be compatible with the other components of the system.
  2. All costs incurred to make equipment comply with other requirements, including providing maintenance, clearance, piping, sheet metal, electrical, replacement of other components, and building alterations shall be included in the original bid.
- B. Voluntary alternates may be submitted for consideration, with listed addition or deduction to the bid, but will not affect the awarding of the contract.

#### 1.11 SUBMITTALS

- A. Submit project specific submittals for review in compliance with Division 01.
- B. Prepare shop drawings to scale for the Architect/Engineer for review. Equipment and material submittals required are indicated in the Mechanical; Fire Suppression; Plumbing; and Heating, Ventilating and Air Conditioning Sections. Refer to Division 01 for submittal quantities.
- C. All submittals shall be submitted in groupings of similar and/or related items. Plumbing fixture submittals shall be submitted as one package including all fixtures intended to be used for this project. Incomplete submittal groupings will be returned "Rejected". Submit shop drawing with identification mark number or symbol numbers as specified or scheduled on the Mechanical Drawings.

- D. All submittals shall be project specific. Standard detail drawings and schedule not clearly indicating which data is associated with this Project will be returned "Rejected".
  - E. Shop drawings shall be reviewed by the Mechanical Contractor for completeness and accuracy prior to submitting to the Architect/Engineer for review. The shop drawings shall be dated and signed by the Mechanical Contractor prior to submission.
  - F. No equipment shall be shipped from stock or fabricated until shop drawings for them have been reviewed by the Architect/Engineer. Review is only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Any action indicated is subject to the requirement of the plans and specifications.
    - 1. By the review of shop drawings, the Architect/Engineer does not assume responsibility for actual dimensions or for the fit of completed work in position, nor does such review relieve Mechanical Trades of full responsibility for the proper and correct execution of the work required.
    - 2. Contractor is responsible for:
      - a. Dimensions, which shall be confirmed and correlated at the job site.
      - b. Fabrication processes and techniques of construction.
      - c. Quantities.
      - d. Coordination of Contractor's work with all other trades.
      - e. Satisfactory performance of Contractor's work.
      - f. Temporary aspects of the construction process.
  - G. If deviations (not substitutions) from Contract Documents are deemed necessary by the Contractor, details of such deviations, including changes in related portions of the project and the reasons therefore, shall be submitted with the submittal for approval.
- 1.12 OPERATION AND MAINTENANCE INSTRUCTIONAL MANUALS
- A. Submit project specific Operation and Maintenance Instructional Manuals for review in compliance with Division 01 Specification Sections.
  - B. Provide complete operation and maintenance instructional manuals covering all mechanical equipment herein specified, together with parts lists. Maintenance and operating instructional manuals shall be job specific to this project. Generic manuals are not acceptable. One copy of all manuals shall be furnished for Owner. Maintenance and operating instructional manuals shall be provided when construction is approximately 75 percent complete.
  - C. Format: Submit operations and maintenance manuals in the following format:
    - 1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Architect.
      - a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
      - b. Enable inserted reviewer comments on draft submittals.
  - D. The operating and maintenance instructions shall include a brief, general description for all mechanical systems including, but not limited to:
    - 1. Routine maintenance procedures.

2. Lubrication chart listing all types of lubricants to be used for each piece of equipment and the recommended frequency of lubrication.
3. Trouble-shooting procedures.
4. Contractor's telephone numbers for warranty repair service.
5. Submittals.
6. Recommended spare parts lists.
7. Names and telephone numbers of major material suppliers and subcontractors.
8. System schematic drawings.

1.13 RECORD DRAWINGS

- A. Submit record drawings in compliance with Division 01.
- B. Contractor shall submit to the Architect/Engineer, record drawings on electronic media or vellum which have been neatly marked to represent as-built conditions for all new mechanical work.
- C. The Contractor shall keep accurate note of all deviations from the construction documents and discrepancies in the underground concealed conditions and other items of construction on field drawings as they occur. The marked up field documents shall be available for review by the Architect, Engineer and Owner at their request.

1.14 INSTRUCTION OF OWNER PERSONNEL

- A. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of mechanical equipment and systems at agreed upon times. A minimum of 24 hours of formal instruction to Owner's personnel shall be provided for each building. Additional hours are specified in individual specification sections.
- B. For equipment requiring seasonal operation, perform instructions for other seasons within six months.
- C. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
- D. In addition to individual equipment training provide overview of each mechanical system. Utilize the as-built documents for this overview.
- E. Prepare and insert additional data in operation and maintenance manual when need for such data becomes apparent during instruction.

1.15 WARRANTY

- A. Warranty: Comply with the requirements in Division 01 Specification Sections. Contractor shall warranty that the mechanical installation is free from defects and agrees to replace or repair, to the Owner's satisfaction, any part of this mechanical installation which becomes defective within a period of one year (unless specified otherwise in other Mechanical; Fire Suppression; Plumbing; or Heating, Ventilating and Air Conditioning Sections) from the date of substantial completion following final acceptance, provided that such failure is due to defects in the equipment, material, workmanship or failure to follow the contract documents.

- B. File with the Owner any and all warranties from the equipment manufacturers including the operating conditions and performance capacities they are based on.

## PART 2 - PRODUCTS

Not Applicable

## PART 3 - EXECUTION

### 3.1 MECHANICAL DEMOLITION WORK

- A. All demolition of existing mechanical equipment and materials shall be done by the Contractor unless otherwise indicated. Include all items such as, but not limited to, existing piping, draining of piping, pumps, ductwork, supports and equipment where such items are not required for the proper operation of the modified system.
- B. In general, demolition work is indicated on the Drawings. However, the Contractor shall visit the job site to determine the full extent and character of this Work.
- C. Unless specifically noted to the contrary, removed materials shall not be reused in the work. Salvaged materials that are to be reused shall be stored safe against damage and turned over to the appropriate trade for reuse. Salvaged materials of value that are not to be reused shall remain the property of the Owner unless such ownership is waived. Remove items from the systems and turn over to the Owner in their condition prior to removal. The Owner shall move and store these materials. Items on which the Owner waives ownership shall become the property of the Contractor, who shall remove and legally dispose of same, away from the premises.
- D. Work that has been cut or partially removed shall be protected against damage until covered by permanent construction.
- E. Clean and flush the interior and exterior of all existing relocated equipment and its related piping, valves, and accessories that are to be reused of all mud, debris, pipe dope, oils, welding slag, loose mill scale, rust and other extraneous material so that the existing equipment and all accessories can be repainted and repaired as required to place in first-class working condition.
- F. Where existing equipment is to be removed, cap piping under floor, behind face of wall, above ceiling or at mains. Cap or plug piping with same or compatible piping material.
- G. Cap ductwork and cap piping immediately adjacent to demolition as soon as demolition commences in order to allow existing systems to remain in operation.
  - 1. Cap or plug piping with same or compatible piping material.
  - 2. Cap or plug ducts with same or compatible ductwork material.

### 3.2 REFRIGERANT HANDLING

- A. Refrigerant Installation and Disposal: Perform all work related to refrigerant contained in chillers, cooling coils, air conditioners, and similar equipment, including related piping, in strict accordance with the following requirements:
  - 1. ASHRAE Standard 15 and Related Revisions: Safety Code for Mechanical Refrigeration.
  - 2. ASHRAE Standard 34 and Related Revisions: Number Designation and Safety Classification of Refrigerants.

- 3. United States Environmental Protection Agency (US EPA) requirements of Section 8 08 (Prohibition of Venting and Regulation of CFC) and applicable State and Local regulations of authorities having jurisdiction.

- B. Recovered refrigerant is the property of the Contractor. Dispose of refrigerant legally, in accordance with applicable rules and regulations.

### 3.3 WORK IN EXISTING BUILDINGS

- A. The Owner will provide access to existing buildings as required. Access requirements to occupied buildings shall be identified on the project schedule. The Contractor, once Work is started in the existing building, shall complete same without interruption so as to return work areas as soon as possible to Owner.
- B. Adequately protect and preserve all existing and newly installed Work. Promptly repair any damage to same at Contractor's expense.
- C. Consult with the Owner's Representative as to the methods of carrying on the Work so as not to interfere with the Owner's operation any more than absolutely necessary. Accordingly, all service lines shall be kept in operation as long as possible and the services shall only be interrupted at such time as will be designated by the Owner's Representative.
- D. Prior to starting work in any area, obtain approval for doing so from a qualified representative of the Owner who is designated and authorized by the Owner to perform testing and abatement, if necessary, of all hazardous materials including but not limited to, asbestos. The Contractor shall not perform any inspection, testing, containment, removal or other work that is related in any way whatsoever to hazardous materials under the Contract.

### 3.4 TEMPORARY SERVICES

- A. Provide temporary service as described in Division 01.
- B. The existing building will be occupied during construction. Maintain mechanical services and provide necessary temporary connections and their removal at no additional cost to the Owner.

### 3.5 WORK INVOLVING OTHER TRADES

- A. Certain items of equipment or materials specified in the Mechanical Division may have to be installed by other trades due to code requirements or union jurisdictional requirements. In such instances, the Contractor shall complete the work through an approved, qualified subcontractor and shall include the full cost for same in proposal.

### 3.6 ACCEPTANCE PROCEDURE

- A. Upon successful completion of start-up and recalibration, but prior to building acceptance, substantial completion and commencement of warranties, the Architect/Engineer shall be requested in writing to observe the satisfactory operation of all mechanical control systems.
- B. The Contractor shall demonstrate operation of equipment and control systems, including each individual component, to the Owner and Architect/Engineer.
- C. After correcting all items appearing on the punch list, make a second written request to the Owner and Architect/Engineer for observation and approval.

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- D. After all items on the punch list are corrected and formal approval of the mechanical systems is provided by the Architect/Engineer, the Contractor shall indicate to the Owner in writing the commencement of the warranty period.
- E. Operation of the following systems shall be demonstrated:
  - 1. Air Handling Systems.
  - 2. Refrigeration Systems.
  - 3. Heating Systems.
  - 4. Steam Pressure Reducing Stations.
  - 5. Domestic Hot Water Heaters.
  - 6. Domestic Hot Water Mixing Stations.
  - 7. Energy Recovery Systems.
  - 8. Temperature Controls.
  - 9. Building Automation System.
  - 10. Exhaust Systems.
- F. For systems requiring seasonal operation, demonstrate system performance within six months when weather conditions are suitable.

**\*\*END OF SECTION\*\***

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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



B. Related Sections include the following:

1. Division 20 Section "Mechanical General Requirements."
2. Division 22 Section "Domestic Water Piping" for flushing and cleaning of potable water piping.
3. Division 23 Section "Piping Systems Flushing and Chemical Cleaning" for flushing and cleaning of HVAC piping.

1.2 SUMMARY

- A. This section includes mechanical materials and installation methods common to mechanical piping systems, sheetmetal systems and equipment. This section supplements all other Division 20, 21, 22, and 23 Mechanical Sections, and Division 01 Specification 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, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
1. ABS: Acrylonitrile-butadiene-styrene plastic.
  2. CPVC: Chlorinated polyvinyl chloride plastic.
  3. PE: Polyethylene plastic.
  4. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
1. EPDM: Ethylene-propylene-diene terpolymer rubber.
  2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.

C. Brazing Certificates: As required by ASME Boiler and Pressure Vessel Code, Section IX, or AWS B2.2.

#### 1.5 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

B. Comply with NSF 14, "Plastics Piping System Components and Related Materials," for plastic, potable domestic water piping and components. Include marking "NSF-pw" on piping.

C. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.

D. Comply with NSF 372, "Drinking Water System Components – Lead Content" for potable domestic water piping and components.

E. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

F. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

G. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

H. Soldering: Qualify processes and operators according to AWS B2.3/2.3M, "Specification for Soldering Procedure and Performance Qualification."

I. Installer Qualifications:

1. Installers of Grooved Components: Installers shall be certified by the grooved component manufacturer as having been trained and qualified to join piping with grooved couplings, fittings, and specialties.

2. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Storage and Protection: Provide adequate weather protected storage space for all mechanical equipment and materials deliveries to the job site. Storage locations will be designated by the Owner's Representative. Equipment stored in unprotected areas must be provided with temporary protection.
  1. Protect equipment and materials from theft, injury or damage.
  2. Protect equipment outlets, pipe and duct openings with temporary plugs or caps.
  3. Materials with enamel or glaze surface shall be protected from damage by covering and/or coating as recommended in bulletin "Handling and Care of Enameled Cast Iron Plumbing Fixtures", issued by the Plumbing Fixtures Manufacturer Association, and as approved.
  4. Electrical equipment furnished by Mechanical Trades and installed by the Electrical Trades: Turn over to Electrical Trades in good condition, receive written confirmation of same.
  5. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
  6. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

#### 1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations. Coordinate with other trades to ensure accurate locations and sizes of mechanical spaces, chases, slots, shafts, recesses and openings.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Install Work to avoid interference with work of other trades including, but not limited to, Architectural and Electrical Trades. Remove and relocate any work that causes an interference at Contractor's expense.
- D. Coordinate requirements for and provide access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
- E. The mechanical trades shall be responsible for all damage to other work caused by their work or through the neglect of their workers.
  1. All patching and repair of any such damaged work shall be performed by the trades which installed the work. The cost shall be paid by the Mechanical Trades.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

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

### 2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 21, 22, and 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

### 2.3 JOINING MATERIALS

- A. Refer to individual Division 21, 22, and 23 piping Sections for special joining materials not listed below.
- B. Unions: Pipe Size 2 Inches and Smaller:
  - 1. Ferrous pipe: Malleable iron ground joint type unions.
  - 2. Unions in galvanized piping system shall be galvanized.
  - 3. Copper tube and pipe: Bronze unions with soldered joints.
- C. Flanges: Pipe Sizes 2-1/2 Inch and Larger:
  - 1. Ferrous pipe: Standard weight, forged steel weld neck flanges.
  - 2. Copper tube and pipe: Slip-on bronze flanges.
- D. 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.
- E. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated. Square head bolts and nuts are not acceptable.
- F. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

- G. Solder Filler Metals: ASTM B 32, lead-free, antimony-free, silver-bearing alloys. Include water-flushable flux according to ASTM B 813.
  - H. Brazing Filler Metals: Alloys meeting AWS A5.8.
    - 1. Use Type BcuP Series, silver-bearing, copper-phosphorus alloys for joining copper or bronze socket fittings with copper pipe. Flux is prohibited unless used with bronze fittings.
    - 2. Use Type Bag Series, cadmium-free silver alloys for joining copper with steel, stainless steel, or other ferrous alloys.
  - I. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
  - J. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.
  - K. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.
  - L. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
  - M. Solvent Cements for Joining ABS Piping: ASTM D 2235.
  - N. Solvent Cements for Joining PVC to ABS Piping Transition: ASTM D 3138.
  - O. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.
- 2.4 PIPE THREAD COMPOUNDS
- A. Pipe thread compounds for the fluid service compatible with piping materials provided.
  - B. Compounds for potable water service and similar applications acceptable to U.S. Department of Agriculture (USDA) or Food and Drug Administration (FDA). Compounds containing lead are prohibited.
  - C. Inorganic zinc-rich coatings or corrosion inhibited proprietary compounds for galvanized carbon steel systems to coat raw carbon steel surfaces, in lieu of subsequent painting.
    - 1. Manufacturers:
      - a. Carboline "Carbo-Zinc 12."
      - b. Tnemec.
      - c. Koppers.
  - D. Graphite and oil or proprietary corrosion inhibited compounds suitable for system temperatures for steam or condensate.
    - 1. Manufacturers:
      - a. WKM; Division of Cooper Industries, Inc., Key "Graphite Paste."
      - b. Other approved.

- E. Use tetrafluoroethylene (Teflon) tape 2 to 3 mils thick for natural gas system threaded joints.

1. Manufacturers:
  - a. Cadillac Plastic.
  - b. Permacel.
  - c. Other approved.

## 2.5 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Manufacturers:
  - a. Cascade Waterworks Mfg. Co.
  - b. Dresser Industries, Inc.; DMD Div.
  - c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
  - d. JCM Industries.
  - e. Smith-Blair, Inc.
  - f. Viking Johnson.

2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
4. Aboveground Pressure Piping: Pipe fitting.

- B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers:
  - a. IPEX Inc. (formerly Eslon Thermoplastics).

- C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers:
  - a. Thompson Plastics, Inc.

- D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

1. Manufacturers:
  - a. NIBCO INC.
  - b. NIBCO, Inc.; Chemtrol Div.

- E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

1. Manufacturers:

- a. Cascade Waterworks Mfg. Co.
- b. Fernco, Inc.
- c. Mission Rubber Company.
- d. Plastic Oddities, Inc.
- e. Can-Tex Industries Division of Harsco Corp. "CT-Adaptors".
- f. Joint Inc., "Caulder".

2.6 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Brass Unions, Brass Nipples, Brass Couplings: For systems up to 286 deg F.
- D. Dielectric-Flange Kits: Include full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:

- a. Advance Products & Systems, Inc.
- b. Calpico, Inc.
- c. Capitol Manufacturing Co.
- d. Central Plastics Company.
- e. Epco Sales, Inc.
- f. Pipeline Seal and Insulator, Inc.
- g. Watts Water Technologies, Inc.; Watts Regulator Co.
- h. Zurn Industries, Inc.; Wilkins Div.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; female NPT threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

- a. Lochinvar Corp.; V-Line Insulating Couplings.

- F. Dielectric Nipple/Waterway Fittings: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, male NPT threaded, or grooved ends; and 300-psig minimum working pressure at 230 deg F.

1. Manufacturers:

- a. Anvil International, Inc.; Gruvlok Manufacturing; DI-LOK Nipples.
- b. Elster Group; Perfection Corp.; ClearFlow.

- c. Precision Plumbing Products, Inc.; ClearFlow.
- d. Sioux Chief Manufacturing Co., Inc.
- e. Tyco Fire & Building Products; Grinnell Mechanical Products; Figure 407 ClearFlow.
- f. Victaulic Co. of America; Style 47 ClearFlow.

## 2.7 MODULAR MECHANICAL SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve or pipe and core drilled hole.
  - 1. Manufacturers:
    - a. Advance Products & Systems, Inc.; Innerlynx.
    - b. Calpico, Inc.
    - c. Metraflex Co.
    - d. Pipeline Seal and Insulator, Inc.; Thunderline Link Seal.
  - 2. Sealing Elements: EPDM NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 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.

## 2.8 SLEEVES

- A. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, and 0.375 inch wall black.
- B. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, and 0.375 inch wall galvanized, plain ends.
- C. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with set screws.

## 2.9 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
  - 1. New Piping:
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    - b. Chrome-Plated Piping or Piping in High Humidity Areas: One-piece, cast-brass type with polished chrome-plated finish.
    - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
    - d. Bare Piping in Finished Spaces: One-piece, stamped-steel type.
    - e. Bare Piping in Unfinished Service Spaces or Equipment Rooms: Split-plate, stamped-steel type with concealed hinge and set screw.



2. Existing Piping: Use the following:
  - a. Chrome-Plated Piping or Piping in High Humidity Areas: Split-casting, cast-brass type with chrome-plated finish.
  - b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
  - c. Bare Piping: Split-plate, stamped-steel type with set screw or spring clips.

#### 2.10 GROUT

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

#### 2.11 EPOXY BONDING COMPOUND

- A. Two-component system suitable for bonding wet or dry concrete to each other and to other materials.
- B. Manufacturers:
  1. Euco 452 #450; Euclid Chemical Co.
  2. Epobond; L & M Construction Chemicals.
  3. Sikadur 87; Sika Corp.

#### 2.12 LEAK DETECTOR SOLUTION

- A. Commercial leak detector solution for pipe system testing.
- B. Manufacturers:
  1. American Gas and Chemicals Inc.; Leak Tec.
  2. Cole-Parmer Inst. Co.; Leak Detector.
  3. Guy Speaker Co. Inc.; Squirt 'n Bubbles.

#### 2.13 PIPE ROOF PENETRATION ENCLOSURES

- A. Manufacturers:
  1. Pate Company (The).
  2. Portals Plus, Inc.
  3. Thybar Corporation; Thycurb.

- B. Minimum 18 gage welded galvanized steel construction.
- C. Integral base plate.
- D. Built-in fully mitered cant.
- E. Factory installed insect and decay resistant wood nailer.
- F. Factory installed 1-1/2 inch thick, 3 pounds per cubic foot density rigid insulation.
- G. EPDM compression molded rubber cap for single or multiple pipes as required.
- H. Stainless steel draw-band clamps.

### PART 3 - EXECUTION

#### 3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Refer to piping application schedules on the Drawings.
- B. Install piping according to the following requirements and Division 21, 22, and 23 Sections specifying piping systems, and in accordance with manufacturer's instructions.
- C. 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. The Drawings shall be followed as closely as elements of construction will permit.
- D. During the progress of construction, protect open ends of pipe, fittings, and valves to prevent the admission of foreign matter. Place plugs or flanges in the ends of all installed work whenever work stops. Plugs shall be commercially manufactured products.
- E. Prior to and during laying of pipe, maintain excavations dry and clear of water and extraneous materials. Provide minimum 4 inches of clearance in all directions for pipe passing under or through building grade beams.
- F. Weld-o-lets and thread-o-lets can be used for annular flow measuring devices, temperature control components, and thermal wells in steel pipe. Pipe taps shall be drilled and deburred. Torch cutting is not acceptable.
- G. Brazolets can be used for annular flow measuring devices, temperature control components, and thermal wells in copper tube. Pipe taps shall be drilled and deburred. Torch cutting is not acceptable.
- H. Clean and lubricate elastomer joints prior to assembly.
- I. Clean damaged galvanized surfaces and touch-up with a zinc rich coating.
- J. Install piping to conserve building space and not interfere with use of space.
- K. Group piping whenever practical at common elevations.
- L. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- M. Slope piping and arrange systems to drain at low points.

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- N. Slope horizontal piping containing noncondensable gases 1 inch per 100 feet, upward in the direction of the flow.
- O. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- P. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- Q. In concealed locations where piping, other than black steel, cast-iron, or galvanized steel, is installed through holes or notches in studs, joists, rafters or similar members less than 1-1/2 inches from the nearest edge of the member, the pipe shall be protected by shield plates. Protective shield plates shall be a minimum of 1/16 inch thick steel, shall cover the area of the pipe where the member is notched or bored, and shall extend a minimum of 2 inches above sole plates and below top plates.
- R. Do not penetrate building structural members unless specifically indicated on drawings.
- S. Install piping above accessible ceilings to allow sufficient space for ceiling panel and light fixture removal.
- T. Install valves with stems upright or horizontal, not inverted.
- U. Provide clearance for installation of insulation and access to valves and fittings.
- V. Install piping to permit valve and equipment servicing. Do not install piping below valves and/or terminal equipment. Do not install piping above electrical equipment.
- W. Install piping at indicated slopes. Provide drain valves with hose end connections and caps at all piping low points, where piping is trapped and at all equipment.
- X. Install piping free of sags and bends.
- Y. Install fittings for changes in direction and branch connections.
- Z. Unless otherwise indicated or specified, install branch connections to mains using tee fittings in main pipe:
  - 1. Branch connected to bottom of main pipe for HVAC systems. Side connection is acceptable. Connection above centerline of main is unacceptable. For up-feed risers, connect branch to top of main pipe.
  - 2. Branch connected to top of main for steam and condensate, plumbing systems, compressible gasses, and vacuum.
- AA. Install piping to allow application of insulation.
- BB. Select system components with pressure rating equal to or greater than system operating pressure.
- CC. After completion, fill, clean, and treat systems. Refer to Division 23 Sections "Hydronic Piping," "Piping Systems Flushing and Chemical Cleaning," and "HVAC Water Treatment."
- DD. Install escutcheons for penetrations of walls below ceiling, and ceilings.

- EE. Sleeves are not required for core-drilled holes in poured concrete walls.
- FF. Permanent sleeves are not required for holes formed by removable PE sleeves in poured concrete walls.
- GG. Install sleeves for pipes passing through footings and foundation walls, masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
  - 1. Cut sleeves to length for mounting flush with both surfaces of walls.
    - a. Exception: Extend sleeves installed in floors 2 inches above finished floor level.
  - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
  - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
    - a. Schedule 40 Black Steel Sleeves: For pipes smaller than NPS 12 penetrating interior walls.
    - b. 0.375 Inch Wall Black Steel Sleeves: For pipes NPS 12 and larger penetrating interior walls.
    - c. Schedule 40 Galvanized Steel Sleeves: For pipes smaller than NPS 12 penetrating floors, and roof slabs.
    - d. 0.375 Inch Wall Galvanized Steel Sleeves: For pipes NPS 12 and larger penetrating floors and roof slabs.
    - e. For pipes penetrating floors with membrane water proofing provide cast iron sleeve with clamping flanges. Secure/seal membrane to sleeves with clamping flanges.
  - 4. Seal sleeves in concrete floors roof slabs and masonry walls with grout.
  - 5. Seal sleeves in plaster/gypsumboard partitions with plaster or dry wall compound and caulk with non-hardening silicone sealant to provide airtight installation.
  - 6. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- HH. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and modular mechanical seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing modular mechanical seals.
  - 1. Install Schedule 40 galvanized steel pipe for sleeves smaller than 12 inches in diameter.
  - 2. Install 0.375 galvanized steel pipe for sleeves 12 inches and larger in diameter.
  - 3. Modular Mechanical Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble modular mechanical seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- II. New, Poured Concrete, Underground, Exterior-Wall and Slab on Grade Pipe Penetrations: Install water stop sleeves prior to pour. Seal pipe penetrations using modular mechanical seals.

Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing modular mechanical seals.

1. Modular Mechanical Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble modular mechanical seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- JJ. Existing Underground, Exterior-Wall and Slab on Grade Pipe Penetrations: Seal core drilled pipe penetrations using modular mechanical seals. Allow for 1-inch annular clear space between pipe and cored opening for installing modular mechanical seals.
1. Modular Mechanical Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of cored hole. Assemble modular mechanical seals and install in annular space between pipe and cored opening. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- KK. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Specification Sections for materials.
- LL. Seal openings around pipes in sleeves and around duct openings through walls, floors and ceilings, and where floors, fire rated walls and smoke barriers are penetrated. Fire and/or smoke barriers shall be UL listed firestopping and shall have a fire rating equal to or greater than the penetrated barrier. Refer to Division 07 Specification Sections for materials.
- MM. Pipe Roof Penetration Enclosures:
1. Coordinate delivery of roof penetration enclosures to jobsite.
  2. Locate and set curbs on roof.
  3. Framing, flashing, and attachment to roof structure are specified under Division 07.
  4. Attach cap to curbs, cut pipe boots to fit pipe, and clamp boots to pipe or conduit.
- NN. Verify final equipment locations for roughing-in.
- OO. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- 3.2 PIPING JOINT CONSTRUCTION
- A. Join pipe and fittings according to the following requirements and Division 21, 22, and 23 Sections specifying piping systems.
  - B. Cut piping square.
  - C. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
  - D. Remove scale, slag, dirt, oil, and debris from inside and outside of pipe and fittings before assembly.

- E. Clean damaged galvanized surfaces and touch-up with a zinc rich coating.
- F. Use standard long sweep pipe fittings for changes in direction. No mitered joints or field fabricated pipe bends will be permitted. Short radius elbows may be used where specified or specifically authorized by the Architect.
- G. Make tee connections with screwed tee fittings, soldered fittings or specified welded connections. Make welded branch connections with either welding tees or forged branch outlet fittings in accordance with ASTM A234, ANSI B16.9 and ANSI B16.11. For forged branch outlets, furnish forged fittings flared for improved flow where attached to the run, reinforced against external strains and to full pipe-bursting strength requirements. "Fishmouth" connections are not acceptable.
- H. Use eccentric reducers for drainage and venting of pipe lines; bushings are not permitted.
- I. Provide pipe openings using fittings for all systems control devices, thermometers, gauges, etc. Drilling and tapping of pipe wall for connections is prohibited.
- J. Provide temperature sensing device thermal wells and similar piping specialty connections.
- K. Provide instrument connections except thermal wells with specified isolating valves at point of connection to system.
- L. Locate instrument connections in accordance with manufacturer's instructions for accurate read-out of function sensed. Locate instrument connections for easy reading and service of devices.
- M. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- N. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
- O. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- P. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
  - 1. Weld-o-lets and thread-o-lets can be used for annular flow measuring devices, temperature control components, and thermal wells. Pipe taps shall be drilled and deburred. Torch cutting is not acceptable.
- Q. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on gaskets and bolt threads.

1. Assemble flanged joints with fresh-stock gasket and hex head nuts, bolts or studs. Make clearance between flange faces such that the connections can be gasketed and bolted tight without strain on the piping system. Align flange faces parallel and bores concentric; center gaskets on the flange faces without projection into the bore.
  2. Lubricate bolts before assembly to insure uniform bolt stressing. Draw up and tighten bolts in staggered sequence to prevent unequal gasket compression and deformation of the flanges. Do not mate a flange with a raised face to a companion flange with a flat face; machine the raised face down to a smooth matching surface and use a full face gasket. After the piping system has been tested and is in service at its maximum temperature, check bolting torque to provide required gasket stress.
- R. Grooved Joints: Assemble joints with grooved-end-pipe or grooved-end-tube coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Galvanized piping shall be cut grooved to prevent damage to galvanizing on internal pipe surfaces. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer's representative shall periodically visit the jobsite and review installation. Contractor shall remove and replace any joints deemed improperly installed.
- S. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.
- T. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.
- U. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with both piping materials. Refer to Application Schedules on the Drawings.
- V. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
  3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
  4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
  5. PVC Nonpressure Piping: Join according to ASTM D 2855.
  6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- W. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- X. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

- Y. Remake joints which fail pressure tests with new materials including pipe, fittings, gaskets and/or a filler.

### 3.3 ACCESS DOORS

- A. Provide access doors for installation by architectural trades unless noted otherwise. Provide access doors in the walls, as required to make all valves, controls, coils, motors, air vents, filters, electrical boxes and other equipment installed by the Contractor accessible. Minimum size 12 inches x 12 inches. Provide access doors in the ceiling, for accessibility as mentioned above, 24 inches x 24 inches minimum size. Areas with accessible ceilings (ceilings where lay-in panels are not fastened in place and can be individually removed without removal of adjacent tiles) will not require access doors. Refer to Division 08 Section "Access Doors and Frames" for manufacturers and model numbers and additional information.
- B. When access doors are in fire resistant walls or ceilings, they shall bear the Underwriters' Laboratories, Inc., Label, with time design rating equal to or greater than the wall or ceiling unless they were a part of the tested assembly.

### 3.4 EQUIPMENT CONNECTIONS

- A. Make connections to equipment, fixtures, and other items included in the work in accordance with the submittals and rough-in measurements furnished by the manufacturers of the particular equipment furnished.
  - 1. Any and all additional connections not shown on the drawings but shown on the equipment manufacturer's submittal or required for the successful operation of the equipment shall be installed as part of this Contract at no additional charge to the Owner.
- B. All piping connections to pumps, coils, and other equipment shall be installed without strain at the pipe connection of this equipment. When directed, remove the bolts in flanged connections or disconnect piping to demonstrate that piping has been so connected.

### 3.5 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
  - 1. Install unions, in piping NPS 2 and smaller, where indicated on Drawings, at final connection to each piece of equipment and at all control valves.
  - 2. Install flanges, in piping NPS 2-1/2 and larger, where indicated on Drawings, at final connection to each piece of equipment and at all control valves.

### 3.6 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated. Housekeeping pad locations and sizes shall be coordinated by mechanical contractor prior to the placement of concrete slabs.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.



- D. Install equipment to allow right of way for piping installed at required slope.
- E. For suspended equipment, furnish and install all inserts, rods, structural steel frames, brackets and platforms required. Obtain approval of Architect for same including loads, locations and methods of attachment.
- F. Equipment Rigging Over Roof Areas: Protect building structure against damage during equipment rigging. Make provisions to distribute load of equipment to main roof structure, and to prevent damage to roof decking, roofing, or purlins.
- G. The Contract Documents indicate items to be purchased and installed. The items are noted by a manufacturer's name, catalog number and/or brief description. The catalog number may not designate all the accessory parts for a particular application. Arrange with the manufacturer for the purchase of all items required for a complete installation.

### 3.7 PAINTING

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

### 3.8 CONCRETE BASES

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

### 3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- C. Where pipe and/or equipment support members must be welded to structural building framing, Contractor shall seek prior approval from Architect and structural engineer. Scrape, brush clean, and apply one coat of zinc rich primer after welding.
- D. Field Welding: Comply with AWS D1.1.

### 3.10 EPOXY BONDING TO EXISTING MATERIALS

- A. Use epoxy bonding compound to set sleeves or pipes in existing concrete to bond new concrete and/or grout to existing materials or to bond dissimilar materials.
- B. The compound, when applied in accordance with the manufacturer's instructions, shall be capable of initial curing within 48 hours at temperatures as low as 40 deg F and shall be capable of bonding any combination of the following properly prepared materials: Wet or dry, cured or uncured concrete or mortar; vitrified clay; cast iron and carbon steel.

### 3.11 JACKING OF PIPE

- A. Do not jack pipe in place except upon prior approval of proposed materials and complete details of methods.

### 3.12 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

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

### 3.13 GROUTING

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

3.14 CUTTING, CORING AND PATCHING

- A. Refer to Division 01 Specification Sections for requirements for cutting, coring, patching and refinishing work necessary for the installation of mechanical work.
- B. All cutting, coring, patching and repair work shall be performed by the Contractor through approved, qualified subcontractors. Contractor shall include full cost of same in bid.

3.15 EXCAVATION AND BACKFILLING

- A. Refer to Division 31 Specification Sections.
- B. Provide all excavation, trenching, tunneling and backfilling required for the mechanical work.
- C. Provide all pumping and/or well pointing required for the mechanical work.
- D. Provide foundations if required to support underground piping.
- E. Backfill all excavations with well-tamped granular material. Backfill all excavations under wall footings with lean mix concrete up to underside of footings and extend concrete within excavation a minimum of four (4) feet each side of footing. Granular backfill shall be placed in layers not more than 8 inches in thickness, 95 percent compaction throughout with approved compaction equipment. Tamp, roll as required. Excavated material shall not be used.

3.16 FLASHING

- A. Provide all flashing required for mechanical work. Refer to Division 07 Specification Sections.

3.17 LUBRICATION

- A. Provide all lubrication for the operation of the equipment until acceptance by the Owner. Contractor is responsible for all damage to bearings up to the date of acceptance of the equipment. Protect all bearings and shafts during installation. Thoroughly grease steel shafts to prevent corrosion. Provide covers as required for proper protection of all motors and other equipment during construction.

3.18 FILTERS

- A. Provide and maintain filters in air handling systems throughout the construction period and prior to final acceptance of the building. Do not run air handling equipment, without all prefilters and final filters as specified.
- B. Immediately prior to final building acceptance by the Owner, Contractor shall:
  - 1. Replace all disposable type air filters with new units.

3.19 CLEANING

- A. Each Mechanical Trade shall be responsible for removing all debris daily as required to maintain the work area in a neat, orderly condition.
- B. After equipment and HVAC water piping systems have been completed and tested, each entire system shall be cleaned and flushed. Refer to Division 23 Section "Piping Systems Flushing and Chemical Cleaning" for requirements. Provide temporary bypass piping and fittings, temporary valves and strainers, temporary water make-up piping with approved means of

backflow prevention, and temporary pumps as needed to perform specified flushing and cleaning requirements.

- C. Prior to connection of new HVAC piping to existing HVAC piping systems, all new piping shall be subject to initial flushing, cleaning and final flushing. Refer to Division 23 Section "Piping Systems Flushing and Chemical Cleaning" for requirements. Provide temporary bypass piping and fittings, temporary valves and strainers, temporary water make-up piping with approved means of backflow prevention, and temporary pumps as needed to perform specified flushing and cleaning requirements.
- D. Flushing, cleaning, and disinfection of domestic water piping is specified in Division 22 Section "Domestic Water Piping."
- E. Exterior surfaces of all piping, ductwork and equipment shall be wiped down to remove excess dirt and debris prior to concealment by Architectural Trades work.
- F. Upon completion of work in each respective area, clean and protect work. Just prior to final acceptance, perform additional cleaning as necessary to provide clean equipment and areas to the Owner.

**\*\*END OF SECTION\*\***

## MOTORS

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  1. Division 20 "Mechanical General Requirements."
  2. Division 20 Section "Mechanical Vibration Controls" for mounting motors and vibration isolation devices.
  3. Division 20 Section "Variable Frequency Controllers".
  4. Division 21, 22, and 23 Sections for application of motors and reference to specific motor requirements for motor-driven equipment.
  5. Division 26 Section "Enclosed Switches and Circuit Breakers".
  6. Division 26 Section "Enclosed Controllers".
  7. Division 26 Section "Fuses".

#### 1.2 SUMMARY

- A. This Section includes basic requirements for factory-installed and field-installed motors, enclosed controllers, disconnect switches, and fuses.

1.3 DEFINITIONS

- A. ABMA: American Bearing Manufacturers Association. (Formerly AFBMA: Anti-Friction Bearing Manufacturers Association.)
- B. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.
- C. Field-Installed Motor: A motor installed at Project site and not factory installed as an integral component of motorized equipment.
- D. Packaged Self Contained Equipment: Equipment which includes component mechanical and electrical equipment mounted on common bases, skids or frames or in common enclosures with internal control and power wiring factory installed and ready to accept a single electrical service connection. Provide the equipment complete with enclosed controllers, main disconnect switches, control transformers, control devices, wiring and accessories as required.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: A Nationally Recognized Testing Laboratory (NRTL), acceptable to authorities having jurisdiction, with the experience and capability to conduct the testing indicated.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

1.5 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices. Provide motors that are:
  - 1. Compatible with the following:
    - a. Magnetic controllers.
    - b. Multispeed controllers.
    - c. Reduced-voltage controllers.
    - d. Solid-state controllers.
    - e. Variable frequency controllers.
  - 2. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.
  - 3. Matched to torque and horsepower requirements of the load.
  - 4. Matched to ratings and characteristics of supply circuit and required control sequence.
- B. Coordinate electrical scope of work to be provided by Division 20, 21, 22, and 23 with this Section, related Division 20, 21, 22, and 23 Specifications, Division 26 Specifications and the Drawings.
- C. Electrical work provided under Division 20, 21, 22, and 23: Furnish UL Listed components in accordance with this section, Division 26, and applicable NEMA and NEC (ANSI C 1) requirements. Provide wiring, external to electrical enclosures, in conduit.
- D. Furnished, installed and wired under Division 20, 21, 22, and 23 unless otherwise indicated:

1. Disconnected components in packaged self-contained equipment that are so constructed that components of wiring must be disconnected for shipment and reconnected after installation.
- E. Furnished and installed under Division 20, 21, 22, and 23 and wired under Division 26 unless otherwise indicated:
1. Motors required for mechanical equipment
  2. Packaged Self-Contained Equipment:
    - a. Provide equipment ready to accept a single electrical service connection.
    - b. For equipment with remote mounted control panels, provide mounting of the control panel and external wiring from the control panel to the package self-contained equipment.
  3. Variable frequency controllers.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:
1. Dayton.
  2. Toshiba Intl.
  3. Baldor Electric/Reliance.
  4. Rockwell Automation/Allen-Bradley.
  5. Nidec Motor Corporation; U.S. Electrical Motors.
  6. Regal Beloit/GE Commercial Motors.
  7. Regal Beloit/Leeson.
  8. Regal Beloit/Marathon.
  9. Siemens.

### 2.2 MOTOR REQUIREMENTS

- A. Motor requirements apply to factory-installed motors except as follows:
1. Different ratings, performance, or characteristics for a motor are specified in another Section.
  2. Manufacturer for a factory-installed motor requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.
  3. Submersible motors integral to pumps and excluded from NEMA and EISA standards.
- B. Electrical Power Supply Characteristics: Coordinate electrical system requirements with Division 26.

- C. Electrical Power System Characteristics: As scheduled on the Drawings.
- D. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide screwed conduit connection in end frame.

## 2.3 MOTOR CHARACTERISTICS

- A. Motors 1/2 HP and Larger: Three phase, unless otherwise indicated.
- B. Motors Smaller Than 1/2 HP: Single phase, unless otherwise indicated.
- C. Frequency Rating: 60 Hz.
- D. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.
- E. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.
- F. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
- G. Brake Horsepower Input: Shall not exceed 90 percent of the rated motor horsepower.
- H. Enclosure: Open dripproof (ODP) for motors installed indoors and out of the airstream. Totally-enclosed fan-cooled (TEFC) for motors installed outdoors or within the airstream.

## 2.4 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Fire pump motors, C-face motors, JP and JM frame motors, and motors over 200 horsepower shall be energy efficient motors. Efficiency of the motor shall be determined based on the NEMA MG1. The minimum efficiencies, nominal efficiencies and shall meet or exceed Table 12-11.

	1800 RPM OPEN DRIP-PROOF MOTORS 4 POLE		1800 RPM ENCLOSED MOTORS 4 POLE	
	NOMINAL <u>EFF</u>	MINIMUM <u>EFF</u>	NOMINAL <u>EFF</u>	MINIMUM <u>EFF</u>
<u>HP</u>				
1	82.5	81.5	82.5	81.5
1.5	84	82.5	84	82.5
2	84	82.5	84	82.5
3	86.5	85.5	87.5	86.5
5	87.5	86.5	87.5	86.5
7.5	88.5	87.5	89.5	88.5
10	89.5	88.5	89.5	88.5
15	91	90.2	91	90.2
20	91	90.2	91	90.2
25	91.7	91	92.4	91.7
30	92.4	91.7	92.4	91.7
40	93	92.4	93	92.4
50	93	92.4	93	93
60	93.6	93	93.6	93



1800 RPM OPEN DRIP-PROOF MOTORS 4 POLE			1800 RPM ENCLOSED MOTORS 4 POLE	
	NOMINAL	MINIMUM	NOMINAL	MINIMUM
<u>HP</u>	<u>EFF</u>	<u>EFF</u>	<u>EFF</u>	<u>EFF</u>
75	94.1	93.6	94.1	93.6
100	94.1	93.6	94.5	94.1
125	94.5	94.1	94.5	94.1
150	95	94.5	95	94.5
200	95	94.5	95	94.5

1200 RPM OPEN DRIP-PROOF MOTORS 6 POLE			3600 RPM OPEN DRIPPROOF MOTORS 2 POLE	
	NOMINAL	MINIMUM	NOMINAL	MINIMUM
<u>HP</u>	<u>EFF</u>	<u>EFF</u>	<u>EFF</u>	<u>EFF</u>
1	80	78.5	--	--
1.5	84	82.5	82.5	81.5
2	85.5	84	84	82.5
3	86.5	85.5	84	82.5
5	87.5	86.5	85.5	84
7.5	88.5	87.5	85.5	86.5
10	90.2	89.5	88.5	87.5
15	90.2	89.5	89.5	88.5
20	91	90.2	90.2	89.5
25	91.7	91	91	90.2
30	92.4	91.7	91	90.2
40	93	92.4	91.7	91
50	93	93	92.4	91.7
60	93.6	93	93	92.4
75	93.6	93	93	92.4
100	94.1	93.6	93	92.4
125	94.1	93.6	93.6	93
150	94.5	94.1	93.6	93
200	94.5	94.1	94.5	94.1

- C. Efficiency: Motors 1 horsepower to 200 horsepower shall be premium efficient motors meeting requirements of NEMA Premium Efficiency Motor Program. Efficiency of the motor shall be determined based on the NEMA MG1. The nominal efficiencies shall meet or exceed Table 12-12.

Nominal Efficiencies For "NEMA Premium™" Induction Motors  
Rated 600 Volts or Less (Random Wound)

Open Drip-Proof				Totally Enclosed Fan-Cooled		
<u>HP</u>	<u>6-pole</u>	<u>4-pole</u>	<u>2-pole</u>	<u>6-pole</u>	<u>4-pole</u>	<u>2-pole</u>
1	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2	87.5	86.5	85.5	88.5	86.5	85.5
3	88.5	89.5	85.5	89.5	89.5	86.5
5	89.5	89.5	86.5	89.5	89.5	88.5

Nominal Efficiencies For "NEMA Premium™" Induction Motors  
Rated 600 Volts or Less (Random Wound)

HP	Open Drip-Proof			Totally Enclosed Fan-Cooled		
	<u>6-pole</u>	<u>4-pole</u>	<u>2-pole</u>	<u>6-pole</u>	<u>4-pole</u>	<u>2-pole</u>
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10	91.7	91.7	89.5	91.0	91.7	90.2
15	91.7	93.0	90.2	91.7	92.4	91.0
20	92.4	93.0	91.0	91.7	93.0	91.0
25	93.0	93.6	91.7	93.0	93.6	91.7
30	93.6	94.1	91.7	93.0	93.6	91.7
40	94.1	94.1	92.4	94.1	94.1	92.4
50	94.1	94.5	93.0	94.1	94.5	93.0
60	94.5	95.0	93.6	94.5	95.0	93.6
75	94.5	95.0	93.6	94.5	95.4	93.6
100	95.0	95.4	93.6	95.0	95.4	94.1
125	95.0	95.4	94.1	95.0	95.4	95.0
150	95.4	95.8	94.1	95.8	95.8	95.0
200	95.4	95.8	95.0	95.8	96.2	95.4

Nominal Efficiencies For "NEMA Premium™" Induction Motors  
Rated Medium Volts for 5kV or Less (Form Wound)

HP	Open Drip-Proof			Totally Enclosed Fan-Cooled		
	<u>6-pole</u>	<u>4-pole</u>	<u>2-pole</u>	<u>6-pole</u>	<u>4-pole</u>	<u>2-pole</u>
250	95.0	95.0	94.5	95.0	95.0	95.0
300	95.0	95.0	94.5	95.0	95.0	95.0
350	95.0	95.0	94.5	95.0	95.0	95.0
400	95.0	95.0	94.5	95.0	95.0	95.0
450	95.0	95.0	94.5	95.0	95.0	95.0
500	95.0	95.0	94.5	95.0	95.0	95.0

- D. Stator: Copper windings, unless otherwise indicated.
  - 1. Multispeed motors shall have separate winding for each speed.
- E. Rotor: Squirrel cage, unless otherwise indicated.
- F. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 120,000 hours. Calculate bearing load with NEMA minimum V- belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- G. Temperature Rise: Match insulation rating, unless otherwise indicated.
- H. Insulation: Class F, unless otherwise indicated.
- I. Code Letter Designation:
  - 1. Motors 10 HP and Larger: NEMA starting Code (KVA Code) F or G.
  - 2. Motors Smaller Than 10 HP: Manufacturer's standard starting characteristic.
- J. Enclosure: Cast iron for motors 7.5 hp and larger; rolled steel for motors smaller than 7.5 hp.

1. Finish: Gray enamel.

K. Sound Level: Not to exceed NEMA MG-1 12.54.

## 2.5 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.

2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.

C. Shaft Grounding: Provide a means to protect motor from common mode currents.

1. Required for:

- a. Motors used with variable frequency controllers.
- b. Motors 100 HP and larger.

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

- a. Electro Static Technology, Inc.; Aegis SGR Conductive Microfiber.

D. Severe-Duty Motors: Totally enclosed, with 1.25 minimum service factor, greased bearings, integral condensate drains, and capped relief vents. Windings insulated with nonhygroscopic material.

1. Finish: Chemical-resistant paint over corrosion-resistant primer.

E. Source Quality Control: Perform the following tests on each motor according to NEMA MG 1:

1. Measure winding resistance.
2. Read no-load current and speed at rated voltage and frequency.
3. Measure locked rotor current at rated frequency.
4. Perform high-potential test.

## 2.6 SINGLE-PHASE MOTORS

A. Type: One of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split-phase start, capacitor run.
3. Capacitor start, capacitor run.

- B. Shaded-Pole Motors: For motors 1/20 hp and smaller only.
- C. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.
- D. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, prelubricated-sleeve type for other single-phase motors.

## 2.7 ENCLOSED CONTROLLERS

- A. Provide enclosed controllers in accordance with requirements specified in Division 26 Section "Enclosed Controllers".
- B. Multispeed Enclosed Controllers:
  - 1. Multispeed Enclosed Controller: Match controller to motor type, application, and number of speeds; include the following accessories:
    - a. Compelling relay to ensure that motor will start only at low speed.
    - b. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.
    - c. Decelerating relay to ensure automatically timed deceleration through each speed.
- C. Enclosures:
  - 1. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
    - a. Outdoor Locations: NEMA 250, Type 3R.
    - b. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
    - c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
    - d. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.
- D. Accessories:
  - 1. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
  - 2. Push-Button Stations, Pilot Lights, and Hand-Off-Auto Selector Switches: NEMA ICS 2, heavy-duty type.
  - 3. Selector Switches: NEMA ISC 2, mounted in front cover to read "HAND/OFF/AUTO". Provide auxiliary contact for auto positioning monitoring.
  - 4. Indicating Lights: NEMA ICS 2, mounted in front cover; run (Red), off or ready (Green).
  - 5. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
  - 6. Control Relays: Auxiliary and adjustable time-delay relays.
  - 7. Elapsed Time Meters: Heavy duty with digital readout in hours.

2.8 ENCLOSED SWITCHES AND CIRCUIT BREAKERS

- A. Provide enclosed switches and circuit breakers in accordance with requirements specified in Division 26 Section "Enclosed Switches and Circuit Breakers".

2.9 FUSES

- A. Provide fuses in accordance with requirements specified in Division 26 Section "Fuses".

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- A. All three phase motors 1/2 HP and above shall be tested by the Testing Agency.
- B. Prepare for acceptance tests as follows:
  - 1. Check motor nameplates for horsepower, speed, phase and voltage.
  - 2. Check coupling alignment and shaft end play.
  - 3. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
  - 4. Test interlocks and control features for proper operation.
  - 5. Verify that current in each phase is within nameplate rating.
- C. Testing: Engage a qualified testing agency to perform the following field quality-control testing:

3.2 ADJUSTING

- A. Align motors, bases, shafts, pulleys and belts. Tension belts according to manufacturer's written instructions.

3.3 CLEANING

- A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean motors, on completion of installation, according to manufacturer's written instructions.

**\*\*END OF SECTION\*\***

PIPE FLEXIBLE CONNECTORS, EXPANSION FITTINGS AND LOOPS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 20 Section "Mechanical General Requirements."
  - 2. Division 20 Section "Basic Mechanical Materials and Methods."
  - 3. Division 23 Section "Refrigerant Piping."

1.2 DEFINITIONS

- A. BR: Butyl rubber.
- B. CR: Chlorosulfonated polyethylene synthetic rubber (Neoprene).
- C. CSM: Chlorosulfonyl-polyethylene rubber (Hypalon).
- D. EPDM: Ethylene-propylene-diene terpolymer rubber.
- E. NBR: Buna-N/Nitrile rubber.
- F. NR: Natural rubber.
- G. PTFE: Polytetrafluoroethylene plastic.

1.3 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products shall be suitable for piping system fluids, materials, working pressures, and temperatures.
- B. Capability: Products shall absorb 150 percent of maximum axial movement between anchors.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of pipe flexible connector, expansion joint and alignment guide indicated.
- B. Delegated-Design Submittal:
  - 1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
  - 2. Locations of pipe anchors and alignment guides and expansion joints and loops.
- C. Shop Drawings: Signed and sealed by a qualified professional engineer.
  - 1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and bends.
  - 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
  - 3. Alignment Guide Details: Detail field assembly and attachment to building structure.
  - 4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.
- D. Product Certificates: For each type of pipe expansion joint, signed by product manufacturer.
- E. Welding certificates.
- F. Operation and Maintenance Data: For pipe expansion joints to include in operation and maintenance manuals.

#### 1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to the following:
  - 1. Steel Shapes and Plates: AWS D1.1, "Structural Welding Code - Steel."
  - 2. Welding to Piping: ASME Boiler and Pressure Vessel Code: Section IX.
- B. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.
- C. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components – Lead Content for potable domestic water piping and components.

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.

PART 3 - EXECUTION

3.1 SWING CONNECTIONS

- A. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.
- B. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.
- C. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

**\*\*END OF SECTION\*\***



## METERS AND GAGES

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### 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.
- B. Related Sections include the following:
  1. Division 22 Section "Water Distribution" for domestic and fire-protection water service meters outside the building.
  2. Division 21 Section "Fire-Suppression Piping" for listed or approved pressure gages.
  3. Division 20 Section "Mechanical General Requirements."
  4. Division 20 Section "Basic Mechanical Materials and Methods."
  5. Division 22 Section "Domestic Water Piping" for domestic and fire-protection water service meters inside the building.
  6. Division 23 Section "Steam and Condensate Piping" for steam and condensate meters.
  7. Division 23 Section "Fuel Gas Piping" for gas utility meters.

#### 1.2 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.
- C. FPR: Fiberglass reinforced plastic.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated; include performance curves.
- B. Shop Drawings: Schedule for thermometers gages flowmeters indicating manufacturer's number, scale range, and location for each.
- C. Product Certificates: For each type of thermometer gage flowmeter, signed by product manufacturer.
- D. Operation and Maintenance Data: For flowmeters to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.
- B. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components – Lead Content for potable domestic water piping and components.

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 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

- A. Manufacturers:
  - 1. AMETEK, Inc.; U.S. Gauge Div.
  - 2. Miljoco Corporation.
  - 3. REOTEMP Instrument Corporation.
  - 4. Terice, H. O. Co.
  - 5. Weiss Instruments, Inc.
  - 6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Case: Die-cast aluminum or Chrome-plated brass, 9 inches long.
- C. Tube: Red, blue, or green reading, organic-liquid filled, with magnifying lens.
- D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.
- E. Window: Glass or plastic.

- F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
- G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.
- H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

## 2.3 THERMOWELLS

- A. Manufacturers: Same as manufacturer of thermometer being used.
- B. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer. Brass for compatible services less than 353 degrees F (178 degrees C); ANSI 18-8 stainless steel for all others to suit service. Furnish extension neck to accommodate insulation where applicable.

## 2.4 PRESSURE GAGES

- A. Manufacturers:
  - 1. AMETEK, Inc.; U.S. Gauge Div.
  - 2. Cambridge.
  - 3. Dwyer Instruments, Inc.
  - 4. Marsh Bellofram.
  - 5. Miljoco Corporation.
  - 6. Terice, H. O. Co.
  - 7. Weiss Instruments, Inc.
  - 8. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
  - 1. Case: Stainless steel, aluminum, or FRP, 4-1/2-inch diameter.
  - 2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
  - 3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
  - 4. Movement: Mechanical, with link to pressure element and connection to pointer.
  - 5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
  - 6. Pointer: Red or other dark-color metal.
  - 7. Window: Glass or plastic.

8. Ring: Stainless steel or chrome plated metal.
9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
11. Water: 0-100 PSIG (1 psi divisions to 50 psi; 5 psi divisions above 50 psi), liquid filled.
12. Steam (15 psig and less): 30 inches Hg vacuum-30 PSIG (1 inch divisions below 0 psi; 1 psi divisions above 0 psi), silicone dampened.
13. Steam (16 to 60 psig): 30 inches Hg vacuum-100 PSIG, silicone dampened.
14. Range for Fluids under Pressure: 1-1/2 times expected working pressure. If not a standard scale, select next largest scale.

C. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass ball type.
2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.5 TEST PLUGS

A. Manufacturers:

1. Peterson Equipment Co., Inc.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F for cold services, and 500 psig at 275 deg F for hot services.

D. Core Inserts: One or two self-sealing rubber valves.

1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be Neoprene.
2. Insert material for air or water service at minus 30 to plus 275 deg F shall be Nordel.

E. Test Kit: Furnish test kit(s) containing one pressure gage and adaptor, thermometer(s), and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.

1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be 0 to 200 psig.
2. Low-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 125 deg F.
3. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.

4. Carrying case shall have formed instrument padding.

## 2.6 FLOW MEASURING DEVICES

### A. Manufacturers:

1. Dietrich Standard Subsidiary of Rosemount Division of Emerson Process Management; Diamond II - Flo-Tap Model.
2. Preso Meters Corporation.
3. Taco, Inc.

- B. Flow measuring device shall be used where indicated on the drawings and in sizes NPS 6 and larger and shall be annular primary flow elements. The annular primary flow elements shall be type 316, stainless steel, diamond shape or elliptical shape in cross-section. Pressure rating shall meet or exceed system minimum pressure rating as indicated for each system. Provide permanent, rust-proof metal identification tag on a chain indicating design flow rates, metered fluid and line size. Flow measuring devices shall be weld insert type. Units shall be capable of being inserted without system shut-down.

- C. Accuracy shall be plus or minus 1 percent over a flow turndown at least 10 to 1, independent of Reynold's number. Repeatability shall be plus or minus 0.1 percent.

- D. Sensors shall be installed in strict accordance with the manufacturer's recommendations with special attention given to alignment and straight run requirements.

- E. Flow gages which read in actual GPM shall be provided for all flow measuring devices on pumps 200 GPM or larger, and for both flow directions on the chilled water system de-coupler pipe flow measuring device. Gage scale shall be linear to flow. Maximum flow rate on scale shall be selected at 120 percent of the pump's scheduled flow rate (120 percent of the scheduled flow rate of one chiller for the chilled water system de-coupler). Gage scale shall be 2.5 inch x 6 inch minimum, or 4 inch diameter minimum, and shall be mounted at eye level on unistrut support.

## PART 3 - EXECUTION

### 3.1 THERMOMETER APPLICATIONS

- A. Install liquid-in-glass thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
3. Inlet and outlet of each hydronic heat exchanger.
4. Outside-air, return-air, and mixed-air ducts.

- B. Provide the following temperature ranges for thermometers:

1. Domestic Hot Water: 30 to 180 deg F, with 2-degree scale divisions.
2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions.
3. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions.

4. Air Ducts: Minus 40 to plus 110 deg F, with 2-degree scale divisions.

### 3.2 GAGE APPLICATIONS

- A. Install dry-case-type pressure gages on inlet and outlet of each pressure-reducing valve.
- B. Install dry-case-type pressure gages at chilled- and condenser-water inlets and outlets of chillers.
- C. Install dry-case-type pressure gages at suction and discharge of each pump.
- D. Except where noted otherwise, select range for twice normal operating pressure.

1. Water (CW and HW): 0 to 100 psig.

### 3.3 INSTALLATIONS

- A. Install direct-mounting thermometers and adjust vertical and tilted positions.
- B. Install thermowells with socket extending one-third of diameter of pipe and in vertical position in piping tees where thermometers are indicated.
- C. Duct Thermometer Support Flanges: Install in wall of duct where duct thermometers are indicated. Attach to duct with screws.
- D. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.
- E. Install ball valve and snubber fitting in piping for each pressure gage for fluids (except steam).
- F. Install ball valve and syphon fitting in piping for each pressure gage for steam.
- G. Install test plugs in tees in piping.
- H. Install flow indicators, in accessible positions for easy viewing, in piping systems.
- I. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters as prescribed by manufacturer's written instructions.
- J. Install flowmeter elements in accessible positions in piping systems.
- K. Install differential-pressure-type flowmeter elements with at least minimum straight lengths of pipe upstream and downstream from element as prescribed by manufacturer's written instructions.
- L. Install wafer-orifice flowmeter elements between pipe flanges.
- M. Install permanent indicators on walls or brackets in accessible and readable positions.
- N. Install connection fittings for attachment to portable indicators in accessible locations.
- O. Install flowmeters at discharge of hydronic system pumps and at inlet of hydronic air coils.
- P. Assemble components and install thermal-energy meters.
- Q. Mount meters on wall if accessible; if not, provide brackets to support meters.

3.4 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.
- B. Connect flowmeter-system elements to meters.
- C. Connect flowmeter transmitters to meters.
- D. Connect thermal-energy-meter transmitters to meters.
- E. Ground equipment according to Division 26 Section "Grounding and Bonding."
- F. Connect wiring according to Division 26 Section "Conductors and Cables."

3.5 ADJUSTING

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

**\*\*END OF SECTION\*\***

## HANGERS AND SUPPORTS

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
  2. Division 21 Section "Fire-Suppression Piping" for pipe hangers for fire-protection piping.
  3. Division 20 Section "Mechanical General Requirements."
  4. Division 20 Section "Basic Mechanical Materials and Methods."
  5. Division 20 Section "Mechanical Vibration Controls" for vibration isolation devices.
  6. Division 20 Section "Pipe Expansion Fittings and Loops" for pipe guides and anchors.



7. Division 23 Section(s) "Metal Ducts" and "Nonmetal Ducts" for duct hangers and supports.

1.2 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. MFMA: Metal Framing Manufacturers Association.

1.3 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.

1.4 SUBMITTALS

- A. Product Data: For the following:
  - 1. Steel pipe hangers and supports.
  - 2. Thermal-hanger shield inserts.
- 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. Pipe stands. Include Product Data for components.
  - 4. Equipment supports.
- C. Welding certificates.

1.5 QUALITY ASSURANCE

- A. MSS Standards: Pipe hangers, supports, and accessories shall comply with the following:
  - 1. MSS SP-58, Pipe Hangers and Supports – Materials, Design and Manufacture.
  - 2. MSS SP-69, Pipe Hangers and Supports – Selection and Application.
  - 3. MSS SP-89, Pipe Hangers and Supports – Fabrication and Installation Practices.
- B. Welding: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1, "Structural Welding Code--Steel."
  - 2. AWS D1.2, "Structural Welding Code--Aluminum."
  - 3. AWS D1.3, "Structural Welding Code--Sheet Steel."

4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
5. ASME Boiler and Pressure Vessel Code: Section IX.

## 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 HANGER ROD MATERIAL

- A. Threaded, hot rolled, steel rod conforming to ASTM A 36 or A575.
  1. Rod continuously threaded.
  2. Use of rod couplings is prohibited.

### 2.3 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-69, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article, and schedules and details on the Drawings for where to use specific hanger and support types.
  1. Hangers and Supports for Fire Protection Piping: UL listed or FMG approved.
- B. Manufacturers:
  1. Anvil International, Inc.
  2. B-Line by Eaton.
  3. Carpenter & Paterson, Inc.
  4. Hilti USA.
  5. ERICO International Corp.
  6. PHD Manufacturing, 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.

### 2.4 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.

2.5 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers:
  - 1. Anvil International, Inc.; Anvil-Strut.
  - 2. B-Line by Eaton.
  - 3. Power-Strut Div.; Tyco International, Ltd.
  - 4. Unistrut Corp.; Tyco International, Ltd.
  - 5. Hilti USA.
- C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
- D. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- E. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.6 METAL INSULATION SHIELDS

- A. Manufacturers:
  - 1. Anvil International, Inc.
  - 2. B-Line by Eaton.
  - 3. Carpenter & Paterson, Inc.
  - 4. ERICO International Corp.
  - 5. PHD Manufacturing, Inc.
- B. Description: MSS SP-69, Type 40, protective shields. Shields shall span an arc of 180 degrees.
- C. Shield Dimensions for Pipe: Not less than the following:
  - 1. NPS 1/4 to NPS 2: 12 inches long and 0.048 inch thick.

2.7 PIPE COVERING PROTECTION SADDLES

- A. Manufacturers:
  - 1. Anvil International, Inc.
  - 2. B-Line by Eaton.
  - 3. Carpenter & Paterson, Inc.
  - 4. ERICO International Corp.

5. PHD Manufacturing, Inc.

B. Description: MSS SP-69, Type 39A and Type 39B, for suspension of insulated hot pipe where heat losses are to be kept to a minimum.

1. Saddles shall match insulation thickness.
2. Saddle length: 12 inches.
3. Furnish with center rib for pipe sized NPS 12 and larger.

## 2.8 PLASTIC INSULATION SHIELDS

A. Manufacturers:

1. B-Line by Eaton; Snap'N Shield.

B. Description: Polypropylene copolymer protective shields designed to snap directly onto strut channel. Shields shall span an arc of 180 degrees.

1. Operating Temperature Range: Minus 40 deg F to plus 178 deg F.

C. Certifications:

1. UL Classified for USA: UL-723 (ASTM E 84).
2. UL listed for Canada: ULC-S102.2.
3. Meets UL94 HB flammability standards.

D. Shield Dimensions for Pipe: Not less than the following:

1. NPS 1/4 to NPS 2: 12 inches long.

## 2.9 THERMAL-HANGER SHIELDS

A. Manufacturers:

1. B-Line by Eaton.
2. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
3. Rilco Manufacturing Company, Inc.
4. American Mechanical Insulation Sales Inc. (AMIS).
5. ERICO International Corp.
6. Value Engineered Products, Inc.

B. Description: Manufactured assembly consisting of insulation insert encased in 360 degree sheet metal shield.

1. Minimum Compressive Strength of Insert Material:

- a. 100-psig- for sizes smaller than NPS 6.
  - b. 600-psig- for sizes NPS 6 and larger.
- C. Insulation-Insert Material for Cold Piping: Full 360 degree, water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Full 360 degree, water-repellent treated, ASTM C 533, Type I calcium silicate.
- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.
- F. Include carbon steel ASTM A36 load distribution plates as required by load, pipe movement, hanger style, and hanger spacing.
- G. Thermal-Hanger Shields for Flexible Foamed Elastomeric Insulated Piping:
  - 1. Manufacturer:
    - a. B-Line by Eaton/Armacell; Armafix IPH.
  - 2. Insulation-Insert Material for Copper Piping with Flexible Foamed Elastomeric Insulation: Use the following:
    - a. Flexible foamed elastomeric, ASTM 534, Type I-Tubular Grade 1 with PUR/PIP support inserts.
- H. Thermal-Hanger Shields for Small Diameter Piping:
  - 1. Manufacturer:
    - a. Hydra-Zorb Company; Klo-Shure Insulation Couplings.
  - 2. Insulation-Insert Material for Small Diameter Piping with Flexible Foamed Elastomeric or Glass Fiber Insulation: Use the following:
    - a. Rigid Hytrel thermoplastic insulation coupling designed for use with pipe or tube NPS 1-1/2 and smaller, and insulation from 3/8 inch to 1-1/2 inch thick.

## 2.10 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated 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. Manufacturers:
    - a. B-Line by Eaton.
    - b. Empire Industries, Inc.
    - c. Hilti, Inc.
    - d. ITW Ramset/Red Head.
    - e. MKT Fastening, LLC.
    - f. Powers Fasteners.

- B. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application. Exception: Do not use chemical fasteners to support hanger systems for fire protection piping.

1. Manufacturers:

- a. Hilti, Inc.
- b. ITW Ramset/Red Head.
- c. MKT Fastening, LLC.
- d. Powers Fasteners.

2. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.

3. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.

4. Washer and Nut: Zinc-coated steel.

- C. Threaded Inserts: Galvanized malleable iron or galvanized steel for 3/4 inch bolts.

1. Manufacturers:

- a. Superior Concrete Accessories; Threaded Insert.
- b. Dayton Sure-Grip and Shore Co.
- c. Richmond Screw Anchor Co.

- D. Slotted Inserts: Continuous galvanized steel with temporary slot fillers and complete with nuts, studs, washers and the like, for 3/4 inch bolts.

1. Manufacturers:

- a. B-Line by Eaton; B22-I Continuous Concrete Insert.
- b. Unistrut Corp.; P-3200 Continuous Insert.
- c. Hohman and Barnard, Inc.
- d. Richmond Screw Anchor Co.
- e. Hilti, Inc.; CIS13812/PG.

## 2.11 ROOF AND GRADE MOUNTED PIPING SUPPORTS

- A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

- B. Low, Fixed-Height, Single-Base Stand: Assembly of base and horizontal member, and pipe support, for roof installation without membrane penetration.

1. Manufacturers:

- a. B-Line by Eaton; Dura-Blok.
- b. Eco Support Products.
- c. ERICO International Corp.
- d. MIRO Industries; Conduit and Condensate Supports.
- e. Portable Pipe Hangers.

2. Base: Plastic, stainless steel, or recycled rubber.
  3. Horizontal Member: Cadmium-plated-steel or galvanized-steel strut designed for use with standard strut clamps and accessories.
- C. Low, Adjustable-Height, Single-Base Stand: Assembly of base, horizontal member, and adjustable vertical members, and pipe support, for roof installation without membrane penetration.
1. Manufacturers:
    - a. B-Line by Eaton; Dura-Blok.
    - b. Eco Support Products.
    - c. ERICO International Corp.
    - d. MIRO Industries; Conduit and Condensate Supports.
    - e. Portable Pipe Hangers.
  2. Base: Plastic, stainless steel, or recycled rubber.
  3. Horizontal Member: Cadmium-plated-steel or galvanized-steel strut designed for use with standard strut clamps and accessories.
  4. Vertical Members: Threaded, hot rolled, steel rod conforming to ASTM A 36 or A575 with cadmium plated nuts and washers. Rod continuously threaded.
- D. High, Adjustable-Height, Single-Base Stand: Assembly of base, horizontal member, and adjustable vertical members, and clevis type pipe support, for roof installation without membrane penetration.
1. Manufacturers:
    - a. B-Line by Eaton; Dura-Blok.
    - b. Eco Support Products.
    - c. ERICO International Corp.
    - d. MIRO Industries; Water and Steam Supports.
    - e. Portable Pipe Hangers.
  2. Base: Plastic, stainless steel, or recycled rubber.
  3. Horizontal Member: Cadmium-plated-steel or galvanized-steel strut designed for use with standard strut clamps and accessories.
  4. Vertical Members: Threaded, hot rolled, steel rod conforming to ASTM A 36 or A575 with cadmium plated nuts and washers. Rod continuously threaded.
- E. Low, Fixed-Height, Single-Base Roller Stand: Assembly of base and horizontal roller, for roof installation without membrane penetration.
1. Manufacturers:
    - a. B-Line by Eaton; Dura-Blok.
    - b. Eco Support Products.
    - c. ERICO International Corp.
    - d. MIRO Industries; Gas and Mechanical Supports.

- e. Portable Pipe Hangers.
  - 2. Base: Plastic, stainless steel, or recycled rubber.
  - 3. Horizontal Member: Cadmium-plated-steel rod and corrosion resistant roller designed for use with standard accessories.
- F. Low, Adjustable-Height, Single-Base Roller Stand: Assembly of base and horizontal roller, for roof installation without membrane penetration.
- 1. Manufacturers:
    - a. B-Line by Eaton; Dura-Blok.
    - b. Eco Support Products.
    - c. ERICO International Corp.
    - d. MIRO Industries; Gas and Mechanical Supports.
    - e. Portable Pipe Hangers.
  - 2. Base: Plastic, stainless steel, or recycled rubber.
  - 3. Horizontal Member: Cadmium-plated-steel rod and corrosion resistant roller designed for use with standard accessories.
  - 4. Vertical Members: Threaded, hot rolled, steel rod conforming to ASTM A 36 or A575 with cadmium plated nuts and washers. Rod continuously threaded.
- G. High, Multiple-Base Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
- 1. Manufacturer:
    - a. B-Line by Eaton; Dura-Blok.
    - b. Eco Support Products.
    - c. ERICO International Corp.
    - d. MIRO Industries; Water and Steam Supports.
    - e. Portable Pipe Hangers.
  - 2. Bases: Two or more plastic, steel, or recycled rubber.
  - 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.
- H. Custom, Multiple-Base Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports or rollers, for roof installation without membrane penetration.
- 1. Manufacturer:
    - a. B-Line by Eaton; Dura-Blok.
    - b. Eco Support Products.
    - c. ERICO International Corp.
    - d. MIRO Industries; Custom Design Products.



- e. Portable Pipe Hangers.
- 2. Bases: Four or more plastic, steel, or recycled rubber.
- 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.
- 6. Pipe Rollers: Cadmium-plated-steel rod and corrosion resistant roller designed for use with standard accessories.
- I. Curb-Mounting 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.
  - 1. Roof Curb Type Supports: Coordinate installation and type with Architectural Trades. Top shall be level and extend a minimum of 10 inches above top of roof insulation.
    - a. Manufacturers:
      - 1) Pate.
      - 2) Thybar; Thycurb.
      - 3) Roof Products and Systems.
      - 4) Greenheck.
      - 5) Creative Metals.

## 2.12 ROOF MOUNTED EQUIPMENT SUPPORTS

- A. Equipment Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted equipment.
- B. Non-Penetrating Equipment Supports: Assembly of two or more bases and horizontal members, for roof installation without membrane penetration.
  - 1. Manufacturers:
    - a. B-Line by Eaton; Dura-Blok.
    - b. ERICO International Corp.
    - c. MIRO Industries; HD and LD Mechanical Unit Supports.
    - d. Portable Pipe Hangers.
  - 2. Base: Plastic, stainless steel, or recycled rubber.
  - 3. Horizontal Member: Cadmium-plated-steel, galvanized-steel, or stainless steel strut, and planking; designed for use with standard strut clamps, all-thread rod, and accessories.
- C. Roof Rail-Type Equipment Stands: Welded 18 gage galvanized steel shell, base plate and counter flashing. Factory installed chemically treated wood nailer. Fully mitered end sections. Internal bulkhead reinforcement.
  - 1. Roof Rail Type Supports: Coordinate installation and type with Architectural Trades. Top shall be level and extend a minimum of 10 inches above top of roof insulation.
    - a. Manufacturers:

- 1) Pate.
- 2) Thybar; TEMS Series.
- 3) Roof Products and Systems.
- 4) Greenheck.
- 5) Creative Metals.

#### 2.13 EQUIPMENT SUPPORTS

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

#### 2.14 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, 28-day compressive strength.

### PART 3 - EXECUTION

#### 3.1 HANGER AND SUPPORT APPLICATIONS

- A. Refer to application schedules on the Drawings.
- B. For insulated pipe, oversize hanger elements to accommodate insulation thickness.
- C. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- D. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- E. Use hangers and supports with galvanized, metallic coatings for outdoor applications or where exposed to outdoor conditions.
- F. Use hangers and supports with plastic coating, or galvanized metallic coatings for applications in corrosive atmospheres.
- G. Use metal framing, with plastic coating, or galvanized metallic coatings for metal framing in corrosive atmospheres.
- H. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- I. Use padded hangers for piping that is subject to scratching.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  1. MSS Type 8 or spring type to meet system requirements.
- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
  3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
  4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- L. Concrete Structure Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Anchor Devices, Concrete and Masonry: in accordance with Group I, Group II, Type 2, Class 2, Style 1 and Style 2, Group III and Group VIII or FS FF-S-325A. Furnish cast-in floor type equipment anchor devices with adjustable positions. Furnish built in anchor devices for masonry, unless otherwise approved by the Architect. Powder actuated anchoring devices shall not be used to support any mechanical systems components.
  2. Inserts, Concrete: TYPE 18 or 19. When applied to loads equivalent to piping in sizes NPS 2 and larger, and where otherwise required by imposed loads, a one foot length of 1/2 inch NPS 4 reinforcing rod shall be inserted and wired through wing slots. Proprietary type continuous inserts may be proposed and shall be submitted for approval.
  3. Use mechanical-expansion anchors where required in concrete construction.
  4. Use chemical fasteners where required in concrete construction.
- M. Steel Frame Structure Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Beam Clamps:
    - a. Center Loading: TYPE 21, 28, 29 and 30, unless otherwise indicated. Type 27 shall be allowed to support single pipes NPS 6 size or smaller only.
    - b. "C" Clamps: Type 19, 20 or 23, for supporting single pipes NPS 2-1/2 size or smaller only. Use of "C" clamps, or beam clamps of "C" pattern, or any modification thereof, is prohibited for supporting multiple pipes or pipes larger than NPS 2-1/2.
- N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Use spring supports and sway braces TYPES 48, 49, 50, 51, 52, 53, 54, 55 or 56. For specific points:
    - a. Provide spring supports at point of support where vertical movement will occur.
    - b. For light loads and vertical movement less than 1/4 inch, TYPES 48 or 49 spring cushion supports.
    - c. For vertical movements in excess of 1/4 inch but less than 1/2 inch, TYPES 51, 52 or 53 variable spring supports shall be used, loaded to not more than 75 percent of published load rating.
    - d. For vertical movements of 1/2 inch and more, TYPES 54, 55 and 56 constant support spring hangers.

- e. Sway braces; TYPE 50.
  - f. Variable spring hangers in accordance with referenced MSS Standards with "medium" allowable load change.
- O. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- P. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

### 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 structural frame.
- B. Provide necessary piping and equipment supporting elements including: building structure attachments, supplementary steel, hanger rods, stanchions and fixtures, vertical pipe attachments, horizontal pipe attachments, anchors, guides, spring supports in accordance with the referenced codes, standards, and requirements specified. Support piping and equipment from building structure, not from roof deck, floor slab, other pipe, duct or equipment.
- C. At connections between piping systems, hangers and equipment of dissimilar metals, insulate, using dielectric insulating material, nonferrous piping against direct contact with the building steel by insulating the contact point of the hanger and pipe or the hanger and building steel. Test each point of dielectric insulation with an ohm meter to ensure proper isolation of dissimilar materials. Test shall be observed by the Owner's Representative and/or Architect.
- D. Use copper plated or plastic coated supporting element in contact with copper tubing or glass piping.
- E. File and paint cut ends and shop or field prime paint supporting element components.
- F. Hang piping parallel with the lines of the building, unless otherwise indicated. Route piping in an orderly manner and maintain gradient. Space piping and components so a threaded pipe fitting may be removed between adjacent pipes and so there will be not less than 1/2 inch of clear space between finished surfaces and piping. Arrange hangers on adjacent parallel service lines in line with each other.
- G. Flange loads on connected equipment shall not exceed 75 percent of maximum allowed by equipment manufacturer. Flange loads in liquid containing systems shall be checked in the presence of the Architect when piping is full of liquid. No flange load is allowed on pumps, vibration isolated equipment or flexible connectors.
- H. Spring supports, within specified limitations: Constant support type, where necessary to avoid transfer of load from support to support or onto connected equipment; otherwise, variable support type located at points subject to vertical movement.
- I. Incorporate pipe anchors into piping systems to maintain permanent pipe positions. Install alignment guides for the piping adjacent to and on each side of pipe expansion loops and expansion joints to maintain alignment.
- J. Where necessary, brace piping and supports against reaction, sway and vibration.
- K. Do not hang piping from joist pans, floor decks, roof decks, equipment, ductwork, or other piping.

- L. Install turnbuckles, swing eyes and clevises to accommodate temperature changes, pipe accessibility, and adjustment for load pitch. Rod couplings are not acceptable.
- M. Install hangers and supports for piping at intervals specified, at locations not more than 3 feet from the ends of each runout, not more than 3 feet from connections to equipment, and not over 25 percent of specified interval from each change in direction of piping and for concentrated loads such as valves, etc.
- N. Base the load rating for pipe support elements on loads imposed by insulated weight of pipe filled with water. The span deflection shall not exceed slope gradient of pipe.
- O. If structural steel, roofs, or tunnels will allow support spacing greater than that shown above, Contractor shall submit proposed support system along with structural calculations documenting the allowance of such spacing, in accordance with ANSI, B31.1, and MSS Guidelines.
- P. Support vertical risers independently of connected horizontal piping whenever practical, with supports at the base and at intervals to accommodate system range of load with thermal conditions. Support vertical risers at each floor penetration for piping in shafts or chases. Guide for lateral stability. Fit horizontal piping connected to moving risers with two spring supports connected adjacent to riser, spaced according to required hanger spacing.
- Q. For risers at temperatures of 100 deg F or less place riser clamps under fittings. Support carbon steel pipe at each operating level or floor and at not more than 15-foot intervals for pipe 2 inches and smaller, and at not more than 20 foot intervals for pipe 2-1/2 inches and larger.
- R. After the piping systems have been installed, tested and placed in satisfactory operation, firmly tighten hanger rod nut and jam nut and upset threads to prevent movement of fasteners.
- S. Attach pipe anchors and pipe alignment guides to the building structure where indicated. If not indicated, the method used is optional to the Contractor, subject to approval by the Architect. In the case of structural steel, make attachment by clamping in accordance with the American Institute of Steel Construction Specification for the Design, Fabrication and Erection of Structural Steel for Building.
- T. Attach supporting elements connected to structural steel columns to preclude vertical slippage and cascading failure.
- U. Attach pipe hangers and other supporting elements to roof purlins and trusses at panel points.
- V. Where eccentric loading beam clamps are approved and where other work is supported by similar eccentric loading support element from the same structural member, locate eccentric loading support elements to minimize structural member torsion load.
- W. Limit the location of supporting elements for piping and equipment, when supported from roof, to panel points of the bar joists.
- X. Building structure shall not be reinforced except as approved by the Architect in writing.
- Y. Use approved cast-in-place inserts or built-in anchors for attachment to concrete structure. Size inserts and anchors for the total applied load with a safety factor in accordance with applicable codes but in no case less than 5. Coordinate installation of all imbedded items in accordance with manufacturer's instructions. Position anchorage and imbedded items as indicated and/or where required and support against displacement during placing of concrete. Cutting or repositioning of concrete beam or girder or reinforcing steel to accommodate inserts will not be allowed. Provide removable closures in imbedded device openings to prevent entry of concrete.

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- Z. Support piping and equipment from concrete building frame, not from roof or floor slabs unless otherwise indicated.
- AA. Use cast-in-place inserts in concrete beams and girders. Drilled anchors/wedge type inserts shall be used on vertical surfaces only. Coordinate with structural engineer.
- BB. Attach piping supports to the side of concrete beams and concrete joist. Provide supplementary support steel as required. Cast-in-place or drilled anchors will not be permitted in the bottom of concrete beams and concrete joist.
- CC. Attach piping supports to the side of concrete beams or concrete joist. Where intermediate hangers are required to meet the hanger spacing schedule, the Contractor may propose attachment of intermediate pipe supports to the bottom of the concrete slab pending submittal of a satisfactory pull out test. The Contractor shall submit pull out test criteria, pull out test results, proposed hanger detail and hanger point loads to the Architect for written approval.
- DD. 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.
- EE. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- FF. Fastener System Installation:
  - 1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- GG. Roof-Mounting Pipe and Equipment Stand Installation:
  - 1. Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
  - 2. Curb or Rail Mounting Type Stands: Assemble components or fabricate stand and mount on permanent, stationary roof curb or rail. Refer to Division 07 Section "Roof Accessories" for curb and rail installation.
  - 3. Maintain support manufacturer's recommended spacing.
- HH. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- II. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- JJ. 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.
- KK. Install lateral bracing with pipe hangers and supports to prevent swaying.

- LL. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- MM. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- NN. 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.
- OO. Refer to individual piping sections for hanger spacing and hanger rod sizes.

### 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.

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1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Equipment Supports: Painting is specified in Division 09 painting Sections.
- C. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- D. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

**\*\*END OF SECTION\*\***



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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 20 Section "Mechanical General Requirements."
  - 2. Division 20 Section "Basic Mechanical Materials and Methods."

#### 1.2 SUBMITTALS

- A. Product Data: Include load deflection curves for each vibration isolation device.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Include the following:
  - 1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
  - 2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system has been examined for excessive stress and that none will exist.
  - 3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

- C. Welding certificates.

### 1.3 QUALITY ASSURANCE

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

### 1.4 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. Installation of these items is specified in Division 07 Section "Roof Accessories."

## PART 2 - PRODUCTS

### 2.1 VIBRATION ISOLATION EQUIPMENT BASES

- A. **Type A:** Direct Isolator Attachment

- 1. Unit to be isolated is so constructed that vibration isolators of the type specified may be directly attached, provided that the edge deflection of the isolated unit base over unsupported span between mountings does not exceed specified or manufacturer's limits. If units to be isolated will not meet required deflection provisions, Type B bases shall be provided.

- B. **Type B:** Factory-fabricated, welded, structural-steel bases or rails.

- 1. Structural Steel Bases:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type WF or a comparable product by one of the following:

- 1) Amber/Booth; a VMC Group Company.
- 2) Kinetics Noise Control, Inc.
- 3) Korfund Dynamics; a VMC Group Company.
- 4) Vibration Eliminator Co., Inc.
- 5) Vibration Isolation Co., Inc. (Pump Bases Only)
- 6) Vibration Mountings & Controls; a VMC Group Company.
- 7) Vibro-Acoustics.

- b. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.
- c. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
- d. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

- 2. Structural-Steel Rails:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type ICS or a comparable product by one of the following:

- 1) Amber/Booth; a VMC Group Company.
- 2) Kinetics Noise Control, Inc.
- 3) Korfund Dynamics; a VMC Group Company.
- 4) Vibration Eliminator Co., Inc.
- 5) Vibration Isolation Co., Inc. (Pump Bases Only)
- 6) Vibration Mountings & Controls; a VMC Group Company.
- 7) Vibro-Acoustics.

- b. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.
- c. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
- d. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. **Type C** Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for field-applied, cast-in-place concrete.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type BMK/KSL or a comparable product by one of the following:
  - 1) Amber/Booth; a VMC Group Company.
  - 2) Kinetics Noise Control, Inc.
  - 3) Korfund Dynamics; a VMC Group Company.
  - 4) Vibration Eliminator Co., Inc.
  - 5) Vibration Isolation Co., Inc. (Pump Bases Only)
  - 6) Vibration Mountings & Controls; a VMC Group Company.
  - 7) Vibro-Acoustics.
2. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.
3. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
4. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
5. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

D. **Type D** Curb Mounted Aluminum Bases:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type CMAB or a comparable product by one of the following:
  - a. Kinetics Noise Control, Inc.
  - b. ThyCurb/Thybar.
  - c. Vibro-Acoustics.

2. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment.
3. Upper Frame: Corrosion resistant extruded aluminum. Upper frame shall overlap lower frame for water runoff. Mitered ends heliarc welded to prevent water leakage through corners.
4. Lower Frame: Corrosion resistant extruded aluminum. Lower framed shall overlap roof curb for water runoff. Mitered ends heliarc welded to prevent water leakage through corners.
5. Safety Stops: Neoprene, mounted in corners of lower frame for extreme wind conditions and mild seismic disturbances under normal conditions.
6. Isolators: Cadmium plated free-standing springs with positive spring retainer and flexible ties.
7. Splicing Kit: Required for bases shipped in multiple pieces.
8. Weatherseal: Flexible frictionless EPDM.
9. Static Deflection: Nominal 1 inch.

E. **Type E Rooftop Spring Curb:**

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type RSC or a comparable product by one of the following:
  - a. Kinetics Noise Control, Inc.
  - b. ThyCurb/Thybar.
  - c. Vibro-Acoustics.
2. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment; and to withstand wind forces as required by local codes.
3. Lower Support Assembly: Sheet-metal "Z" section containing adjustable and removable steel springs that support upper floating frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist wind forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.
4. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch-thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
  - a. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with restraint.
    - 1) Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.

- 2) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 3) Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 4) Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
  - 5) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- b. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers (maximum 3 layers separated by steel shims) to achieve 90 percent efficiency, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
- 1) Material: Bridge-bearing neoprene, complying with AASHTO M 251.
  - 2) Durometer Rating: 40.
5. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.
6. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.
7. Sound Isolation: Within perimeter of roof curb rails and as detailed on the Drawings:
- a. Two layers of 2-inch thick board insulation, minimum 3-lb/cu. ft. density, glass fibers bonded with a thermosetting resin. Comply with ASTM C 612 Type IA or Type IB.
  - b. Two layers of 5/8-inch thick water-resistant gypsum core wall panel surfaced with paper on front, back, and long edges. Comply with ASTM C 1396.
  - c. One layer of 6-inch thick fiberglass blanket insulation.
8. Static Deflection: Nominal 1 inch, 2 inches, or 3 inches.

## 2.2 VIBRATION ISOLATORS

- A. **Type 1a** Elastomeric Isolator Pads: Oil- and water-resistant elastomer, arranged in single or multiple layers (maximum 3 layers separated by steel shims) to achieve 90 percent efficiency, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type W, Super W, WSW, and WSWSW or comparable products by one of the following:
    - a. Amber/Booth; a VMC Group Company.
    - b. Kinetics Noise Control, Inc.
    - c. Korfund Dynamics; a VMC Group Company.
    - d. Vibration Eliminator Co., Inc.
    - e. Vibration Mountings & Controls; a VMC Group Company.
    - f. Vibro-Acoustics.
  2. Material: Standard neoprene for indoor applications.

3. Material: Bridge-bearing neoprene, complying with AASHTO M 251 for outdoor applications.
- B. **Type 1b** Elastomeric Isolator Pads: Oil- and water-resistant elastomer, single layer, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and 1/4 inch steel load bearing plate. Factory cut to sizes that match requirements of supported equipment.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type Super WMSW and MBSW or a comparable product by one of the following:
    - a. Amber/Booth; a VMC Group Company.
    - b. Kinetics Noise Control, Inc.
    - c. Korfund Dynamics; a VMC Group Company.
    - d. Vibration Eliminator Co., Inc.
    - e. Vibration Mountings & Controls; a VMC Group Company.
    - f. Vibro-Acoustics.
  2. Material: Standard neoprene for indoor applications.
  3. Material: Bridge-bearing neoprene, complying with AASHTO M 251 for outdoor applications.
- C. **Type 2** Elastomeric Mounts: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type ND or a comparable product by one of the following:
    - a. Amber/Booth; a VMC Group Company.
    - b. Kinetics Noise Control, Inc.
    - c. Korfund Dynamics; a VMC Group Company.
    - d. Vibration Eliminator Co., Inc.
    - e. Vibration Mountings & Controls; a VMC Group Company.
    - f. Vibro-Acoustics.
  2. Durometer Rating: Selected for maximum possible static deflection with the loading of each piece of equipment.
  3. Materials: Cast-ductile-iron housing containing two separate and opposing, molded, bridge-bearing neoprene elements that prevent central threaded sleeve and attachment bolt from contacting the casting during normal operation.
  4. Neoprene: Bridge-bearing neoprene as defined by AASHTO.
- D. **Type 3** Spring Isolators: Freestanding, open-spring isolators.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type SLF or a comparable product by one of the following:
    - a. Amber/Booth; a VMC Group Company..

- b. Kinetics Noise Control, Inc.
  - c. Korfund Dynamics; a VMC Group Company.
  - d. Vibration Eliminator Co., Inc.
  - e. Vibration Mountings & Controls; a VMC Group Company.
  - f. Vibro-Acoustics.
- 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  - 5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 100 psig.
  - 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- E. **Type 4** Restrained Spring Isolators: Restrained single and multiple spring mounts.
- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Types SLR and SLRS or comparable products by one of the following:
    - a. Amber/Booth; a VMC Group Company..
    - b. Kinetics Noise Control, Inc.
    - c. Korfund Dynamics; a VMC Group Company.
    - d. Vibration Eliminator Co., Inc.
    - e. Vibration Mountings & Controls; a VMC Group Company..
    - f. Vibro-Acoustics.
  - 2. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
  - 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- F. **Type 5** Thrust Restraints
- 1. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression or tension as required, and with a load stop. Include rod and angle-iron brackets with back-up plates for attaching to equipment and ductwork.
    - a. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type WBI for fan inlet connections, and Type WBD for fan outlet connections, or comparable products by one of the following:

- 1) Amber/Booth; a VMC Group Company.
- 2) Kinetics Noise Control, Inc.
- 3) Korfund Dynamics; a VMC Group Company.
- 4) Vibration Eliminator Co., Inc.
- 5) Vibration Mountings & Controls; a VMC Group Company.
- 6) Vibro-Acoustics.

- b. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
- c. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
- d. Minimum Additional Travel: 50 percent of the required deflection at rated load.
- e. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
- f. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- g. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
- h. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

### 2.3 VIBRATION ISOLATION HANGERS

- A. **Type 8a** Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type 30N or a comparable product by one of the following:
  - a. Amber/Booth; a VMC Group Company..
  - b. Kinetics Noise Control, Inc.
  - c. Korfund Dynamics; a VMC Group Company.
  - d. Vibration Eliminator Co., Inc.
  - e. Vibration Mountings & Controls; a VMC Group Company.
  - f. Vibro-Acoustics.
2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

- B. **Type 8b** Spring Hangers with Vertical-Limit Stop: Precompressed combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.



1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type PC30N or a comparable product by one of the following:
  - a. Amber/Booth; a VMC Group Company..
  - b. Kinetics Noise Control, Inc.
  - c. Korfund Dynamics; a VMC Group Company.
  - d. Vibration Eliminator Co., Inc.
  - e. Vibration Mountings & Controls; a VMC Group Company.
  - f. Vibro-Acoustics.
2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

## 2.4 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
  1. Powder coating on springs and housings.
  2. All hardware shall be electrogalvanized. Hot-dip galvanize metal components for exterior use.
  3. Baked enamel for metal components on isolators for interior use.
  4. Color-code or otherwise mark vibration isolation devices to indicate capacity range.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements, installation tolerances, and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install roof curbs, equipment supports, and roof penetrations as specified in Division 07 Section "Roof Accessories."
- B. Install thrust limits at centerline of thrust, symmetrical on either side of equipment.

### 3.3 CONNECTIONS

- A. Provide flexible electrical connections in the form of large radius, 360 degree loop of flexible conduit for all vibrating isolated equipment. Any cooling water lines, compressed air, or other piping services (except inlet and outlet water connections for pumps, chillers or cooling tower) shall be made with 360 degree loops of reinforced neoprene hose, which are attached using nipples of appropriate gender. All service connections made with neoprene hose shall have shut-off valves between the hose and the supply service.
- B. Vibration isolate piping connected to vibration isolated equipment using Type 8a or 8b spring hangers, and with distance to be isolated as scheduled on the Drawings. Maximum spacing between isolators same as maximum distance between pipe hangers and supports.
- C. Vibration isolate ductwork connected to air handling units, return air fans, and vibration isolated equipment using Type 8a or 8b spring hangers, and in accordance with isolation distances scheduled on the Drawings.

### 3.4 EQUIPMENT BASES

- A. Fill concrete inertia bases, after installing base frame, with 3000-psi concrete; trowel to a smooth finish.
  - 1. Cast-in-place concrete materials and placement requirements are specified in Division 03.
- B. Concrete Bases: Anchor equipment to concrete base according to supported equipment manufacturer's written instructions.
  - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
  - 2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base and anchor into structural concrete floor.
  - 3. Place and secure anchorage devices. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
  - 6. Cast-in-place concrete materials and placement requirements are specified in Division 03.

### 3.5 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:

1. Isolator deflection.
2. Snubber minimum clearances.

3.6 ADJUSTING

- A. Adjust isolators after piping systems have been filled and equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop.
- D. Adjust active height of spring isolators.
- E. Adjust snubbers according to manufacturer's written recommendations.

3.7 CLEANING

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

**\*\*END OF SECTION\*\***

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 20 Section "Mechanical General Requirements."

#### 1.2 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. Valve numbering scheme.
- D. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in Maintenance Manuals.

#### 1.3 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME (ANSI) A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.4 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 location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified:
  - 1. Seton.
  - 2. Brady.
  - 3. EMED.
  - 4. Craftmark.
  - 5. Brimar Industries, Inc.
  - 6. Marking Services Inc. (MSI).
  - 7. Kolbi Pipe Marker Co.

2.2 EQUIPMENT IDENTIFICATION DEVICES

- A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
  - 1. Data:
    - a. Manufacturer, product name, model number, and serial number.
    - b. Capacity, operating and power characteristics, and essential data.
    - c. Labels of tested compliances.
  - 2. Location: Accessible and visible.
  - 3. Fasteners: As required to mount on equipment.
- B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.
  - 1. Terminology: Match schedules as closely as possible.
  - 2. Data:
    - a. Name and plan number.
    - b. Equipment service.
    - c. Design capacity.

- d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.
- 3. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.
- C. Equipment 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. Fabricate in sizes required for message. Provide holes for mechanical fastening.
  - 1. Data: Instructions for operation of equipment and for safety procedures.
  - 2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.
  - 3. Thickness: Minimum 1/16 inch, unless otherwise indicated.
  - 4. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.
- D. Access Panel and Door Markers: 1/16-inch- thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.
  - 1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

## 2.3 PIPING IDENTIFICATION DEVICES

- A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
  - 1. Colors: Comply with ASME (ANSI) A13.1, unless otherwise indicated.
  - 2. Type and Size of Letters: Comply with ANSI A13.1, unless otherwise indicated.
  - 3. Legends: Spelled out in full or commonly used and accepted abbreviations.
  - 4. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
  - 5. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
  - 6. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
- B. Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.
- C. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.
- D. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

- E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.
  - 1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
  - 2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.
- F. Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape of not less than 6 inches wide by 4mil thick, manufactured for direct burial service.
- G. Detectable Underground Pipe Markers: Continuously printed plastic ribbon tape with detectable aluminum core and with colors meeting APWA requirements, not less than 6 inches wide by 4 mil thick, manufactured for direct burial service.

#### 2.4 DUCT IDENTIFICATION DEVICES

- A. Duct Markers: Engraved, color-coded laminated plastic. Include direction and quantity of airflow, air handling unit or fan number, and duct service (such as supply, return, and exhaust). Include contact-type, permanent adhesive.
- B. Duct Markers: Vinyl, 2-inch minimum character height, with permanent pressure sensitive adhesive. Include direction and quantity of airflow, air handling unit or fan number, and duct service (such as supply, return, and exhaust).

#### 2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme approved by Architect/Engineer. Provide 5/32-inch hole for fastener.
  - 1. Material: 0.032-inch- thick brass.
  - 2. Valve-Tag Fasteners: Brass wire-link chain or beaded chain.

#### 2.6 VALVE SCHEDULES

- A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
  - 1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
  - 2. Frame: Finished hardwood or extruded aluminum.
  - 3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

#### 2.7 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
4. Color: Yellow background with black lettering.

### PART 3 - EXECUTION

#### 3.1 APPLICATIONS, GENERAL

- A. Products specified are for applications referenced in other Division 20, 21, 22, and 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

#### 3.2 EQUIPMENT IDENTIFICATION

- A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
  1. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
  2. Fans, blowers, primary balancing dampers, and mixing boxes.
  3. Packaged HVAC central-station and zone-type units.
- B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.
  1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
  3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
    - a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
    - b. Fire department hose valves and hose stations.
    - c. Meters, gages, thermometers, and similar units.
    - d. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
    - e. Pumps, compressors, chillers, condensers, and similar motor-driven units.
    - f. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
    - g. Fans, blowers, primary balancing dampers, and mixing boxes.



- h. Packaged HVAC central-station and zone-type units.
  - i. Tanks and pressure vessels.
  - j. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.
- C. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.
  - 1. Identify mechanical equipment with equipment markers in the following color codes:
    - a. Green: For cooling equipment and components.
    - b. Yellow: For heating equipment and components.
    - c. Orange: For combination cooling and heating equipment and components.
    - d. Brown: For energy-reclamation equipment and components.
  - 2. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  - 3. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
  - 4. Include signs for the following general categories of equipment:
    - a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
    - b. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
    - c. Pumps, compressors, chillers, condensers, and similar motor-driven units.
    - d. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
    - e. Fans, blowers, primary balancing dampers, and mixing boxes.
    - f. Packaged HVAC central-station and zone-type units.
    - g. Tanks and pressure vessels.
    - h. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.
- D. Install access panel markers with screws on equipment access panels.
- E. Area Served: Equipment serving different areas of a building other than where the equipment is installed shall be permanently marked in a manner that, in addition to identifying the equipment as specified in this Section, also identifies the area it serves.

### 3.3 PIPING IDENTIFICATION

- A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
  - 1. Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, minimum 3/4 inch wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
  - 2. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, minimum 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.

- B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:
  - 1. Near each valve and control device.
  - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  - 3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
  - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
  - 5. Near major equipment items and other points of origination and termination.
  - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
  - 7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.
- C. Underground Pipe Markers: Install 6 to 8 inches below finished grade, directly above buried pipe.

#### 3.4 DUCT IDENTIFICATION

- A. Install engraved duct markers with permanent adhesive on air ducts in the following color codes:
  - 1. Refer to Schedule.
  - 2. ASME (ANSI) A13.1 Colors and Designs: For hazardous material exhaust.
  - 3. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- B. Identify ductwork with vinyl markers and flow direction arrows.
- C. Locate markers at air handling units, each side of floor and wall penetrations, near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

#### 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; plumbing fixture supply stops; 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:
  - 1. Valve-Tag Size and Shape:

- a. Cold Water: Minimum 1-1/2 inches, round or square.
- b. Hot Water: Minimum 1-1/2 inches, round or square.
- c. Fire Protection: Minimum 1-1/2 inches, round or square.

### 3.6 VALVE-SCHEDULE INSTALLATION

- A. Mount valve schedule on wall in accessible location in each major equipment room.

### 3.7 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

### 3.8 ADJUSTING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

### 3.9 CLEANING

- A. Clean faces of mechanical identification devices and glass frames of valve schedules.

### 3.10 SCHEDULES

- A. Paint colors are listed here for reference only. Painting is specified under Division 9.

#### PIPE LABELING AND COLOR CODING

<u>Pipe System Label</u>	<u>Drawing Abbrev.</u>	<u>Labels</u>	<u>Piping</u>
Sanitary Sewer	SAN	White on Green	Dark Brown
Sanitary Vent	V	White on Green	Dark Brown
Rain Conductor	RC	White on Green	Dark Brown
Domestic Cold Water	CW	White on Green	Light Green
Domestic Hot Water	HW	Black on Yellow	Dark Green
Domestic Hot Water Return	HWR	Black on Yellow	Dark Green
Hot Water Htg. Supply	HWHS	Black on Yellow	Dark Blue
Hot Water Htg. Return	HWHR	Black on Yellow	Dark Blue
Chilled Water Supply	CHWS	White on Green	Light Blue
Chilled Water Return	CHWR	White on Green	Light Blue
Refrigerant Liquid	RL	Black on Yellow	
Refrigerant Suction	RS	Black on Yellow	
Fire Protection	FP	White on Red	Bright Red

#### SHEET METAL WORK

<u>Service</u>	<u>Abbrev.</u>	<u>Labels</u>	<u>Ductwork</u>
Air Conditioning Supply	Supply Air	White on Green	White
Air Conditioning Return	Return Air	White on Green	White
Exhaust Systems	Exhaust Air	Black on Yellow	Green
Outside Air Intake	Outside Air	White on Green	White
Mixed Air	Mixed Air	White on Green	White

\*\*END OF SECTION\*\*

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

1. Division 20 Section "Mechanical General Requirements."
2. Division 20 Section "Basic Materials and Methods."
3. Division 20 Section "Hanger and Supports" for thermal hanger shield inserts.
4. Division 22 Section "Plumbing Fixtures: for protective shielding guards.
5. Division 22 Section "Medical Plumbing Fixtures" for protective shielding guards.
6. Division 23 Section "Metal Ducts" for duct liners.
7. Division 33 Section "Underground Hydronic Distribution Piping" for preinsulated piping systems.
8. Division 33 Section "Underground Steam and Condensate Distribution Piping" for preinsulated piping systems.

#### 1.2 SUMMARY

- A. This Section includes mechanical insulation for pipe, duct, and equipment.

#### 1.3 DEFINITIONS

- A. ASJ: All-service jacket.
- B. FSK: Foil, scrim, kraft paper.
- C. FSP: Foil, scrim, polyethylene.
- D. PVC: Polyvinyl Chloride.
- E. PVDC: Polyvinylidene chloride.
- F. SSL: Self-sealing lap.

#### 1.4 INDOOR PIPING INSULATION SYSTEMS DESCRIPTION

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are scheduled on the Drawings, or identified for each piping system and pipe size range.
- B. Sanitary Waste Piping Where Heat Tracing Is Installed, All Pipe Sizes: Glass-Fiber Pipe Insulation, Type I: 1-1/2 inches thick.

#### 1.5 OUTDOOR, ABOVEGROUND PIPING INSULATION SYSTEMS DESCRIPTION

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are scheduled on the Drawings, or identified for each piping system and pipe size range.
- B. Sanitary or Storm Piping Where Heat Tracing Is Installed, All Pipe Sizes: Glass-Fiber Pipe Insulation, Type I: 2 inches thick.

#### 1.6 INDOOR DUCT AND PLENUM INSULATION SYSTEMS DESCRIPTION

- A. Acceptable indoor duct and plenum insulation materials and thicknesses are scheduled on the Drawings.

1.7 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SYSTEMS DESCRIPTION

- A. Acceptable outdoor duct and plenum insulation materials and thicknesses are scheduled on the Drawings.

1.8 EXTERNAL DUCT LAGGING SYSTEM

- A. System for controlling low frequency sound transmission in metal ducts consisting of:

1. One layer of 1-inch thick rigid fiberglass duct board.
2. Two layers of 5/8-inch thick gypsum board.

1.9 EQUIPMENT INSULATION SYSTEMS DESCRIPTION

- A. Acceptable equipment insulation materials and thicknesses are scheduled on the Drawings.

1.10 SUBMITTALS

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

1. ESR Report: For fire-rated grease duct insulation.

- 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. Attachment and covering of heat tracing inside insulation.
3. Insulation application at pipe expansion joints for each type of insulation.
4. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Removable insulation at piping specialties, equipment connections, and access panels.
6. Application of field-applied jackets.
7. Application at linkages of control devices.
8. Field application for each equipment type
9. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

- C. Field quality-control inspection reports.

1.11 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.
- C. Ductwork Maximum Temperature Limits: Based on ASTM C 411 test procedures.

#### 1.12 DELIVERY, STORAGE, AND HANDLING

- A. Prior to installation, protect insulation from exposure to water and from physical damage. Prior to installation, store insulation in manufacturer's original packaging.

#### 1.13 COORDINATION

- A. Coordinate size and location of supports, hangers, and pre-insulated pipe shields/supports specified in Division 20 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.
- C. Coordinate installation and testing of heat tracing.

#### 1.14 SCHEDULING

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

### PART 2 - PRODUCTS

#### 2.1 INSULATION MATERIALS, GENERAL REQUIREMENTS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Adhesives used shall be fire resistant in their dry states and UL listed.

## 2.2 PIPE INSULATION MATERIALS

- A. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
  - 1. Products: Subject to compliance with requirements, provide one of the products specified.
    - a. Armacell LLC; AP Armaflex.
    - b. Nomaco K-Flex; Insul-Tube and Insul-Sheet.
- B. Glass-Fiber, Preformed Pipe Insulation, Type I:
  - 1. Products: Subject to compliance with requirements, provide one of the products specified.
    - a. Johns Manville; Micro-Lok.
    - b. Knauf Insulation; 1000 Pipe Insulation.
    - c. Manson Insulation Inc.; Alley-K.
    - d. Owens Corning; Fiberglas Pipe Insulation.
  - 2. Type I, 850 deg F Materials: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ or ASJ-SSL. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
- C. Mineral-Wool, Preformed Pipe Insulation, Type II:
  - 1. Products: Subject to compliance with requirements, provide one of the products specified.
    - a. Fibrex Insulations Inc.; Coreplus 1200.
    - b. Rock Wool Manufacturing Company; Delta PC and PF.
    - c. Roxul Inc.; 1200 Pipe Insulation.
  - 2. Type II, 1200 deg F Materials: Mineral wool fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ or ASJ-SSL. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

## 2.3 DUCTWORK INSULATION MATERIALS

- A. Blanket Insulation: 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. Products: Subject to compliance with requirements, provide one of the products specified.
    - a. CertainTeed Corp.; Duct Wrap.
    - b. Johns Manville; Microlite.
    - c. Knauf Insulation; Duct Wrap.
    - d. Manson Insulation Inc.; Alley Wrap FSK.
    - e. Owens Corning; All-Service Duct Wrap.



- B. Board Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the products specified.
  - a. CertainTeed Corp.; Commercial Board.
  - b. Fibrex Insulations Inc.; FBX.
  - c. Johns Manville; 800 Series Spin-Glas.
  - d. Knauf Insulation; Insulation Board.
  - e. Manson Insulation Inc.; AK Board.
  - f. Owens Corning; Fiberglas 700 Series.

#### 2.4 DUCTWORK LAGGING MATERIALS

- A. Board Insulation: Minimum 3 pounds per cubic foot density, glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB.

1. Products: Subject to compliance with requirements, provide one of the products specified.
  - a. CertainTeed Corp.; CertaPro Commercial Board.
  - b. Johns Manville; 800 Series Spin-Glas.
  - c. Knauf Insulation; Insulation Board.
  - d. Manson Insulation Inc.; AK Board.
  - e. Owens Corning; Fiberglas 700 Series.

- B. Gypsum Board: Gypsum core wall panel surfaced with paper on front, back, and long edges.

1. Comply with ASTM C 1396.
2. Edges: Square.

- C. Acoustical Sealant:

1. Products: Subject to compliance with requirements, provide one of the products specified.
  - a. Acoustical Surfaces, Inc.; Noise S.T.O.P. Sealant.
  - b. Johns Manville; Dux Seal.

#### 2.5 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide one of the products specified.
  - a. Insulco, Division of MFS, Inc.; Triple I.
  - b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

1. Products: Subject to compliance with requirements, provide one of the products specified.

- a. P. K. Insulation Mfg. Co., Inc.; Thermal-V-Kote.

- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

1. Products: Subject to compliance with requirements, provide one of the products specified.

- a. Insulco, Division of MFS, Inc.; SmoothKote.
  - b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
  - c. Rock Wool Manufacturing Company; Delta One Shot.

## 2.6 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to it and to surfaces to be insulated, unless otherwise indicated.

- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the products specified.

- a. Armacell LCC; 520 Adhesive.
  - b. Foster Products Corporation, H. B. Fuller Company; 85-75.
  - c. RBX Corporation; Rubatex Contact Adhesive.

- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the products specified.

- a. Childers Products, H.B. Fuller Company; CP-82.
  - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
  - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
  - d. Marathon Industries, Inc.; 225.
  - e. Mon-Eco Industries, Inc.; 22-25.
  - f. Vimasco Corporation.

- D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the products specified.

- a. Childers Products, H.B. Fuller Company; CP-82.
  - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
  - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
  - d. Marathon Industries, Inc.; 225.
  - e. Mon-Eco Industries, Inc.; 22-25.

- E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the products specified.
  - a. Dow Chemical Company (The); 739, Dow Silicone.
  - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
  - c. P.I.C. Plastics, Inc.; Welding Adhesive.
  - d. Red Devil, Inc.; Celulon Ultra Clear.
  - e. Speedline Corporation; Speedline Vinyl Adhesive.

## 2.7 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
  1. Products: Subject to compliance with requirements, provide one of the products specified.
    - a. Childers Products, H.B. Fuller Company; CP-35.
    - b. Foster Products Corporation, H. B. Fuller Company; 30-90.
    - c. ITW TACC, Division of Illinois Tool Works; CB-50.
    - d. Marathon Industries, Inc.; 590.
    - e. Mon-Eco Industries, Inc.; 55-40.
    - f. Vimasco Corporation; 749.
  2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
  3. Service Temperature Range: Minus 20 to plus 180 deg F.
  4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
  5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
  1. Products: Subject to compliance with requirements, provide one of the products specified.
    - a. Childers Products, H.B. Fuller Company; CP-10.
    - b. Foster Products Corporation, H. B. Fuller Company; 35-00.
    - c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
    - d. Marathon Industries, Inc.; 550.
    - e. Mon-Eco Industries, Inc.; 55-50.
    - f. Vimasco Corporation; WC-1/WC-5.
  2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
  3. Service Temperature Range: Minus 20 to plus 200 deg F.
  4. Solids Content: 63 percent by volume and 73 percent by weight.
  5. Color: White.

2.8 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. Products: Subject to compliance with requirements, provide one of the products specified.
    - a. Childers Products, H.B. Fuller Company; CP-52.
    - b. Foster Products Corporation, H. B. Fuller Company; 81-42.
    - c. Marathon Industries, Inc.; 130.
    - d. Mon-Eco Industries, Inc.; 11-30.
    - e. Vimasco Corporation; 136.
  2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
  3. Service Temperature Range: Minus 50 to plus 180 deg F.
  4. Color: White.

2.9 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the products specified.
    - a. Childers Products, H.B. Fuller Company; CP-76-8.
    - b. Foster Products Corporation, H. B. Fuller Company; 95-44.
    - c. Marathon Industries, Inc.; 405.
    - d. Mon-Eco Industries, Inc.; 44-05.
    - e. Vimasco Corporation; 750.
  2. Materials shall be compatible with insulation materials, jackets, and substrates.
  3. Fire- and water-resistant, flexible, elastomeric sealant.
  4. Service Temperature Range: Minus 40 to plus 250 deg F.
  5. Color: Aluminum.
- B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the products specified.
    - a. Childers Products, H.B. Fuller Company; CP-76.
  2. Materials shall be compatible with insulation materials, jackets, and substrates.
  3. Fire- and water-resistant, flexible, elastomeric sealant.
  4. Service Temperature Range: Minus 40 to plus 250 deg F.

5. Color: White.

C. Joint Sealants for Cellular-Glass, Phenolic-Foam, and Polyisocyanurate:

1. Products: Subject to compliance with requirements, provide one of the products specified.
  - a. Childers Products, H.B. Fuller Company; CP-76.
  - b. Foster Products Corporation, H. B. Fuller Company; 30-45.
  - c. Marathon Industries, Inc.; 405.
  - d. Mon-Eco Industries, Inc.; 44-05.
  - e. Pittsburgh Corning Corporation; Pittseal 444.
  - f. Vamasco Corporation; 750.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.

2.10 FACTORY-APPLIED JACKETS

- A. Insulation systems 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.

2.11 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 as specified; roll stock ready for shop or field cutting and forming.
1. Products: Subject to compliance with requirements, provide one of the products specified.
    - a. Johns Manville; Zeston and Ceel-Co.
    - b. P.I.C. Plastics, Inc.; FG Series.
    - c. Proto PVC Corporation; LoSmoke.
    - d. Speedline Corporation; SmokeSafe.
  2. Adhesive: As recommended by jacket material manufacturer.

3. Color: White.
  4. Factory-fabricated tank heads and tank side panels.
- D. PVC Fitting Covers: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C, and including flexible glass fiber insulation inserts.
1. Products: Subject to compliance with requirements, provide one of the products specified.
    - a. Johns Manville; Zeston and Ceel-Co.
    - b. P.I.C. Plastics, Inc.; FG Series.
    - c. Proto PVC Corporation; LoSmoke.
    - d. Speedline Corporation; SmokeSafe.
  2. Adhesive: As recommended by manufacturer.
  3. Color: White.
  4. Factory-fabricated fitting covers:
    - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, and mechanical joints.
- E. Metal Jacket:
1. Products: Subject to compliance with requirements, provide one of the products specified.
    - a. PABCO-Childers Metals; ITW Insulation Systems; Metal Jacketing Systems.
    - b. RPR Products, Inc.; Insul-Mate.
  2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
    - a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
    - b. Finish and thickness are indicated in field-applied jacket schedules.
    - 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 or 2.5-mil- thick Polysurlyn.
    - e. Factory-Fabricated Fitting Covers:
      - 1) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      - 2) Provide factory fabricated PVC tee covers, flange and union covers, beveled collars and valve covers.
      - 3) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
  3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
    - a. Sheet and roll stock ready for shop or field sizing factory cut and rolled to size.
    - b. Material, finish, and thickness are indicated in field-applied jacket systems.

- 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 or 2.5-mil- thick Polysurlyn.
- e. Factory-Fabricated Fitting Covers:
  - 1) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
  - 2) Provide factory fabricated PVC tee covers, flange and union covers, beveled collars and valve covers.
  - 3) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- F. Self-Adhesive Outdoor Jacket: Laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with aluminum-foil facing.
  - 1. Products: Subject to compliance with requirements, provide one of the products specified.
    - a. MFM Building Products Corp.; FlexClad-400
    - b. Polyguard; Alumaguard.
    - c. Venture Tape Corp.; VentureClad.
- G. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
  - 1. Products: Subject to compliance with requirements, provide one of the products specified.
    - a. Dow Chemical Company (The), Saran 540 Vapor Retarder Film.
- H. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
  - 1. Products: Subject to compliance with requirements, provide one of the products specified.
    - a. Dow Chemical Company (The), Saran 560 Vapor Retarder Film.
- I. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
  - 1. Products: Subject to compliance with requirements, provide one of the products specified.
    - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
- J. Sound Barrier Jacket: Uni-composite film laminated to 0.020 inch thick stucco embossed aluminum using viscoelastic film adhesive.

1. Products: Subject to compliance with requirements, provide one of the products specified.
  - a. PABCO-Childers Metals; ITW Insulation Systems; 1 pound Muffl-Jac.
2. Properties:
  - a. Sound Transmission Class (STC): 29.
  - b. Thickness (film): 0.080 to 0.110 inch.
  - c. Weight (film): 1 pound per square foot.
  - d. Service Temperature Range: Minus 40 deg F to 180 deg F.
3. Proprietary sound jacketing by steam pressure reducing valve manufacturer is also acceptable.

## 2.12 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136 and UL listed.
  1. Products: Subject to compliance with requirements, provide one of the products specified.
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
    - b. Compac Corp.; 104 and 105.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
    - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
  2. Width: 3 inches.
  3. Thickness: 11.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136 and UL listed.
  1. Products: Subject to compliance with requirements, provide one of the products specified.
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
    - b. Compac Corp.; 110 and 111.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
    - d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
  2. Width: 3 inches.
  3. Thickness: 6.5 mils.



4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide one of the products specified.
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
    - b. Compac Corp.; 130.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
    - d. Venture Tape; 1506 CW NS.
  2. Width: 2 inches.
  3. Thickness: 6 mils.
  4. Adhesion: 64 ounces force/inch in width.
  5. Elongation: 500 percent.
  6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive and UL listed.
1. Products: Subject to compliance with requirements, provide one of the products specified.
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    - b. Compac Corp.; 120.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
    - d. Venture Tape; 3520 CW.
  2. Width: 2 inches.
  3. Thickness: 3.7 mils.
  4. Adhesion: 100 ounces force/inch in width.
  5. Elongation: 5 percent.
  6. Tensile Strength: 34 lbf/inch in width.
- E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the products specified.
    - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.

2. Width: 3 inches.
3. Film Thickness: 4 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the products specified.
  - a. Dow Chemical Company (The); Saran 560 Vapor Retarder Tape.
2. Width: 3 inches.
3. Film Thickness: 6 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

2.13 SECUREMENTS

A. Bands:

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

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
  - a. Products: Subject to compliance with requirements, provide one of the products specified.

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

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
    - a. Products: Subject to compliance with requirements, provide one of the products specified.
      - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
      - 2) GEMCO; Press and Peel.
      - 3) Midwest Fasteners, Inc.; Self Stick.
    - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
    - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
    - d. Adhesive-backed base with a peel-off protective cover.
  6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
    - a. Products: Subject to compliance with requirements, provide one of the products specified.
      - 1) AGM Industries, Inc.; RC-150.
      - 2) GEMCO; R-150.
      - 3) Midwest Fasteners, Inc.; WA-150.
      - 4) Nelson Stud Welding; Speed Clips.
    - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
  7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
    - a. Manufacturers:
      - 1) GEMCO.
      - 2) Midwest Fasteners, Inc.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- D. Wire: 0.062-inch soft-annealed, stainless steel.
1. Manufacturers:
    - a. ACS Industries, Inc.
    - b. C & F Wire.
    - c. PABCO-Childers Metals; ITW Insulation Systems.
    - d. RPR Products, Inc.

## 2.14 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.
- C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

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

#### 3.3 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 the 4 o'clock or 8 o'clock position on 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 as recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. For services with surface temperatures below ambient, install a continuous unbroken vapor barrier. 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 thermal hanger 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 thermal hanger 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 the 4 o'clock or 8 o'clock position on the 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. For below ambient services, 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. Where compression of insulation is possible, fabricate/install insulation per manufacturer's recommendations.
- 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:
1. Terminate ductwork insulation at angle closure of fire damper sleeves.
  2. Install pipe insulation continuously through penetrations of fire-rated walls and partitions.
    - a. Firestopping is specified in Division 07 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 angle closure of fire damper sleeves.
  2. Pipe: Install insulation continuously through floor penetrations.
    - a. Seal penetrations through fire-rated assemblies according to Division 07 Section "Through-Penetration Firestop Systems."

### 3.5 GENERAL PIPE INSULATION INSTALLATION

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



5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
  6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
  7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
  8. For services not specified to receive a field-applied jacket except for flexible Elastomeric, 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 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.

- E. Install removable and reusable insulation covers in accordance with fabricator's instructions, and at the following locations:

### 3.6 FLEXIBLE ELASTOMERIC PIPE 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.

### 3.7 GLASS-FIBER AND MINERAL WOOL PIPE 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. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.

3. For piping systems with surface temperatures below ambient, install a continuous unbroken vapor barrier. Seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
  - a. 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. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

B. Insulation Installation on Pipe Flanges:

1. Install PVC fitting covers when available.
2. When PVC fitting covers are not available, install preformed pipe insulation to outer diameter of pipe flange:
  - a. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  - b. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with fiberglass or mineral wool blanket insulation as specified for system.
3. 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 PVC fitting covers when available.
2. When PVC fitting covers 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 PVC fitting covers when available.
2. When PVC fitting covers 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.

3.8 DUCT AND PLENUM INSULATION INSTALLATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions. Adhesive may be omitted from top surface of horizontal rectangular ducts.
  3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - d. Do not over compress insulation during installation.
    - e. Impale insulation over pins and attach speed washers.
    - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
  4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
  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.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
  2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - d. Do not over compress insulation during installation.
    - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
  4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
  5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
  6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- C. Flexible Elastomeric Thermal Insulation Installation for Ducts and Plenums: Install insulation over entire surface of ducts and plenums.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
  2. Seal longitudinal seams and end joints.
  3. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with strips of same material used to insulate duct and following manufacturer's installation instructions.

3.9 DUCT LAGGING INSTALLATION

- A. Install between silencers and shaft or Mechanical Equipment Room walls, and where indicated on Drawings.
- B. Ensure sufficient clearance between ductwork to be lagged and adjacent items.
- C. Install lagging as detailed on Drawings.
- D. Adhere board insulation with adhesive. Do not use pins.
- E. Install gypsum board layers. Stagger joints between layers. Seal joints with acoustical sealant.

3.10 FIELD-APPLIED JACKET INSTALLATION

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
  - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
  - 2. For services with surface temperatures below ambient, maintain continuous unbroken vapor barrier.
- C. 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.
- D. Where sound barrier jackets are indicated, install in accordance with manufacturer's instructions.
- E. Where PVDC jackets are indicated, install as follows:
  - 1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
  - 2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
  - 3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
  - 4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket

to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fish mouthing," and use PVDC tape along lap seal to secure joint.

5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

### 3.11 FINISHES

- A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system specified in Division 09 painting Sections.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

**\*\*END OF SECTION\*\***

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 specification sections, apply to work of this section.
- B. Related Sections include the following:
  - 1. Division 20 Section "Mechanical General Requirements."
  - 2. Division 20 Section "Basic Mechanical Materials and Methods."

#### 1.2 REFERENCES

- A. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- C. ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.
- D. ANSI/NEMA MG 1 - Motors and Generators.
- E. ANSI/NFPA 70 - National Electrical Code.
- F. IEEE 519 (1992) - Applicability to Adjustable Frequency Controllers.



1.3 DEFINITIONS

- A. BAS: Building automation system.
- B. EMI: Electromagnetic interference.
- C. LED: Light-emitting diode.
- D. RFI: Radio-frequency interference.
- E. THD: Total harmonic disturbance.
- F. VFC: Variable frequency controller. Variable frequency controllers may also be referred to as variable speed drives, variable frequency drives, VSDs, or VFDs in other Specification Sections or on the Drawings.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated VFCs shall be tested and certified by an NRTL as meeting the ICC-ES AC 156 test procedure requirements.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 SUBMITTALS

- A. Submit under provisions of Division 20 Section "Mechanical General Requirements" and as supplemented in this section.
- B. Submit for review, drawings indicating power, control and instrument wiring including ladder diagrams for field work as well as factory assembled work. Manufacturer's drawings are acceptable only when modified and supplemented to reflect project conditions. The drawings shall include:
  - 1. Overall schematic (elementary) diagram in JIC form of the entire system of power and control circuitry. Indicate interfaces with control wiring by temperature controls contractor.
  - 2. Wiring diagrams showing the wiring layout of component assemblies or systems.
  - 3. Interconnection wiring diagrams showing terminations of interconnecting conductors between component assemblies, systems, control devices, and control panels complete with conductor identification, number of conductors, conductor and conduit size.
  - 4. Sequence of operation for components, assemblies or systems.
  - 5. Dimensional data.
- C. Shop drawings for motor-driven equipment shall be accompanied by complete information concerning the respective motors including the following.
  - 1. Principal dimensions.
  - 2. Weights.

3. Horsepower.
4. Voltage, phase, frequency.
5. Speed.
6. Class of insulation.
7. Enclosure type.
8. Frame.
9. Bearings including AFBMA Rating Life (L-10 basis).
10. Design letter.
11. Manufacturer.
12. Service Factor

- D. Descriptive data shall include catalogues, guaranteed performance data with efficiency and power factor indicated at 75 percent and 100 percent of rated load and verification of conformance with other requirements of the Contract Documents. The information enumerated under NEMA MG1 Paragraph MG1-10.38, shall be arranged on one sheet for each motor.

#### 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

#### 1.8 COORDINATION

- A. Coordinate with temperature controls contractor for interfaces with temperature controls wiring.

#### 1.9 WARRANTY

- A. Warranty shall be 36 months from date of project acceptance. The warranty shall include all parts, labor, travel time and expenses.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. For Electrical Work Provided under Division 20, 21, 22, and 23 Specifications: Furnish UL Listed components, in accordance with Division 26 Specifications and applicable NEMA and NEC (ANSI C 1) requirements. Provide wiring, external to electrical enclosures, in conduit.
- B. Electrical Power Supply Characteristics: 480 volts, 3 phase, 60 hertz (Hz).
- C. Provide Electrical Work required for the operation of components and assemblies provided as part of the Work under Division 20, 21, 22, and 23 Specifications.
- D. Mount line voltage (120 VAC) control components specified as part of the Work under Division 20, 21, 22, and 23 Specifications.
- E. Refer to ELECTRICAL DRAWINGS and Division 26 Specifications for specified information regarding provisions for the arrangement of electrical circuits and components and for interface with Work specified under Division 20, 21, 22, and 23 Specifications.
- F. The controller(s) shall be suitable for use with any standard NEMA-B squirrel-cage induction motor(s) having a 1.15 Service Factor. At any time in the future, it shall be possible to substitute any standard motor (equivalent horsepower, voltage and RPM) in the field.
- G. Electrical testing of motors is specified as part of the Work under Division 26 Specifications.
- H. The mechanical contractor shall furnish and install the variable frequency controller. Electrical trades shall make power connections to both load and line side of the VFC.

### 2.2 MOTORS

- A. Refer to Division 20 Section "Motors."

### 2.3 VARIABLE FREQUENCY CONTROLLERS

- A. Variable Frequency Controller Manufacturers:
  - 1. A.B.B.
  - 2. Danfoss.
  - 3. Eaton (Cutler-Hammer).
  - 4. General Electric.
  - 5. Hitachi.
  - 6. Johnson Controls Incorporated (Private labeled A.B.B.).
  - 7. Mitsubishi Electric Automation, Inc
  - 8. Square D.
  - 9. Toshiba International Corporation.

10. Yaskawa Electric America, Inc.
- B. Provide variable frequency controllers as scheduled including bypass starter, coasting motor restart, and step over frequency.
  - C. Standards: VFC shall comply with IEEE Standard 519 (1992 version) applicability to Adjustable Frequency Controllers (AC Line Disturbances).
  - D. Provide 3 percent AC input line reactors sized appropriate for each current rating variable frequency controller.
  - E. The variable frequency controller (VFC) shall comply with all applicable provisions of the National Electrical Code.
  - F. The line side of the VFC shall have a displacement power factor of 0.95 or greater when motor is operating at 50 to 100 percent motor speed.
  - G. The VFC shall have an efficiency greater than 85 percent when motor is operating at 50 to 100 percent motor speed.
  - H. Each variable frequency controller shall consist of an adjustable frequency converter which shall convert 460 volt (+10 percent -5 percent), 3-phase, 60 hertz (+2 hertz) input power into an adjustable frequency output in an ambient temperature of zero to 40 deg C. Output power shall be of suitable capacity and waveform to provide stepless speed control of the specified horsepower motor throughout the required speed range under variable torque load not exceeding the motor's full-load rating.
  - I. Provide fault detection and trip circuits to protect itself and the connected motor against line voltage transients, power line under voltage, output overvoltage and overcurrent. A disconnect with padlockable door interlocked external handle shall be supplied to conveniently disconnect the incoming 460 VAC. Minimum short circuit design shall be 42,000 amperes symmetrical. Criteria in Paragraph B shall be met without the use of isolation transformers. Variable frequency controller will be accepted only if criteria can be met without isolation transformers.
  - J. The minimum output frequency shall be the lowest frequency at which the connected motor can be operated without overheating.
  - K. The variable frequency controllers shall contain current limiting circuitry, adjustable to 100 percent of motor full-load current to provide soft start, acceleration, and running without exceeding motor rated current. The current limit circuit shall be of the type for variable torque load, which acts to diminish output frequency while limiting, without directly causing shutdown.
  - L. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts. For safety, drive shall shut down and require manual reset and restart if automatic reset/restart function is not successful within three attempts.
  - M. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
  - N. Isolate signal circuits from the power circuits and design to accept a speed signal from a remote process controller in the automatic mode and from the speed control potentiometer in the manual mode. A door-mounted switch shall provide mode selection. The selected signal shall control the motor speed between the adjustable minimum and maximum speed settings. Maximum speed shall be field adjustable to 100 percent of rated speed. The speed signal shall follow a linear time ramp,

adjustable from 4-20 seconds to provide acceleration from zero to minimum speed. When minimum speed is reached, the speed signal shall follow the linear time ramp for acceleration and deceleration control.

- O. Mount the variable frequency controllers and other electrical components that provide the operation specified in a NEMA 12 enclosure. Equipment shall have external heat sinks or air filters on all vents. The enclosure shall have hinged, front access doors with latch. Cabinet to cabinet interconnecting wiring shall be factory dressed, tagged and harnessed, and shipped with one end attached.
- P. The controller shall have the ability to step-over certain set frequencies that may cause a system to resonate. The controller shall have at least two manually set points of frequency in which the controller shall step-over during operation.
- Q. Operating and monitoring devices for the inverter shall be door mounted and shall include the following:
  - 1. Manual Speed Control to set speed in the hand (manual) mode.
  - 2. Speed indicating meter, either in revolutions per minute, proportional to the applied frequency and voltage to indicate speed of the converter-powered motor or frequency (hertz).
  - 3. VFC "fault/reset" pilot light pushbutton combination with dry contact for external alarm. Fault alarm shall not actuate upon normal shutdown.
  - 4. Inverter "control power" indicator.
  - 5. Motor "running" indicator and two (2) dry contacts that close when motor is running.
  - 6. Output current meter calibrated in "AC amps."
  - 7. Operating selector switches and indicating light to perform the following functions:
    - a. One hand-off-auto switch for the VFC with indicating lights (red-running, green-energized). In hand position, unit (VFC or bypass starter) shall start. In auto position, unit (VFC or bypass starter) shall start when remote dry contact is closed.
    - b. Unit shall be capable of being padlocked in the off position.
  - 8. Output voltmeter (0 - 600 V.A.C) (analog or digital).
- R. The VFC is to be provided with isolated 4-20 mA DC output signals proportional to speed, current and voltage for connection by others.
- S. The VFC shall be provided with the ability to communicate (monitoring) through RS485 connector.
- T. Remote speed control shall be +4 to 20 mA control signal from a remote controller.
- U. Variable frequency controller shall not cause motor to produce noise levels exceeding 80 dBA measured at a distance of 3 feet from the motor. If noise level of motor exceeds this amount, the contractor shall be responsible for correcting the problem.
- V. Provide connection points for system safety controls such as smoke detectors, freeze stats, damper end switches, etc. as shown on mechanical temperature control drawings. Opening of a contact on safety controls wired to the drive shall shut down the motor(s).

- W. Provide in each VFC, a relay, that upon loss of the automatic speed control signal, shall automatically set the motor rpm to half speed. This loss of signal relay shall be manually adjustable to be able to set default speed to some other value than half speed if required later in the field.
- X. Coordinate with the Temperature Controls Contractor for the interface of control wiring to the drive as required to meet the requirements of the temperature control drawings. Drive shall be furnished with internal control wiring configured in the factory so as to allow single connections of field wiring to terminal blocks in the drive by the Temperature Controls Contractor.
- Y. All indicating lights shall be push to test or LED.

#### 2.4 SOURCE QUALITY CONTROL

- A. Factory Tests: The controller shall be subject to, but not limited to, the following quality assurance controls, procedures and tests:
  - 1. Power transistors, SCRs and diodes shall be tested to ensure correct function and highest reliability.
  - 2. All printed circuit boards shall be tested at 50 deg C for 50 hours. The VFC manufacturer shall provide certification that the tests have been completed.
  - 3. Every controller will be functionally tested with a motor to ensure that if the drive is started up according to the instruction manual provided, the unit will run properly.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.
- B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Install and adjust materials and equipment in accordance with the manufacturer's instructions.
- B. Obtain the manufacturer's instructions for materials and equipment provided under the Contract in detail necessary to comply with the requirements of the Contract Documents.
- C. If unit is free standing, provide a concrete housekeeping pad.

#### 3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Upon completion of each installation, conduct complete acceptance tests in the presence of duly notified authorities having jurisdiction and the Owner to demonstrate component, assembly or system performance in accordance with the requirements of the Contract Documents.

- C. In the event that a test demonstrates that a component assembly or system performance is deficient, the Owner may require additional tests after corrective work.
- D. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.
- E. Component assembly and systems acceptance is predicated upon completion of specified work and receipt by the Owner of data specified under "Submittals."

#### 3.4 ADJUSTING

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set the taps on reduced-voltage autotransformer controllers.
- C. Set field-adjustable circuit-breaker trip ranges.
- D. Set field-adjustable pressure switches.

#### 3.5 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.
- B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

#### 3.6 DEMONSTRATION

- A. The VFC supplier/support group shall provide the following additional services:
  - 1. On-site training of customer personnel in operation and maintenance of variable frequency controllers.
  - 2. Provide four copies of a troubleshooting manual and factory training manuals to help the building operator determine what steps must be taken to correct any problem that may exist in the system.
  - 3. Coordinate enrollment of customer personnel in factory-held service schools.

**\*\*END OF SECTION\*\***

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 20 Section "Mechanical Identification" for valve tags and charts.
  - 2. Division 22 piping Sections for specialty valves applicable to those Sections only.
  - 3. Division 23 Section "General-Duty Valves for HVAC" for HVAC valves.
  - 4. Division 23 Section "Temperature Controls" for control valves and actuators.

#### 1.2 SUMMARY

- A. This Section includes valves for general plumbing applications. Refer to piping Sections for specialty valve applications.

#### 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. NRS: Nonrising stem.
5. OS&Y: Outside screw and yoke.
6. PTFE: Polytetrafluoroethylene plastic.
7. RPTFE: Reinforced polytetrafluoroethylene plastic.
8. SWP: Steam working pressure.
9. TFE: Tetrafluoroethylene plastic.
10. WOG: Water, oil, and gas.

#### 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. Certification that products for use in potable water systems comply with NSF 61 and NSF 372.

#### 1.5 QUALITY ASSURANCE

- A. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.
- B. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.
- C. NSF Compliance: NSF 61 and NSF 372 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 VALVES, GENERAL

- A. Isolation valves are scheduled on the Drawings. For other general plumbing valve applications, use the following:
1. Shutoff Service: Ball and butterfly valves.
  2. Throttling Service: Angle, ball, butterfly, or globe valves.
  3. Pump Discharge: Spring-loaded, lift-disc check valves; and bronze lift check valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. 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.
- D. For valves not indicated in the Application Schedules, select valves 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 condenser water, heating hot water, steam, and steam condensate services.
  2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged, solder-joint, or threaded ends.
  3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
  4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
  5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends.
  6. For Steel Piping, NPS 5 and Larger: Flanged ends.
  7. For Grooved-End Systems: Valve ends may be grooved.
- E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted unless otherwise noted. Wetted surfaces of valves contacted by consumable water shall contain not more than 0.25 percent weighted average lead content.

1. Exceptions:
    - a. Valves in pumped sanitary systems.
    - b. Valves in pumped storm systems.
    - c. Drain valves.
    - d. Valves in general air or vacuum systems.
    - e. Valves in irrigation systems.
    - f. Valves in non-potable water systems.
    - g. Valves in other plumbing systems not intended for human consumption.
  - F. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
  - G. 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 Operator: For quarter-turn valves NPS 8 and larger.
    3. Handwheel: For valves other than quarter-turn types.
    4. Lever Handle: For quarter-turn valves NPS 6 and smaller.
  - H. Extended Valve Stems: On insulated valves.
  - I. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.
  - J. Valve Grooved Ends: AWWA C606.
  - K. Solder Joint: With sockets according to ASME B16.18.
    1. Caution: Disassemble valves when soldering, as recommended by the manufacturer, to prevent damage to internal parts.
  - L. Threaded: With threads according to ASME B1.20.1.
  - M. Valve Bypass and Drain Connections: MSS SP-45.
- 2.2 BRONZE BALL VALVES
- A. Bronze Ball Valves, General: MSS SP-110 and have bronze body complying with ASTM B 584, except for Class 250 which shall comply with ASTM B 61, full-depth ASME B1.20.1 threaded or solder ends, and blowout-proof stems.
  - B. Two-Piece, Regular Port Bronze Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel ball and stem, reinforced TFE seats, blow-out-proof stem, with adjustable stem packing, soldered or threaded ends; and 150 psig SWP and 600-psig CWP ratings.
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - a. Apollo Valves; by Conbraco Industries, Inc.; Series 70LF-140/240.
      - b. Hammond Valve.
      - c. Milwaukee Valve Company; Model UPBA100S/150S.

- d. NIBCO INC.; Models S-580-70-66-LF/T-580-70-66-LF.
  - e. Watts Water Technologies, Inc.
- C. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel ball and stem, reinforced TFE seats, blow-out-proof stem, with adjustable stem packing, soldered or threaded ends; 150 psig SWP and 600-psig CWP ratings.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Apollo Valves; by Conbraco Industries, Inc.; Series 77CLF-140/240.
    - b. Hammond Valve.
    - c. Milwaukee Valve Company; UPBA400S/450S.
    - d. NIBCO INC.; Models S-585-70-66-LF/T-585-70-66-LF.
    - e. Watts Water Technologies, Inc.

## 2.3 GENERAL SERVICE BUTTERFLY VALVES

- A. General: MSS SP-67, for bubble-tight shutoff, extended-neck for insulation, disc and lining suitable for potable water, unless otherwise indicated, and with the following features:
- 1. Full lug, and grooved valves shall be suitable for bi-directional dead end service at full rated pressure without the use or need of a downstream flange.
  - 2. Valve sizes NPS 2 through NPS 6 shall have lever lock operator; valve sizes NPS 8 and larger shall have weatherproof gear operator.
- B. Lug-Style (Single-Flange) Size NPS 2-1/2 through NPS 12, 200-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, Type 416 stainless-steel stem, copper bushing, aluminum-bronze disc, and molded-in EPDM seat (liner).
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Apollo Valves; by Conbraco Industries, Inc.; Series 143 and Series LD145.
    - b. Bray International, Inc.
    - c. DeZurik.
    - d. Forum Energy Technologies; ABZ Valve.
    - e. Hammond Valve.
    - f. Milwaukee Valve Company.
    - g. NIBCO INC.; LD-2000-3/5.
    - h. Pentair Valves & Controls; Keystone.
    - i. Tyco Flow Control; Grinnell Flow Control.
    - j. Watts Water Technologies.
- C. Lug-Style (Single-Flange) Size NPS 14 and Larger, 150-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, one- or two-piece Type 416 stainless-steel stem, bronze bushing, and phenolic-backed EPDM seat (liner) attached to the body.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Apollo Valves; by Conbraco Industries, Inc.; Series 143 and Series LD145.
  - b. Bray International, Inc.
  - c. DeZurik.
  - d. Forum Energy Technologies; ABZ Valve.
  - e. Milwaukee Valve Company.
  - f. NIBCO INC.; LD-1000-5.
  - g. Pentair Valves & Controls; Keystone.
  - h. Tyco Flow Control; Grinnell Flow Control.
  - i. Watts Water Technologies.
- D. Grooved-End Butterfly Valves with EPDM-Encapsulated Ductile-Iron Disc: Ductile-iron body with grooved or shouldered ends and polyamide coating inside and outside; Type 416 stainless-steel stem, PTFE bronze sintered on steel bushing, and 300-psig CWP Rating for Valves NPS 2 through NPS 8, 200 psig CWP Rating for Valves NPS 10 through NPS 12.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. Anvil International, Inc.
  - b. NIBCO INC.; Model GD-4765-3/5.
  - c. Tyco Fire & Building Products; Grinnell Mechanical Products.
  - d. Victaulic Co. of America.

#### 2.4 BRONZE CHECK VALVES

- A. Bronze Check Valves, General: MSS SP-80.
- B. Class 125, Bronze, Swing Check Valves with Bronze Disc: ASTM B-62 bronze body and seat with regrinding-type bronze disc, Y-pattern design, soldered or threaded end connections, and having 200 psig CWP rating.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. Apollo Valves; by Conbraco Industries, Inc.; Model 162T-LF and 163T-LF (61YLF Series).
  - b. Milwaukee Valve Company; Model UP509/UP1509.
  - c. NIBCO INC.; Models S-413-B-LF or T-413-B-LF.
  - d. Watts Water Technologies; LFCVY/LFCVYS.

#### 2.5 IRON SWING CHECK VALVES

- A. Iron Swing Check Valves, General: MSS SP-71.
- B. Class 125, Gray-Iron, Standard Swing Check Valves: ASTM A-126, Class B cast-iron body and bolted bonnet with flanged end connections; non-asbestos synthetic-fiber gaskets; bronze disc and seat; and having 200 psig CWP rating.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. Apollo Valves; by Conbraco Industries, Inc.; Model 910F.
  - b. Crane Co.; Crane Valves.
  - c. Crane Co.; Stockham Div.
  - d. Hammond Valve; IR1124-HI.

- e. Milwaukee Valve Company; Model F-2974.
  - f. NIBCO INC.; Model F-918-B.
  - g. Watts Water Technologies.
- C. Class 250, Gray-Iron, Swing Check Valves: ASTM A-126, Class B cast-iron body and bolted bonnet with flanged end connections; non-asbestos synthetic-fiber gaskets; and bronze disc and seat; and having 500 psig CWP rating.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Apollo Valves; by Conbraco Industries, Inc.; Model 920F.
    - b. Crane Co.; Crane Valves.
    - c. Crane Co.; Stockham Div.
    - d. Hammond Valve; IR322.
    - e. Milwaukee Valve Company; Model F-2970.
    - f. NIBCO INC.; Model F-968-B.
    - g. Watts Water Technologies.
- D. Grooved-End, Swing Check Valves: Ductile-iron body with grooved or shouldered ends; nonasbestos, synthetic-fiber gaskets; rubber seats; and having 250-psig CWP Rating.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Mueller Co.
    - b. NIBCO, INC.; Model G-917-W.
    - c. Tyco Fire & Building Products; Grinnell Mechanical Products.
    - d. Victaulic Co. of America.

## 2.6 LIFT CHECK VALVES

- A. Class 125, Lift Check Valves with Nonmetallic TFE Disc:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Apollo Valves; by Conbraco Industries, Inc.; Model CBV-LF (61LF Series).
    - b. Hammond Valve; UP943 and UP947.
    - c. Milwaukee Valve Company; UP548T and UP1548T.
    - d. NIBCO INC.; Model S-480-Y-LF and T-480-Y-LF.
    - e. Watts Water Technologies; LF600.
  - 2. Description:
    - a. Standard: MSS SP-80, Type 2.
    - b. CWP Rating: 250 psig.
    - c. Body Design: Vertical flow.
    - d. Body Material: Lead free brass or bronze.
    - e. Ends: Threaded or Solder.
    - f. Disc: PTFE, or TFE.

2.7 BRONZE GLOBE VALVES

- A. Bronze Globe Valves, General: MSS SP-80, with malleable-iron handwheel.
- B. Class 125, TFE Disc, Bronze Globe Valves: ASTM B-62 bronze body, bonnet, and seat, TFE disc, copper-silicone bronze stem, union-ring bonnet, soldered or threaded end connections; and having 200 psig CWP rating.
  - 1. Manufacturers: Subject to compliance with requirements, Provide products by one of the following:
    - a. Apollo Valves; by Conbraco Industries, Inc.; Model 121T-LF.
    - b. Hammond Valve; UP418 and UP440.
    - c. Milwaukee Valve Company; Model UP502 and UP1502.
    - d. Watts Water Technologies, Inc.; LFGLV.

2.8 CAST-IRON GLOBE VALVES

- A. Cast-Iron Globe Valves, General: MSS SP-85 with bolted bonnet, flanged end connections, and non-asbestos packing and gasket.
- B. Class 125, Metal Seat, Cast-Iron Globe Valves: ASTM A-126, Class B cast-iron body and bonnet with bronze trim and having 200 psig CWP rating.
  - 1. Manufacturers: Subject to compliance with requirements, Provide products by one of the following:
    - a. Apollo Valves; by Conbraco Industries, Inc.; Model 711F.
    - b. Crane Co.; Crane Valves.
    - c. Crane Co.; Stockham Valves.
    - d. Hammond Valve.
    - e. Milwaukee Valve Company; Model F-2981.
    - f. NIBCO INC.; Model F-718-B.
    - g. Watts Water Technologies, Inc.

2.9 CAST-IRON ANGLE VALVES

- A. Cast-Iron Angle Valves, General: MSS SP-85, Type II; having ASTM A 126, Class B cast-iron body and bolted bonnet; bronze mounted, non-asbestos packing and gaskets; and flanged-end connections.
- B. Class 125, Cast-Iron, Standard Angle Valves: 200-psig CWP rating.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. NIBCO INC.; Model F-818-B.
    - b. Crane Co.; Stockham Valves.
    - c. Crane Co.; Crane Valves.

2.10 DRAIN VALVES

- A. Ball-Valve-Type, Hose-End Drain Valves:
  - 1. Bronze ball valve as specified in this Section. Lead free construction is not required.

2. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

## 2.11 SOURCE QUALITY CONTROL

- A. Identification: Factory label or color coding to identify lead free valves.

## 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 INSTALLATION

- A. Piping installation requirements are specified in other Division 20 and 22 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. Butterfly valves shall be installed with stem horizontal to allow support for the disc and the cleaning action of the disc.
- E. Install valves in position to allow full stem movement.
- F. Install chainwheel operators on valves NPS 4 and larger and more than 84 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.



3.3 JOINT CONSTRUCTION

- A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

3.4 ADJUSTING

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

**\*\*END OF SECTION\*\***

## DOMESTIC WATER PIPING

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 20 Section "Mechanical General Requirements."
  - 2. Division 20 Section "Basic Mechanical Materials and Methods" for materials and methods common to mechanical piping systems.
  - 3. Division 20 Section "Hangers and Supports."
  - 4. Division 20 Section "Meters and Gages" for thermometers, pressure gages, and fittings.
  - 5. Division 20 Section "Valves" for general duty plumbing valves.
  - 6. Division 22 Section "Domestic Water Piping Specialties" for water distribution piping specialties.

#### 1.2 SUMMARY

- A. This Section includes domestic water (and pool water) piping inside the building.

1.3 PERFORMANCE REQUIREMENTS

- A. Where not indicated on the Drawings, provide components and installation capable of producing domestic water piping systems with 125 psig, unless otherwise indicated.

1.4 SYSTEMS DESCRIPTION

- A. Potable and non-potable domestic water piping system materials are scheduled on the Drawing.
- B. Refer to Application Schedules on the Drawings for valve types to be used.
- C. Transition and special fittings with pressure ratings at least equal to piping rating may be used unless otherwise indicated.

1.5 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Field quality-control test reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.
- C. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components – Lead Content for potable domestic water piping and components.
- D. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be as recommended by the manufacturer of the grooved components.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
  - 1. Notify Owner no fewer than two days in advance of proposed interruption of water service.
  - 2. Do not proceed with interruption of water service without Owner's written permission.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

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 PIPING MATERIALS

- A. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

## 2.3 COPPER TUBE AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper.
  1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
  2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
  3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- B. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.
  1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
  2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
  3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- C. Grooved-Joint Systems:
  1. Manufacturers:
    - a. Anvil International, Inc.; Gruvlok Manufacturing; Model 7401.
    - b. Tyco Fire & Building Products; Grinnell Mechanical Products; Model 672.
    - c. Victaulic Company; Style 606 and Style 607.
  2. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.
  3. Copper, Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.
- D. Copper or Bronze Pressure-Seal Fittings:
  1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Viega North America; ProPress System.
    - b. NIBCO Inc.; Press System.
    - c. Elkhart Products Corporation; an Aalberts Industries Company; Xpress.
    - d. Apollo Valves; by Conbraco Industries; ApolloXpress.
  2. Housing: Copper.

3. O-Rings and Pipe Stops: EPDM.
4. Tools: Manufacturer's special tools.
5. Maximum 200-psig working-pressure rating at 250 deg F.
- E. Copper, Mechanically Formed Tee Option: For forming T-branch on copper water tube. Mechanically formed tee fittings may be used up to half size of main.
  1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. T-DRILL Industries Inc.

### PART 3 - EXECUTION

#### 3.1 PIPING SYSTEM INSTALLATION

- A. Basic piping installation requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops.
- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
  1. Install hose-end drain valves at low points in water mains, risers, and branches.
  2. Install stop-and-waste drain valves where indicated.
- D. Install domestic water piping level without pitch and plumb.

#### 3.2 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

#### 3.3 HANGER AND SUPPORT INSTALLATION

- A. Pipe hanger and support devices are specified in Division 20 Section "Hangers and Supports." Install the following:
  1. Vertical Piping: MSS Type 8 or Type 42, clamps.
  2. Individual, Straight, Horizontal Piping Runs: According to the following:
    - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    - b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
    - c. Longer than 100 Feet: MSS Type 49, spring cushion rolls, if indicated.
  3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
  4. Base of Vertical Piping: MSS Type 52, spring hangers.

- B. Install supports according to Division 20 Section "Hangers and Supports."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
  - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
  - 3. NPS 2: 10 feet with 3/8-inch rod.
  - 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
  - 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
  - 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
- F. Install supports for vertical steel piping every 15 feet.
- G. Install hangers for drawn-temper copper tubing with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 3/4 and Smaller: 60-inches with 3/8-inch rod.
  - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
  - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
  - 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
  - 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
- H. Install supports for vertical copper tubing every 10 feet.
- I. Soft copper tube: Continuous support using v-shaped plastic pipe channel, maximum hanger spacing 8 feet with 3/8-inch rod.
- J. Alternate support for copper tubing NPS 3/4 and smaller: Continuous support using v-shaped plastic pipe channel, maximum hanger spacing 8 feet with 3/8-inch rod.
- K. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

### 3.4 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect domestic water piping to existing domestic water distribution piping. Use dielectric fitting if connection dissimilar metals. Refer to Application Schedule on the Drawings and Division 20 Section "Basic Mechanical Materials and Methods" for dielectric fittings.
- C. Install piping adjacent to equipment and machines to allow service and maintenance.

D. Connect domestic water piping to the following:

1. Water Heaters: Cold water supply and hot water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.

### 3.5 FIELD QUALITY CONTROL

A. Inspect domestic water piping as follows:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
  - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
  - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test domestic water piping as follows:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 150 psig. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

### 3.6 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves.
2. Open shutoff valves to fully open position.

3. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
4. Remove and clean strainer screens. Close drain valves and replace drain plugs.
5. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.7 CLEANING AND DISINFECTION

- A. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.
- B. Clean and disinfect potable domestic water piping as follows:
  1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
  2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
    - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    - b. Fill and isolate system according to either of the following:
      - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
      - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
    - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities.

**\*\*END OF SECTION\*\***



# DOMESTIC WATER PIPING SPECIALTIES

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## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  1. Division 20 Section "Mechanical General Requirements."
  2. Division 20 Section "Basic Mechanical Materials and Methods."
  3. Division 20 Section "Meters and Gages" for thermometers, pressure gages, and flow meters in domestic water piping.
  4. Division 22 Section "Domestic Water Piping" .

### 1.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Flow Reports and Settings: For calibrated balancing valves.
- E. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
- B. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.
- C. NSF Compliance:
  - 1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
  - 2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."
  - 3. Comply with NSF 372, "Drinking Water System Components – Lead Content" for components with wetted surfaces in contact with potable water.

PART 2 - PRODUCTS

2.1 BALANCING VALVES

- A. Calibrated Balancing Valves NPS 1/2 :
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Armstrong International, Inc.
    - b. Armstrong Pumps, Inc.
    - c. Apollo Valves; by Conbraco Industries, Inc.
    - d. Bell & Gossett; Xylem Inc.
    - e. Flo Fab Inc.
    - f. Flow Design Inc.
    - g. Griswold Controls.
    - h. NIBCO INC.
    - i. IMI Indoor Climate; Tour & Andersson.
    - j. Taco, Inc.
    - k. Watts Water Technologies, Inc.; Watts Regulator Co.
  - 2. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
  - 3. Body: Dezincification resistant brass, or bronze.
  - 4. Minimum Flow Rate: 0.3 gpm.
- B. Calibrated Balancing Valves NPS 3/4 to NPS 2 :
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Armstrong International, Inc.
    - b. Armstrong Pumps, Inc.

- c. Apollo Valves; by Conbraco Industries, Inc.
  - d. Bell & Gossett; Xylem Inc.
  - e. Flo Fab Inc.
  - f. Flow Design Inc.
  - g. Griswold Controls.
  - h. NIBCO INC.
  - i. IMI Indoor Climate; Tour & Andersson.
  - j. Taco, Inc.
  - k. Watts Water Technologies, Inc.; Watts Regulator Co.
- 2. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
  - 3. Body: Dezincification resistant brass, or bronze.
  - 4. Size: Same as connected piping, but not larger than NPS 2.
- C. Calibrated Balancing Valves NPS 2-1/2 to NPS 4 :
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Armstrong International, Inc.
    - b. Bell & Gossett; Xylem Inc.
    - c. Flo Fab Inc.
    - d. Flow Design Inc.
    - e. Griswold Controls.
    - f. NIBCO INC.
    - g. IMI Indoor Climate; Tour & Andersson.
    - h. Watts Water Technologies, Inc.; Watts Regulator Co.
  - 2. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.
  - 3. Size: Same as connected piping, but not smaller than NPS 2-1/2.
- D. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.
- 2.2 TEMPERATURE-ACTUATED WATER MIXING VALVES
- A. Primary, Thermostatic, Water Mixing Valves, refer to schedule on plans.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Apollo Valves; Conbraco Industries, Inc.
    - b. Armstrong International, Inc.
    - c. Bradley Corporation.
    - d. Lawler Manufacturing Company, Inc.
    - e. Leonard Valve Company.
    - f. Symmons Industries, Inc.
    - g. Watts Water Technologies, Inc.; Powers Division.
    - h. Watts Water Technologies, Inc.; Watts Regulator Co.
    - i. Zurn Plumbing Products Group; Wilkins Div.
  - 2. Standard: ASSE 1017.

3. Type: Exposed-mounting, thermostatically controlled water mixing valve.
4. Material: Bronze body with corrosion-resistant interior components.
5. Connections: Union inlets and outlet.
6. Accessories: Manual temperature control, check stops and strainers on hot- and cold-water supplies, and adjustable, temperature-control handle.
7. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.
8. Tempered-Water Setting: Refer to plans.

## 2.3 STRAINERS FOR DOMESTIC WATER PIPING

### A. Y-Pattern Strainers:

1. Manufacturers:
  - a. Apollo Valves; Conbraco Industries, Inc.
  - b. Keckley.
  - c. Metraflex.
  - d. Mueller Steam Specialty.
  - e. NIBCO, Inc.
  - f. Spence.
  - g. SSI Equipment, Inc.
  - h. Watts Water Technologies, Inc.
  - i. Yarway.
2. CWP: 200 psig minimum, unless otherwise indicated.
3. SWP: 125 psig minimum, unless otherwise indicated.
4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
5. End Connections: Threaded or soldered for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
6. Screen: Stainless steel with round perforations, unless otherwise indicated.

## 2.4 AIR VENTS

### A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.

6. Inlet and Vent Outlet End Connections: Threaded.
- B. Welded-Construction Automatic Air Vents:
1. Body: Stainless steel.
  2. Pressure Rating: 150-psig minimum pressure rating.
  3. Float: Replaceable, corrosion-resistant metal.
  4. Mechanism and Seat: Stainless steel.
  5. Size: NPS 3/8 minimum inlet.
  6. Inlet and Vent Outlet End Connections: Threaded.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.
- B. Install balancing valves in locations where they can easily be adjusted.
- C. Install temperature-actuated water mixing valves with strainers, and check stops or shutoff valves on inlets and with shutoff valve on outlet.
  1. Install thermometers and water regulators if specified.
- D. Install Y-pattern strainers for water on supply side of each control valve, solenoid valve, and pump.
- E. Install air vents at high points of water piping.

#### 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping and specialties.

#### 3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
  1. Calibrated balancing valves.
  2. Primary, thermostatic, water mixing valves.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 20 Section "Mechanical Identification."

#### 3.4 FIELD QUALITY CONTROL

- A. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

- A. Set field-adjustable flow set points of balancing valves as follows:
  - 1. Set calibrated balancing valves at calculated presettings.
  - 2. Measure flow at all stations and adjust where necessary.
  - 3. Record settings and mark balancing devices.
- B. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

**\*\*END OF SECTION\*\***

## DOMESTIC WATER CIRCULATION PUMPS

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 20 Section "Mechanical General Requirements."
  - 2. Division 20 Section "Basic Mechanical Materials and Methods."

#### 1.2 SUBMITTALS

- A. Product Data: For each type and size of domestic water pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and Maintenance Data: For domestic water pumps to include in emergency, operation, and maintenance manuals.

#### 1.3 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of domestic water pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

- C. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.
- D. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components – Lead Content for potable domestic water piping and components.
- E. UL Compliance: Comply with UL 778 for motor-operated water pumps.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written rigging instructions for handling.

### 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 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS (SMALL)

- A. Manufacturers:
  - 1. Armstrong Pumps Inc.
  - 2. Bell & Gossett; Xylem Inc.; Series PL.
  - 3. Grundfos Pumps Corp.
  - 4. Taco, Inc.; Series 1400.
- B. Description: Factory-assembled and –tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; and designed for installation with pump and motor shafts mounted horizontally.
  - 1. Pump Construction: All bronze.
    - a. Casing: Radially split, bronze, with threaded companion-flange connections.
    - b. Impeller: Glass-reinforced corrosion-resistant material; keyed to shaft.
    - c. Shaft: High-strength alloy steel.
    - d. Seal: Mechanical, carbon/silicon carbide seal.
    - e. Bearings: Permanently oil-lubricated type.
  - 2. Motor-Single speed, with oil-lubricated bearings, unless otherwise indicated; and directly mounted to pump casing. Comply with requirements in Division 20 Section "Motors."



- C. Capacities and Characteristics: Refer to Schedule on Drawings.

## 2.3 CONTROLS

- A. Thermostats: Electric; adjustable for control of hot-water circulation pump.

- 1. Manufacturers:

- a. Honeywell International, Inc.
  - b. Square D.
  - c. White-Rodgers Div.; Emerson Electric Co.

- 2. Type: Water-immersion sensor, for installation in hot-water circulation piping.

- 3. Range: 50 to 125 deg F.

- 4. Operation of Pump: On or off.

- 5. Transformer: Provide if required.

- 6. Power Requirement: 120 V, ac.

- 7. Settings: Start pump at 110 deg F and stop pump at 120 deg F.

## 2.4 FLEXIBLE CONNECTORS

- A. Refer to Division 20 Section "Pipe Flexible Connectors, Expansion Fittings and Loops."

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

### 3.2 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping. Do not use pump motors as a support point.

### 3.3 CONTROL INSTALLATION

- A. Install immersion-type thermostats in hot-water return piping.

### 3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to pumps to allow service and maintenance.

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- C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles. Refer to Division 22 Section "Domestic Water Piping."
  - 1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
    - a. Separately coupled, in-line centrifugal pumps.
  - 2. Install shutoff valve and strainer on suction side of pumps, and check valve and throttling valve on discharge side of pumps. Install valves same size as connected piping. Refer to Division 20 Section "Valves" for general-duty valves for domestic water piping and Division 22 Section "Domestic Water Piping Specialties" for strainers.
  - 3. Install pressure gages at suction and discharge of pumps. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Refer to Division 20 Section "Meters and Gages" for pressure gages and gage connectors.
- D. Ground equipment according to Division 26 Section "Grounding and Bonding."
- E. Connect wiring according to Division 26 Section "Conductors and Cables."
- F. Connect thermostats to pumps that they control.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. Check piping connections for tightness.
  - 3. Clean strainers on suction piping.
  - 4. Set thermostats for automatic starting and stopping operation of pumps.
  - 5. Perform the following startup checks for each pump before starting:
    - a. Verify bearing lubrication.
    - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    - c. Verify that pump is rotating in the correct direction.
  - 6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
  - 7. Start motor.
  - 8. Open discharge valve slowly.
  - 9. Adjust temperature settings on thermostats.
  - 10. Adjust timer settings.

3.6 DEMONSTRATION

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

**\*\*END OF SECTION\*\***

# DOMESTIC WATER AND POOL WATER HEAT EXCHANGERS

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## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 20 Section "Mechanical General Requirements."
  - 2. Division 20 Section "Basic Mechanical Materials and Methods."

### 1.2 SUBMITTALS

- A. Product Data: For each type and size of heat exchanger indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Product Certificates: For each type of heat exchanger, signed by product manufacturer.
- D. Source quality-control test reports.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For heat exchangers to include in operation and maintenance manuals.
- G. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain same type of heat exchangers through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of heat exchangers and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
- D. ASME Compliance: Where ASME-code construction is indicated, fabricate and label heat-exchanger to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- E. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with water.

1.4 COORDINATION

- A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

1.5 WARRANTY

- A. Manufacturer's Warranty: The Heat Exchanger and all accessories shall carry an 18-month guarantee against mechanical failure or workmanship from the date of shipment.

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 PACKAGED PLATE-AND-FRAME HEAT EXCHANGERS:

- 1. Manufacturers:
  - a. Harsco Industrial Patterson-Kelley; Duration II.
  - b. Aerco International, Inc.; SmartPlate Double-Wall Heater.
- 2. Description: Assembly of nonfixed-position, heat-exchanger plates, with frame, for using heating hot water to heat domestic water (and pool water) with separate storage tank, pump, piping and controls on a skid.
- 3. Working-Pressure Rating: 150 psig minimum.
- 4. Frame:
  - a. Carrying and Guide Bars: Stainless steel.

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- b. Fixed, Frame Plate; Pressure Plate; Support Column; and Nuts and Bolts: Stainless steel.
- 5. Channel Plates:
  - a. Type: Vented, double wall.
  - b. Material: ASTM A 666, Type 316 stainless steel.
  - c. Gasket Material: EPDM, suitable for potable water.
- 6. Connections: Suitable for potable water.
  - a. NPS 2 and Smaller: Threaded.
  - b. NPS 2-1/2 and Larger: Flanged.
- 7. Protective Shroud: Steel, covering channel plates.
- 8. Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire heat exchanger except connections.
- 9. Electronic Control System:
  - a. 3-way electronic control valve.
  - b. Constant speed domestic water circulator pump as specified in Division 22 Section "Domestic Water Circulation Pumps."
  - c. Control panel enclosure housing a PID temperature controller with digital indication of:
    - 1) Shell outlet water temperature.
    - 2) Boiler water inlet and boiler water outlet temperatures.
    - 3) Digital over-temperature limit switch.
    - 4) Feed-forward and feedback temperature sensors.
  - d. Controller shall close control valve in over-temperature condition. System shall have the following additional characteristics:
    - 1) Controller Temperature Setpoint Range: 50 deg F to 180 deg F maximum.
    - 2) Configured for 120V, single phase, 60 Hz.
    - 3) Easy start-up. Dial in setpoint.
  - e. Electronic control valve shall be of equal percentage flow characteristics, and have tight shut-off with low leakage rate of 0.02 percent of its Cv value. Valve shall have the following performance characteristics:
    - 1) 1000 to 1 turndown.
    - 2) Magnetic actuator with fail closed design, particularly on loss of power.
    - 3) Time to Full Open Position: Two seconds.
    - 4) Time to Full Closed Position: Two seconds.
  - f. PID temperature controller shall incorporate feed-forward function and be password protected.

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- g. Controls interface with BACnet and Lonworks shall utilize optional communications gateway to act as a MODBUS interface/translator between the BAS and the MODBUS port of the temperature controller. Communications gateway shall be comprised of a microprocessor based control utilizing the MODBUS protocol to communicate with the temperature controller. Non-volatile backup of point mappings and programs shall be internally provided as standard. Connection between gateway and individual water heaters shall be daisy chain with shielded, twisted pair, low voltage wiring.
  - h. The following information shall be accessible locally at controller or remotely via communications port:
    - 1) Setpoint: Can be changed remotely.
    - 2) Outlet temperature.
    - 3) Over temperature alarm.
    - 4) Control output signal to valve.
10. Heater shall be supplied by manufacturer ready to accept boiler water and domestic water lines, and furnished with following accessories:
- a. Y-strainers with blowdown valves for boiler water and domestic water.
  - b. Boiler water strainer differential pressure gage.
  - c. Combination temperature and pressure relief valve as specified in this Section.
  - d. Isolation valves.
  - e. Domestic water drain valve.
  - f. Domestic water air vent.
  - g. In-place connections for cleaning of plate and frame heat exchanger.
11. Circulating Pump: UL 778, all-bronze, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3. Include mechanical seals, 125-psig minimum working-pressure rating, and 225 deg F continuous-water-temperature rating.
12. Piping: Copper tubing; copper, solder-joint fittings; and brazed or flanged joints.
13. Capacity and Characteristics: Refer to Schedule on Drawings.

2.3 EXPANSION TANKS (DOMESTIC HOT WATER SYSTEM)

- A. Description: Steel, pressure-rated tank, ASME-code constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
  - 1. Manufacturers:
    - a. AMTROL Inc.
    - b. Armstrong Pumps, Inc.
    - c. Bell & Gossett; Xylem Inc.
    - d. Taco, Inc.
    - e. Wessels Co.
  - 2. Construction:

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- a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
- b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
- c. Air-Charging Valve: Factory installed.

3. Capacity and Characteristics: Refer to Schedules on Drawings.

## 2.4 HEAT-EXCHANGER ACCESSORIES

- A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger.
- B. Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include pressure setting less than working-pressure rating of heat exchanger.
- C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

## 2.5 SOURCE QUALITY CONTROL

- A. Test and inspect heat-exchanger, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Prepare test reports.

# PART 3 - EXECUTION

## 3.1 HEAT-EXCHANGER INSTALLATION

- A. Install heat exchangers on concrete bases.
  - 1. Concrete base construction requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."
- B. Install heat exchangers level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- C. Anchor heat exchangers to substrate.
- D. Install combination temperature and pressure relief valves in water piping for heat exchangers without storage. Extend relief-valve outlet, with drain piping same as water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- E. Install heat-exchanger drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for heat exchangers that do not have drains. Refer to Division 20 Section "Valves" for hose-end drain valves.
- F. Install thermometer on each heat-exchanger domestic-water and pool water inlet and outlet piping, and install thermometer on each heat-exchanger heating-fluid inlet and outlet piping. Refer to Division 20 Section "Meters and Gages" for thermometers.



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- G. Install pressure gages on heat-exchanger heating-fluid piping. Refer to Division 20 Section "Meters and Gages" for pressure gages.
- H. Fill heat exchangers with water.
- I. Charge expansion tanks with air.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to heat exchangers to allow service and maintenance. Arrange piping for easy removal of heat exchangers.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding."
- D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
  - 1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace heat exchangers that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

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

**\*\*END OF SECTION\*\***

## HVAC AIR-DISTRIBUTION SYSTEM CLEANING

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 20 Section "Mechanical General Requirements."
  - 2. Division 23 Section "Metal Ducts."
  - 3. Division 23 Section "Nonmetal Ducts."
  - 4. Division 23 Section "Duct Accessories."

#### 1.2 SUMMARY

- A. Section includes cleaning HVAC air-distribution equipment, ducts, plenums, and system components.

#### 1.3 DEFINITIONS

- A. ASCS: Air systems cleaning specialist.
- B. NADCA: National Air Duct Cleaners Association.
- C. VSMR: Ventilation system mold remediator.

#### 1.4 SUBMITTALS

- A. Qualification Data: For an ASCS.
- B. Qualification Data: For an VSMR.

- C. Strategies and procedures plan.
- D. Cleanliness verification report.

#### 1.5 QUALITY ASSURANCE

- A. ASCS Qualifications: A certified member of NADCA.
  - 1. Certification: Employ an ASCS certified by NADCA on a full-time basis.
  - 2. Supervisor Qualifications: Certified as an ASCS by NADCA.
- B. VSMR Qualifications: A certified member of NADCA.
  - 1. Certification: Employ a VSMR certified by NADCA on a full-time basis.
  - 2. Supervisor Qualifications: Certified as a VSMR by NADCA.
- C. UL Compliance: Comply with UL 181 and UL 181A for fibrous-glass ducts.

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

#### PART 3 - EXECUTION

##### 3.1 ACCEPTABLE AGENCIES

- A. Engage a NADCA member company with qualified ASCS and VSMR to clean HVAC air distribution systems.
  - 1. Acceptable HVAC air distribution system cleaning companies:
    - a. ACCU-Clean Services, LLC.; Hazel Park, MI.
    - b. Dalton Environmental Cleaning Corp.; Whitmore Lake, MI.
    - c. DUCTZ; Ann Arbor, MI.
    - d. Dusty Ducts, Inc.; Melvindale, MI.
    - e. Fresh Air Solutions, Inc.; Carleton, MI.
    - f. Safety King, Inc.; Utica, MI.
    - g. Sani-Vac Service, Inc.; Warren MI.

##### 3.2 EXAMINATION

- A. Examine HVAC air-distribution equipment, ducts, plenums, and system components to determine appropriate methods, tools, and equipment required for performance of the Work.
- B. Perform "Project Evaluation and Recommendation" according to NADCA ACR 2006.
- C. Prepare written report listing conditions detrimental to performance of the Work.
- D. Proceed with work only after unsatisfactory conditions have been corrected.

##### 3.3 PREPARATION

- A. Prepare a written plan that includes strategies and step-by-step procedures. At a minimum, include the following:

1. Supervisor contact information.
  2. Work schedule including location, times, and impact on occupied areas.
  3. Methods and materials planned for each HVAC component type.
  4. Required support from other trades.
  5. Equipment and material storage requirements.
  6. Exhaust equipment setup locations.
- B. Use the existing service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and for inspection.
- C. Comply with NADCA ACR 2006, "Guidelines for Constructing Service Openings in HVAC Systems" Section.

#### 3.4 CLEANING

- A. Comply with NADCA ACR 2006.
- B. Remove visible surface contaminants and deposits from within the HVAC system.
- C. Systems and Components to Be Cleaned:
1. Air devices for supply and return air.
  2. Air-terminal units.
  3. Ductwork:
    - a. Supply-air ducts, including turning vanes and reheat coils, to the air-handling unit.
    - b. Return-air ducts to the air-handling unit.
    - c. Exhaust-air ducts.
  4. Air-Handling Units:
    - a. Interior surfaces of the unit casing.
    - b. Coil surfaces compartment.
    - c. Condensate drain pans.
    - d. Fans, fan blades, and fan housings.
  5. Filters and filter housings.
- D. Collect debris removed during cleaning. Ensure that debris is not dispersed outside the HVAC system during the cleaning process.
- E. Particulate Collection:
1. For particulate collection equipment, include adequate filtration to contain debris removed. Locate equipment downwind and away from all air intakes and other points of entry into the building.

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2. HEPA filtration with 99.97 percent collection efficiency for particles sized 0.3 micrometer or larger shall be used where the particulate collection equipment is exhausting inside the building,
- F. Control odors and mist vapors during the cleaning and restoration process.
- G. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning. Restore them to their marked position on completion of cleaning.
- H. System components shall be cleaned so that all HVAC system components are visibly clean. On completion, all components must be returned to those settings recorded just prior to cleaning operations.
- I. Clean all air-distribution devices, registers, grilles, and diffusers.
- J. Clean visible surface contamination deposits according to NADCA ACR 2006 and the following:
1. Clean air-handling units, airstream surfaces, components, condensate collectors, and drains.
  2. Ensure that a suitable operative drainage system is in place prior to beginning wash-down procedures.
  3. Clean evaporator coils, reheat coils, and other airstream components.
- K. Duct Systems:
1. Create service openings in the HVAC system as necessary to accommodate cleaning.
  2. Mechanically clean duct systems specified to remove all visible contaminants so that the systems are capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).
- L. Debris removed from the HVAC system shall be disposed of according to applicable Federal, state, and local requirements.
- M. Mechanical Cleaning Methodology:
1. Source-Removal Cleaning Methods: The HVAC system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and to safely remove these contaminants from the facility. No cleaning method, or combination of methods, shall be used that could potentially damage components of the HVAC system or negatively alter the integrity of the system.
    - a. Use continuously operating vacuum-collection devices to keep each section being cleaned under negative pressure.
    - b. Cleaning methods that require mechanical agitation devices to dislodge debris that is adhered to interior surfaces of HVAC system components shall be equipped to safely remove these devices. Cleaning methods shall not damage the integrity of HVAC system components or damage porous surface materials such as duct and plenum liners.
  2. Cleaning Mineral-Fiber Insulation Components:

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- a. Fibrous-glass thermal or acoustical insulation elements present in equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment while the HVAC system is under constant negative pressure and shall not be permitted to get wet according to NADCA ACR 2006.
- b. Cleaning methods used shall not cause damage to fibrous-glass components and will render the system capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).
- c. Fibrous materials that become wet shall be discarded and replaced.

N. Coil Cleaning:

1. Measure static-pressure differential across each coil.
2. See NADCA ACR 2006, "Coil Surface Cleaning" Section. Type 1, or Type 1 and Type 2, cleaning methods shall be used to render the coil visibly clean and capable of passing Coil Cleaning Verification (see applicable NADCA ACR 2006).
3. Coil drain pans shall be subject to NADCA ACR 2006, "Non-Porous Surfaces Cleaning Verification." Ensure that condensate drain pans are operational.
4. Electric-resistance coils shall be de-energized, locked out, and tagged before cleaning.
5. Cleaning methods shall not cause any appreciable damage to, cause displacement of, inhibit heat transfer, or cause erosion of the coil surface or fins, and shall comply with coil manufacturer's written recommendations when available.
6. Rinse thoroughly with clean water to remove any latent residues.

O. Antimicrobial Agents and Coatings:

1. Apply antimicrobial agents and coatings if active fungal growth is reasonably suspected or where unacceptable levels of fungal contamination have been verified. Apply antimicrobial agents and coatings according to manufacturer's written recommendations and EPA registration listing after the removal of surface deposits and debris.
2. When used, antimicrobial treatments and coatings shall be applied after the system is rendered clean.
3. Apply antimicrobial agents and coatings directly onto surfaces of interior ductwork.
4. Sanitizing agent products shall be registered by the EPA as specifically intended for use in HVAC systems and ductwork.

3.5 CLEANLINESS VERIFICATION

- A. Verify cleanliness according to NADCA ACR 2006, "Verification of HVAC System Cleanliness" Section.
- B. Verify HVAC system cleanliness after mechanical cleaning and before applying any treatment or introducing any treatment-related substance to the HVAC system, including biocidal agents and coatings.

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- C. Perform visual inspection for cleanliness. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.
- D. Additional Verification:
  - 1. Perform surface comparison testing or NADCA vacuum test.
  - 2. Conduct NADCA vacuum gravimetric test analysis for nonporous surfaces.
- E. Verification of Coil Cleaning:
  - 1. Measure static-pressure differential across each coil.
  - 2. Coil will be considered clean if cleaning restored the coil static-pressure differential within 10 percent of, the differential measured when the coil was first installed.
  - 3. Coil will be considered clean if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection.
- F. Prepare a written cleanliness verification report. At a minimum, include the following:
  - 1. Written documentation of the success of the cleaning.
  - 2. Site inspection reports, initialed by supervisor, including notation on areas of inspection, as verified through visual inspection.
  - 3. Surface comparison test results if required.
  - 4. Gravimetric analysis (nonporous surfaces only).
  - 5. System areas found to be damaged.
- G. Photographic Documentation: Comply with requirements in Division 01 Section "Photographic Documentation."

3.6 RESTORATION

- A. Restore and repair HVAC air-distribution equipment, ducts, plenums, and components according to NADCA ACR 2006, "Restoration and Repair of Mechanical Systems" Section.
- B. Restore service openings capable of future reopening. Comply with requirements in Division 23 Section "Metal Ducts." Include location of service openings in Project closeout report.
- C. Replace fibrous-glass materials that cannot be restored by cleaning or resurfacing. Comply with requirements in Division 23 Sections "Metal Ducts" and "Nonmetal Ducts."
- D. Replace damaged insulation according to "Division 23 Section "HVAC Insulation."
- E. Ensure that closures do not hinder or alter airflow.
- F. New closure materials, including insulation, shall match opened materials and shall have removable closure panels fitted with gaskets and fasteners.

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- G. Reseal fibrous-glass ducts. Comply with requirements in Division 23 Section "Nonmetal Ducts."

**\*\*END OF SECTION\*\***



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### PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS
  - A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
  - B. Related Sections include the following:
    1. Division 20 Section "Mechanical General Requirements."
    2. Division 20 Section "Basic Mechanical Materials and Methods."
    3. Division 23 Section "Testing, Adjusting, and Balancing."
- 1.2 SUMMARY
  - A. This Section includes common requirements for fans and air moving equipment.
- 1.3 SUBMITTALS
  - A. Product Data: For the following:
    1. Fan bearings.
    2. V-belt fan drives.

3. Direct drive couplings.

#### 1.4 QUALITY ASSURANCE

- A. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
- B. Fan Performance Data: AMCA Standard 210.
- C. Sound Power Level Ratings:
  1. Ducted Fans - Rated per AMCA 301, when tested per AMCA 300.
  2. Nonducted Fans - Rated in Zones at 5 feet from acoustic center of fan rated per AMCA 301, tested per AMCA 300 and converted per AMCA 302.

#### 1.5 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate equipment for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

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

#### 2.2 FAN SHAFTS

- A. Fan Shafts: Ground from solid cold rolled steel, and proportioned to run at least 25 percent below the first critical speed.

#### 2.3 FAN POWER TRANSMISSION

- A. V-Belt Type Fan Drives: In accordance with Engineering Standard Specification for Drives Using Multiple V-Belts, sponsored by the Mechanical Power Transmission Association and the Rubber Manufacturer's Association.
- B. A given manufacturer's V-belt drive, as applied to specific equipment provided under the Contract, shall conform to the equipment manufacturer's published recommendations, except as otherwise specified.
- C. Base horsepower rating of drive on minimum pitch diameter of small sheave.
- D. Locate belt drives outboard of bearings. Align drive and driven shafts by the four-point method.
- E. Adjust belt tension in accordance with the manufacturer's recommendations.
- F. Perform alignment and final belt tensioning in the presence of the Architect.

## 2.4 SHEAVES

- A. Furnish sheaves of machined cast iron or carbon steel, bushing type of fixed bore, secured to the shaft by key and keyway.
- B. For all constant speed fans at or above 2 inches of total static pressure, Contractor shall provide and install two sets of fixed sheaves. First set shall be installed for initial start-up and shall be based on scheduled data. The second set shall be installed after system balance is complete and shall be based on actual field conditions.
- C. For all constant speed fans below 2 inches total static pressure, Contractor shall provide and install two sets of adjustable sheaves. First set shall be installed for initial start-up and shall be based on scheduled data. The second set shall be installed after the balance is complete and shall be based on actual field conditions, and selected at mid-range of the sheave.
- D. Set pitch diameters of fixed pitch and adjustable or variable pitch sheaves when adjusted as specified, at not less than that recommended by NEMA Standard MG1-14.42.
- E. For companion sheaves for adjustable or variable pitch drives, furnish wide groove spacing to match driving sheaves.
- F. For all variable frequency controller (VFC) operated fans, contractor shall provide and install one set of fixed sheaves sized to allow full utilization of fan motor horsepower provided, with VFC at 100 percent of fan motor RPM.

## 2.5 V-BELT FAN DRIVES

- A. Fan Drives: Multiple V-belt style with adjustable pitch driver sheaves for fans up to 2 inches of total static pressure and fixed pitch driver sheaves for fans at or above 2 inches of total static pressure and up. Sheaves shall have split, taper style bushings. Drives shall be selected for a 150 percent service factor and shall provide for adjustment of both belt tension and alignment.
- B. Manufacturers:
  - 1. Emerson Power Transmission; Browning.
  - 2. Rockwell Automation; Dodge.
  - 3. T.B. Wood's Incorporated.

## 2.6 FAN DRIVE, SHAFT, AND COUPLING GUARDS

- A. Safety Provisions: Include guards and screens for power transmission equipment, but do not negate vibration isolation provision.
- B. Furnish ANSI and OSHA compliant mechanical power transmission apparatus guards except where superseded by other governing codes, and except as modified and supplemented. Requirements specified apply to all types of fans.
- C. Fabricate mechanical power transmission device guards such that the completed structure is capable of withstanding a load of at least 200 pounds applied in any direction.
- D. Furnish a guard enclosure for each V-belt drive, coupling, shaft, and rotating component. Secure guards in place, easily removable for maintenance. Guard fasteners used for maintenance access shall be "captive type." Locate holes on each guard for tachometer readings on both the motor and fan shafts. Fabricate guard of minimum 16 gage sheet metal with hemmed edges at openings for

shafts. Weld four mounting lugs or feet of 10 gage material to the guard. Fabricate guards for couplings five inches in diameter and larger of 12 gage sheet metal. Furnish holes in mounting feet sized for suitable machine screws.

- E. Centrifugal exhaust fans shall be provided with shaft seals.

## 2.7 BELT DRIVE GUARDS

- A. Belt Guards: ANSI and OSHA compliant with provision for readily viewing belt tension and measuring shaft speeds. Guards shall be installed with quick release pins, so that removal of three to five clip pins, will allow the guard to be removed from fan housing.
- B. Fabricate guards which completely enclose moving parts of the particular drive. Design and construct guards of such rigidity as to contain a belt which breaks during operation. Minimum material thickness, 16 gage sheet metal. Where ventilation is required, perforated metal shall be used for the sides. Fabricate top of solid sheet metal.

## 2.8 V-BELTS

- A. Notched or cogged style, endless type, of Dacron reinforced elastomer construction, with cross-section to suit sheave grooves. Determine the number of V-belts from the motor horsepower to which apply the service factor to obtain the design horsepower. Determine the corrected horsepower per belt by multiplying the nominal horsepower per belt by an arc of contact factor not greater than 0.85. Divide the design horsepower by the corrected horsepower per belt to obtain the number of belts required. In any case, furnish not less than two belts for each drive.
- B. Furnish belts that have been factory or factory-authorized distributor matched and measured on a belt-matching machine. Selection by "code numbers," "sag numbers" or "match numbers" is not acceptable. Bind each belt set with wire and tag with equipment identification.
- C. Manufacturers:
  - 1. Emerson Power Transmission; Browning; AX, BX, and CX Series and 3VX and 5VX Series.
  - 2. Rockwell Automation; Dodge; Classic Cog and Narrow Cog V-Belts.
  - 3. T.B. Wood's Incorporated; Classical Cog and Narrow Cog V-Belts.

## 2.9 V-BELT DRIVE MOTOR BASES

- A. Furnish fan motors with slide or adjustable pivoted bases wherever equipment configuration permits proper installation.
- B. Provide for adjustment of both belt tension and alignment.

## 2.10 AIR HANDLING SYSTEM BALANCING PROVISIONS

- A. Provide extra sheaves, sized as recommended by the Balancing Agent, for the adjustment of fan speed for each air handling system during air quantity balancing operations. Furnish sheaves as specified in this Section.
- B. Provide sheaves, sized as recommended by the Balancing Agent, for the adjustment of fan speed for each existing air handling system requiring rebalancing during air quantity balancing operations. Furnish sheaves as specified in this Section.

2.11 FLEXIBLE COUPLINGS (DIRECT DRIVE)

- A. Fan shaft shall be connected to the motor shaft through a flexible coupling. The flexible member shall be a tire shape, in shear, or a solid mass serrated edge disc shape, made of chloroprene materials and retained by fixed flanges. Flexible coupling shall act as a dielectric connector and shall not transmit sound, vibration or end thrust.
- B. Manufacturer:
  - 1. Falk Corporation (The).

2.12 MOTOR REQUIREMENTS

- A. Furnish motors in accordance with Division 20 Section "Motors."

2.13 FAN BEARINGS

- A. Bearings: Anti-friction ball or roller type with provision for self-alignment and thrust load. Made in U.S.A. with ABMA L<sub>10</sub> minimum life of 200,000 hours. Use cast iron housings and dust-tight seals suitable for lubricant pressures.
  - 1. Lubrication Provisions - Use surface ball check type supply fittings. Provide extension tubes to allow safe maintenance while equipment is operating. Provide manual or automatic pressure relief fittings to prevent overheating or seal blow-out due to excess lubricant or pressure. Arrange relief fittings opposite supply but visible for normal maintenance observation.
  - 2. Bearings on Equipment with less than 1/2 horsepower rating or on shafts smaller than 1-3/4 inch in diameter: Permanently sealed, pre-lubricated anti-friction bearings per specified materials and ABMA L<sub>10</sub> life requirements.

2.14 IDENTIFICATION

- A. Nameplate: Affix metallic, corrosion-resistant data plate for each fan in a conspicuous location. Include selection point capacity conditions.

2.15 ACCESSORIES

- A. Bird Screens: Of material to match adjacent contact construction, 1/2 inch mesh or equal expanded metal. Use on inlet or outlet of each nonducted fan.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Field Rigging: Do not negate balancing. Do not bend shaft. Use lifting eyes.
- B. Install sheaves where recommended by Testing, Adjusting, and Balancing agency.
- C. Refer to individual Division 23 HVAC equipment Sections for additional requirements.

**\*\*END OF SECTION\*\***

## GENERAL-DUTY VALVES FOR HVAC

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  1. Division 21 fire-suppression piping and fire pump Sections for fire-protection valves.
  2. Division 20 Section "Mechanical Identification" for valve tags and charts.
  3. Division 22 Section "General-Duty Valves for Plumbing" for plumbing valves.
  4. Division 23 Section "Temperature Controls" for control valves and actuators.

#### 1.2 SUMMARY

- A. This Section includes valves for general HVAC applications. Refer to piping Sections for specialty valve applications.

### 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. NRS: Nonrising stem.
5. OS&Y: Outside screw and yoke.
6. PTFE: Polytetrafluoroethylene plastic.
7. RPTFE: Reinforced polytetrafluoroethylene plastic.
8. SWP: Steam working pressure.
9. TFE: Tetrafluoroethylene plastic.
10. WOG: Water, oil, and gas.

### 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.
- B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

### 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 VALVES, GENERAL

- A. Isolation valves are scheduled on the Drawings. For other general HVAC valve applications, use the following:
  1. Throttling Service: Angle, ball, butterfly, or globe valves.
  2. Pump Discharge: Spring-loaded, lift-disc check valves; and bronze lift check valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. 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.
- D. For valves not indicated in the Application Schedules, select valves 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 condenser water, heating hot water, steam, and steam condensate services.
  2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged, solder-joint, or threaded ends.
  3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
  4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
  5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends.
  6. For Steel Piping, NPS 5 and Larger: Flanged ends.
  7. For Grooved-End Systems: Valve ends may be grooved. Do not use for steam or steam condensate piping.
- E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- F. Valve Sizes: Same as upstream pipe, unless otherwise indicated.



G. 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 Operator: For quarter-turn valves NPS 8 and larger.
3. Handwheel: For valves other than quarter-turn types.
4. Lever Handle: For quarter-turn valves NPS 6 and smaller.

H. Extended Valve Stems: On insulated valves.

I. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

J. Valve Grooved Ends: AWWA C606.

K. Solder Joint: With sockets according to ASME B16.18.

1. Caution: Disassemble valves when soldering, as recommended by the manufacturer, to prevent damage to internal parts.

L. Threaded: With threads according to ASME B1.20.1.

M. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Bronze Ball Valves, General: MSS SP-110 and have bronze body complying with ASTM B 584, except for Class 250 which shall comply with ASTM B 61, full-depth ASME B1.20.1 threaded or solder ends, and blowout-proof stems.

B. Two-Piece, Regular Port Bronze Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel ball and stem, reinforced TFE seats, blow-out-proof stem, with adjustable stem packing, soldered or threaded ends; and 150 psig SWP and 600-psig CWP ratings.

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

- a. Apollo Valves; by Conbraco Industries, Inc.; Series 70-140.
- b. Crane Co.; Crane Valves.
- c. Hammond Valve.
- d. Milwaukee Valve Company; Model BA100S.
- e. NIBCO INC.; Models S-580-70-66 or T-580-70-66.
- f. Watts Water Technologies, Inc.

C. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel ball and stem, reinforced TFE seats, blow-out-proof stem, with adjustable stem packing, soldered or threaded ends; 150 psig SWP and 600-psig CWP ratings.

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

- a. Apollo Valves; by Conbraco Industries, Inc.; Series 77C-140.
- b. Crane Co.; Crane Valves.
- c. Hammond Valve.
- d. Milwaukee Valve Company.
- e. NIBCO INC.; Models S-585-70-66 or T-585-70-66.
- f. Watts Water Technologies, Inc.

## 2.3 GENERAL SERVICE BUTTERFLY VALVES

- A. General: MSS SP-67, for bubble-tight shutoff, extended-neck for insulation, disc and lining suitable for potable water, unless otherwise indicated, and with the following features:
  - 1. Full lug, and grooved valves shall be suitable for bi-directional dead end service at full rated pressure without the use or need of a downstream flange.
  - 2. Valve sizes NPS 2 through NPS 6 shall have lever lock operator; valve sizes NPS 8 and larger shall have weatherproof gear operator.
- B. Lug-Style (Single-Flange) Size NPS 2-1/2 through NPS 12, 200-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, Type 416 stainless-steel stem, copper bushing, aluminum-bronze disc, and molded-in EPDM seat (liner).
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Apollo Valves; by Conbraco Industries, Inc.; Series 143 and Series LD 145.
    - b. Bray International, Inc.
    - c. DeZurik.
    - d. Forum Energy Technologies; ABZ Valve.
    - e. Hammond Valve.
    - f. Milwaukee Valve Company.
    - g. NIBCO INC.; LD-2000-3/5.
    - h. Pentair Valves & Controls; Keystone.
    - i. Tyco Flow Control; Grinnell Flow Control.
    - j. Watts Water Technologies.
- C. Lug-Style (Single-Flange) Size NPS 14 and Larger, 150-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, one- or two-piece Type 416 stainless-steel stem, bronze bushing, and phenolic-backed EPDM seat (liner) attached to the body.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Apollo Valves; by Conbraco Industries, Inc.; Series 143 and Series LD 145.
    - b. Bray International, Inc.
    - c. Dezurik.
    - d. Forum Energy Technologies; ABZ Valve.
    - e. Hammond Valve.
    - f. Milwaukee Valve Company.
    - g. NIBCO INC.; LD-1000-5.
    - h. Pentair Valves & Controls; Keystone.
    - i. Tyco Flow Control; Grinnell Flow Control.

- j. Watts Water Technologies.
- D. Grooved-End Butterfly Valves with EPDM-Encapsulated Ductile-Iron Disc: Ductile-iron body with grooved or shouldered ends and polyamide coating inside and outside; Type 416 stainless-steel stem, PTFE bronze sintered on steel bushing, and 300-psig CWP Rating for Valves NPS 2 through NPS 8, 200 psig CWP Rating for Valves NPS 10 through NPS 12.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anvil International, Inc.
    - b. NIBCO INC.; Model GD-4765-3/5.
    - c. Tyco Fire & Building Products; Grinnell Mechanical Products.
    - d. Victaulic Co. of America.

## 2.4 BRONZE CHECK VALVES

- A. Bronze Check Valves, General: MSS SP-80.
- B. Class 150, Bronze, Swing Check Valves with Bronze Disc: ASTM B-62 bronze body and seat with regrinding-type bronze disc, Y-pattern design, soldered or threaded end connections, and having 300 psig CWP rating.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Apollo Valves; by Conbraco Industries, Inc.
    - b. Crane Co.; Crane Valves.
    - c. Crane Co.; Stockham Div.
    - d. Hammond Valve.
    - e. Milwaukee Valve Company; Model 515.
    - f. NIBCO INC.; Models S-433-B or T-433-B.
    - g. Watts Water Technologies.

## 2.5 IRON SWING CHECK VALVES

- A. Iron Swing Check Valves, General: MSS SP-71.
- B. Class 125, Gray-Iron, Standard Swing Check Valves: ASTM A-126, Class B cast-iron body and bolted bonnet with flanged end connections; non-asbestos synthetic-fiber gaskets; bronze disc and seat; and having 200 psig CWP rating.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Apollo Valves; by Conbraco Industries, Inc.
    - b. Crane Co.; Crane Valves.
    - c. Crane Co.; Stockham Div.
    - d. Hammond Valve.
    - e. Milwaukee Valve Company; Model F-2974.
    - f. NIBCO INC.; Model F-918-B.
    - g. Watts Water Technologies.

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- C. Class 250, Gray-Iron, Swing Check Valves: ASTM A-126, Class B cast-iron body and bolted bonnet with flanged end connections; non-asbestos synthetic-fiber gaskets; and bronze disc and seat; and having 500 psig CWP rating.

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

- a. Apollo Valves; by Conbraco Industries, Inc.
- b. Crane Co.; Crane Valves.
- c. Crane Co.; Stockham Div.
- d. Hammond Valve.
- e. Milwaukee Valve Company; Model F-2970.
- f. NIBCO INC.; Model F-968-B.
- g. Watts Water Technologies.

- D. Grooved-End, Swing Check Valves: Ductile-iron body with grooved or shouldered ends; nonasbestos, synthetic-fiber gaskets; rubber seats; and having 250-psig CWP Rating.

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

- a. Mueller Co.
- b. NIBCO, INC.; Model G-917-W.
- c. Tyco Fire & Building Products; Grinnell Mechanical Products.
- d. Victaulic Co. of America.

## 2.6 BRONZE LIFT CHECK VALVES

- A. Class 125, Lift Check Valves with Nonmetallic TFE Disc:

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

- a. Hammond Valve.
- b. Milwaukee Valve Company.
- c. NIBCO INC.; Model S-480-Y or T-480-Y.
- d. The Wm. Powell Company.

2. Description:

- a. Standard: MSS SP-80, Type 2.
- b. CWP Rating: 250 psig.
- c. Body Design: Vertical flow.
- d. Body Material: ASTM B 584 Alloy C844, bronze.
- e. Ends: Threaded or Solder.
- f. Disc: PTFE, or TFE.

## 2.7 SPRING-LOADED, CENTER-GUIDED LIFT-DISC (SILENT) CHECK VALVES

- A. Lift-Disc Check Valves, General: FCI 74-1 and MIL-V-18436F, with spring-loaded, center-guided bronze disc and seat.

- B. Class 125, Wafer, Lift-Disc Check Valves: Wafer style with cast-iron body with diameter made to fit within bolt circle, and having 200 psig CWP rating.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. NIBCO INC.; Model W-910-B.
    - b. Mueller Steam Specialty.
    - c. Milwaukee Valve Company.
    - d. Hammond Valve.
- C. Class 250, Wafer, Lift-Disc Check Valves: Wafer style with cast-iron body with diameter made to fit within bolt circle, and having 400 psig CWP rating.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. NIBCO INC.; Model W-960-B.
    - b. Mueller Steam Specialty.
    - c. Milwaukee Valve Company.
    - d. Hammond Valve.
- D. Class 125, Globe, Flanged Lift-Disc Check Valves: Globe style with cast-iron body and flanged ends, and having 200 psig CWP rating.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. NIBCO INC.; Model F-910-B.
    - b. Mueller Steam Specialty.
    - c. Milwaukee Valve Company.
    - d. Hammond Valve.
- E. Class 250, Globe, Flanged Lift-Disc Check Valves: Globe style with cast-iron body and flanged ends, and having 400 psig CWP rating.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. NIBCO INC.; Model F-960-B.
    - b. Mueller Steam Specialty.
    - c. Milwaukee Valve Company.
    - d. Hammond Valve.

## 2.8 BRONZE GLOBE VALVES

- A. Bronze Globe Valves, General: MSS SP-80, with malleable-iron handwheel.
- B. Class 150, TFE Disc, Bronze Globe Valves: ASTM B-62 bronze body, bonnet, and seat, TFE disc, copper-silicone bronze stem, union-ring bonnet, soldered or threaded end connections; and having 300 psig CWP rating.

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1. Manufacturers: Subject to compliance with requirements, Provide products by one of the following:

- a. Apollo Valves; by Conbraco Industries, Inc.
- b. Crane Co.; Crane Valves.
- c. Hammond Valve.
- d. Milwaukee Valve Company; Model 590.
- e. NIBCO INC.; Models S-235-Y or T-235-Y.
- f. Watts Water Technologies, Inc.

## 2.9 CAST-IRON GLOBE VALVES

- A. Cast-Iron Globe Valves, General: MSS SP-85 with bolted bonnet, flanged end connections, and non-asbestos packing and gasket.
- B. Class 125, Metal Seat, Cast-Iron Globe Valves: ASTM A-126, Class B cast-iron body and bonnet with bronze trim and having 200 psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, Provide products by one of the following:

- a. Apollo Valves; by Conbraco Industries, Inc.
- b. Crane Co.; Crane Valves.
- c. Crane Co.; Stockham Valves.
- d. Hammond Valve.
- e. Milwaukee Valve Company; Model F-2981.
- f. NIBCO INC.; Model F-718-B.
- g. Watts Water Technologies, Inc.

## 2.10 BRONZE ANGLE VALVES

- A. Bronze Angle Valves, General: MSS SP-80, with silicon bronze stem, non-asbestos packing and malleable-iron handwheel.
- B. Class 150, Bronze Angle Valves: ASTM B 62 bronze body with TFE disc, union-ring bonnet, threaded ends, and having 300-psig CWP rating.

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

- a. Crane Co.; Crane Valves.
- b. Crane Co.; Stockham Valves.
- c. Hammond Valve.
- d. Milwaukee Valve Company; Model 595T.
- e. NIBCO INC.; Model T-335-Y.
- f. The Wm. Powell Company.

## 2.11 CAST-IRON ANGLE VALVES

- A. Cast-Iron Angle Valves, General: MSS SP-85, Type II; having ASTM A 126, Class B cast-iron body and bolted bonnet; bronze mounted, non-asbestos packing and gaskets; and flanged-end connections.
- B. Class 125, Cast-Iron, Standard Angle Valves: 200-psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. NIBCO INC.; Model F-818-B.
  - b. Crane Co.; Stockham Valves.
  - c. Crane Co.; Crane Valves.

## 2.12 DRAIN VALVES

### A. Ball-Valve-Type, Hose-End Drain Valves :

1. Bronze ball valve as specified in this Section.
2. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

## 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 INSTALLATION

- A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above center of pipe. Butterfly valves shall be installed with stem horizontal to allow support for the disc and the cleaning action of the disc.
- E. Install valves in position to allow full stem movement.

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- F. Install chainwheel operators on valves NPS 4 and larger and more than 84 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.

3.3 JOINT CONSTRUCTION

- A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

3.4 ADJUSTING

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

**\*\*END OF SECTION\*\***



# TESTING, ADJUSTING, AND BALANCING

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## 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.
- B. Related Sections include the following:
  1. Division 20 Section "Mechanical General Requirements."
  2. Division 20 Section "Basic Mechanical Materials and Methods."
  3. Division 23 Section "Common Work Results for HVAC."

### 1.2 SUMMARY

- A. This Section includes testing, adjusting, and balancing to produce design objectives for the following:

1. Air Systems:
    - a. Constant-volume air systems.
    - b. Dual-duct systems.
    - c. Variable-air-volume systems.
    - d. Multizone systems.
    - e. Induction-unit systems.
  2. Hydronic Piping Systems:
    - a. Constant-flow systems.
    - b. Variable-flow systems.
    - c. Primary-secondary systems.
  3. HVAC equipment quantitative-performance settings.
  4. Laboratory fume hood airflow balancing.
  5. Exhaust hood airflow balancing.
  6. Existing systems TAB.
  7. Verifying that automatic control devices are functioning properly.
  8. Reporting results of activities and procedures specified in this Section.
- B. Include rebalancing of air systems, or system portions affected by recommended sheave changes.
- 1.3 DEFINITIONS
- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
  - B. AHJ: Authority having jurisdiction.
  - C. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.
  - D. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
  - E. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
  - F. NC: Noise criteria.
  - G. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
  - H. RC: Room criteria.
  - I. Report Forms: Test data sheets for recording test data in logical order.

- J. Smoke-Control System: An engineered system that uses fans to produce airflow and pressure differences across barriers to limit smoke movement.
- K. Smoke-Control Zone: A space within a building that is enclosed by smoke barriers and is a part of a zoned smoke-control system.
- L. Stair Pressurization System: A type of smoke-control system that is intended to positively pressurize stair towers with outdoor air by using fans to keep smoke from contaminating the stair towers during an alarm condition.
- M. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
- N. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- O. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- P. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- Q. TAB: Testing, adjusting, and balancing.
- R. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- S. Test: A procedure to determine quantitative performance of systems or equipment.
- T. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

#### 1.4 SUBMITTALS

- A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit 4 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days from Contractor's Notice to Proceed, submit 4 copies of the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 60 days from Contractor's Notice to Proceed, submit 4 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.
- D. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.
- E. Sample Report Forms: Submit two sets of sample TAB report forms.
- F. Warranties specified in this Section.

#### 1.5 QUALITY ASSURANCE

- A. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.

- B. Smoke Control System Testing: Additional Qualifications: The TAB firm shall be a qualified special inspector for the smoke control systems. The TAB firm for the smoke control system shall have expertise in fire protection engineering, mechanical engineering, and certification as air balancers.
- C. Approved Balancing Agencies.
  - 1. The TAB firm selected shall be from the following list:
    - a. Absolut Balance Company, Inc.; South Lyon, MI.
    - b. Airflow Testing Inc.; Lincoln Park, MI.
    - c. Barmatic Inspecting Co., Inc.; Lincoln Park, MI.
    - d. Ener-Tech Testing; Holly, MI.
    - e. Enviro-Aire/Total Balance Co.; St. Clair Shores, MI.
    - f. International Test & Balance Inc.; Southfield, MI.
- D. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.
  - 1. Agenda Items: Include at least the following:
    - a. Submittal distribution requirements.
    - b. The Contract Documents examination report.
    - c. TAB plan.
    - d. Work schedule and Project-site access requirements.
    - e. Coordination and cooperation of trades and subcontractors.
    - f. Coordination of documentation and communication flow.
- E. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
  - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
  - 2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.
- F. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems." TAB firm's forms approved by Architect.
- G. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."
- H. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
  - 1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.6 PROJECT CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

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

1.8 WARRANTY

- A. National Project Performance Guarantee: If AABC standards are used, provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:
  - 1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
  - 2. Systems are balanced to optimum performance capabilities within design and installation limits.
- B. Special Guarantee: If NEBB standards are used, provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:
  - 1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
  - 2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- B. Examine system and equipment test reports.
- C. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

- D. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- E. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.
- F. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.
- G. Examine strainers for clean screens and proper perforations.
- H. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- I. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- J. Examine system pumps to ensure absence of entrained air in the suction piping.
- K. Examine equipment for installation and for properly operating safety interlocks and controls.
- L. Examine automatic temperature system components to verify the following:
  - 1. Dampers, valves, and other controlled devices are operated by the intended controller.
  - 2. Dampers and valves are in the position indicated by the controller.
  - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
  - 4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
  - 5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
  - 6. Sensors are located to sense only the intended conditions.
  - 7. Sequence of operation for control modes is according to the Contract Documents.
  - 8. Controller set points are set at indicated values.
  - 9. Interlocked systems are operating.
  - 10. Changeover from heating to cooling mode occurs according to indicated values.
- M. 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. Perform the following field tests and inspections to new and renovated portions of duct systems according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:
  - 1. 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.
  - 2. Maximum Allowable Leakage: Leakage rates are scheduled on the Drawings.
- C. Complete system readiness checks and prepare system readiness reports. Verify the following:
  - 1. Permanent electrical power wiring is complete.
  - 2. Hydronic systems are filled, clean, and free of air.
  - 3. Automatic temperature-control systems are operational.
  - 4. Equipment and duct access doors are securely closed.
  - 5. Balance, smoke, and fire dampers are open.
  - 6. Isolating and balancing valves are open and control valves are operational.
  - 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
  - 8. Windows and doors can be closed so indicated conditions for system operations can be met.

### 3.3 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 Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
- B. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.
- C. 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, or use reduced scale contract documents with notations.
- 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. Cut insulation, and drill ducts for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes with neat patches, neoprene plugs, threaded plugs, or threaded twist-on metal caps, and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- F. Check air flow within intake plenums and mixing boxes of air handling units for uneven flow and temperature stratification and prepare a report with profile elevations (temperature and velocity) on each coil or filter face for Architect.
- G. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- H. Verify that motor starters are equipped with properly sized thermal protection.
- I. Check dampers for proper position to achieve desired airflow path.
- J. Check for airflow blockages.
- K. Check condensate drains for proper connections and functioning.
- L. Check for proper sealing of air-handling unit components.
- M. Check for proper sealing of air duct system.

### 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 fan static pressures to determine actual static pressure as follows:
    - a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
    - b. Measure static pressure directly at the fan outlet.
    - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
    - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
  - 2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
    - a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
  - 3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
  - 4. Select required sheave sizes and advise installing contractor to change drive sheaves accordingly. Refer to Division 23 Section "Common Work Results for HVAC" for additional requirements.
  - 5. When existing air handling systems require rebalancing, select required sheave sizes and advise Mechanical Contractor to change drive sheaves accordingly. Refer to Division 23 Section "Common Work Results for HVAC" for additional requirements.



6. Do not recommend fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.
  - B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
    1. Measure airflow at a point downstream from the balancing damper and adjust volume dampers until the proper airflow is achieved.
      - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
    2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
  - C. Measure terminal outlets and inlets without making adjustments.
    1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
  - D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.
    1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
    2. Adjust patterns of adjustable outlets for proper distribution without drafts.
- 3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS
- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
  - B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
    1. Set outside-air dampers at minimum, and 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 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 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.
  - 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 outside airflow. Adjust the fan and balance the return-air ducts and inlets 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 the 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 approved pump flow rate.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts, or use reduced scale contract documents with notations.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
  1. Open all manual valves for maximum flow.
  2. Check expansion tank liquid level.
  3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
  4. Check flow-control valves for specified sequence of operation and set at indicated flow.
  5. Set system controls so automatic valves are wide open to heat exchangers.
  6. 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.
  7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.

### 3.8 PROCEDURES FOR HYDRONIC SYSTEMS

- A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
  2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
  3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
  4. Report flow rates that are not within plus or minus 5 percent of design.
- B. Set calibrated balancing valves, if installed, at calculated presettings.
- C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
1. Determine the balancing station with the highest percentage over indicated flow.
  2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
  3. Record settings and mark balancing devices.
- F. Equipment installed with pressure independent characterized control valves (PICCV) or auto-flow devices shall not require hydronic system balancing unless multiple coils are served from a single PICCV or auto-flow device (Example: AHU coil banks with multiple coils). Measure flow through each PICCV and auto-flow device and compare measured value to scheduled value to verify proper valve/device was installed and valve is functional. Verify flow for 100 percent of PICCV and auto-flow devices. Report discrepancies.
- G. Chilled beams do not require individual hydronic balancing. Verify proper flow is achieved through balancing or control device serving chilled beam control zone. Report discrepancies.
- H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- I. Measure the differential-pressure control valve settings existing at the conclusions of balancing, and record in report.
- 3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS
- A. Balance variable-flow hydronic systems by following the "Proportional Balancing Procedure" in accordance with NEBB.

- B. 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.

### 3.10 PROCEDURES FOR PRIMARY-SECONDARY-FLOW HYDRONIC SYSTEMS

- A. Balance the primary system crossover flow first, then balance the secondary system.

### 3.11 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
  - 1. Manufacturer, model, and serial numbers.
  - 2. Motor horsepower rating.
  - 3. Motor rpm.
  - 4. Efficiency rating.
  - 5. Power factor.
  - 6. Nameplate and measured voltage, each phase.
  - 7. Nameplate and measured amperage, each phase.
  - 8. Starter size.
  - 9. Starter thermal-protection-element rating.
  - 10. Fuse number and size.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

### 3.12 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Water Coils: Measure the following data for each 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. Electric-Heating Coils: Measure the following data for each 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. Refrigerant Coils: Measure the following data for each 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.

3.13 PROCEDURES FOR TEMPERATURE MEASUREMENTS

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

3.14 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
  1. Measure and record the operating speed, airflow, and static pressure of each fan.
  2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
  3. Check the condition of filters.
  4. Check the condition of coils.
  5. Check the operation of the drain pan and condensate drain trap.
  6. Check bearings and other lubricated parts for proper lubrication.
  7. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

- B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished.
  - 1. New filters are installed.
  - 2. Coils are clean and fins combed.
  - 3. Drain pans are clean.
  - 4. Fans are clean.
  - 5. Bearings and other parts are properly lubricated.
  - 6. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
  - 1. Compare the indicated airflow of the renovated work to the measured fan airflows and determine the new fan, speed, filter, and coil face velocity.
  - 2. If calculations increase or decrease the airflow and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated airflow and water flow rates. If 5 percent or less, equipment adjustments are not required.
  - 3. Air balance each air outlet.

### 3.15 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
  - 1. Air handling equipment and outlets: Plus or minus 5 percent.
    - a. Where terminal units serve 6 or more outlets within a common room, individual outlets may vary up to plus or minus 10 percent of design flow rates if overall room supply is within plus or minus 5 percent.
  - 2. Heating-Water Flow Rate: 0 to minus 10 percent.
  - 3. Cooling-Water Flow Rate: 0 to plus 5 percent.

### 3.16 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: As Work progresses, prepare 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.

3.17 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
  - 1. Include a list of instruments used for procedures, along with proof of calibration.
- C. 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, but do not include Shop Drawings and Product Data.
- D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
  - 1. Title page.
  - 2. Name and address of TAB firm.
  - 3. Project name.
  - 4. Project location.
  - 5. Architect's name and address.
  - 6. Engineer's name and address.
  - 7. Contractor's name and address.
  - 8. Report date.
  - 9. Signature of TAB firm who certifies the report.
  - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
  - 11. Summary of contents including the following:
    - a. Indicated versus final performance.
    - b. Notable characteristics of systems.
    - c. Description of system operation sequence if it varies from the Contract Documents.
  - 12. Nomenclature sheets for each item of equipment.

13. Notes to explain why certain final data in the body of reports varies from indicated values.
14. Test conditions for fans and pump performance forms including the following:
  - a. Settings for outside-, 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.
- E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
  1. Quantities of outside, supply, return, and exhaust airflows.
  2. Water flow rates.
  3. Terminal units.
  4. Balancing stations.
- F. Air-Handling Unit - Test Reports: For air-handling units with coils, include the following:
  1. Unit Data: Include the following:
    - 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, and bore.
    - i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
    - j. Number of belts, make, and size.
    - k. Number of filters, type, and size.
  2. Motor Data:
    - a. Make and frame type and size.
    - b. Horsepower and rpm.
    - c. Volts, phase, and hertz.
    - d. Full-load amperage and service factor.
    - e. Sheave make, size in inches, and bore.
    - f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
    - g. Power factor efficiency.
  3. Test Data (Indicated and Actual Values):
    - a. Total airflow rate in cfm.
    - b. Total system static pressure in inches wg.



- c. Fan rpm.
- d. Discharge static pressure in inches wg.
- e. Filter static-pressure differential in inches wg.
- f. Preheat coil static-pressure differential in inches wg.
- g. Cooling coil static-pressure differential in inches wg.
- h. Heating coil static-pressure differential in inches wg.
- i. Outside airflow in cfm.
- j. Return airflow in cfm.
- k. Outside-air damper position.
- l. Return-air damper position.
- m. Vortex damper position.

G. 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 o.c.
- f. Make and model number.
- g. Face area in sq. ft..
- h. Tube size in NPS.
- i. Tube and fin materials.
- j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in cfm.
- b. Average face velocity in fpm.
- c. Air pressure drop in inches wg.
- d. Outside-air, wet- and dry-bulb temperatures in deg F.
- e. Return-air, wet- and dry-bulb temperatures in deg F.
- f. Entering-air, wet- and dry-bulb temperatures in deg F.
- g. Leaving-air, wet- and dry-bulb temperatures in deg F.
- h. Water flow rate in gpm.
- i. Water pressure differential in feet of head or psig.
- j. Entering-water temperature in deg F.
- k. Leaving-water temperature in deg F.

H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

- a. System identification.
- b. Location.
- c. Coil identification.
- d. Capacity in Btuh.
- e. Number of stages.
- f. Connected volts, phase, and hertz.
- g. Rated amperage.
- h. Airflow rate in cfm.

- i. Face area in sq. ft..
  - j. Minimum face velocity in fpm.
- 2. Test Data (Indicated and Actual Values):
  - a. Heat output in Btuh.
  - b. Airflow rate in cfm.
  - c. Air velocity in fpm.
  - d. Entering-air temperature in deg F.
  - e. Leaving-air temperature in deg F.
  - f. Voltage at each connection.
  - g. Amperage for each phase.
- I. Fan Test Reports: For supply, return, and exhaust fans, include the following:
  - 1. Fan Data:
    - a. System identification.
    - b. Location.
    - c. Make and type.
    - d. Model number and size.
    - e. Manufacturer's serial number.
    - f. Arrangement and class.
    - g. Sheave make, size in inches, and bore.
    - h. Sheave dimensions, center-to-center, and amount of adjustments in inches.
  - 2. Motor Data:
    - a. Make and frame type and size.
    - b. Horsepower and rpm.
    - c. Volts, phase, and hertz.
    - d. Full-load amperage and service factor.
    - e. Sheave make, size in inches, and bore.
    - f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
    - g. Number of belts, make, and size.
  - 3. Test Data (Indicated and Actual Values):
    - a. Total airflow rate in cfm.
    - b. Total system static pressure in inches wg.
    - c. Fan rpm.
    - d. Discharge static pressure in inches wg.
    - e. Suction static pressure in inches wg.
- J. 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.
    - d. Duct static pressure in inches wg.
    - e. Duct size in inches.

- f. Duct area in sq. ft..
- g. Indicated airflow rate in cfm.
- h. Indicated velocity in fpm.
- i. Actual airflow rate in cfm.
- j. Actual average velocity in fpm.
- k. Barometric pressure in psig.

K. Air-Terminal-Device Reports:

1. Unit Data:

- a. System and air-handling unit identification.
- b. Location and zone.
- c. Test apparatus used.
- d. Area served.
- e. Air-terminal-device make.
- f. Air-terminal-device number from system diagram.
- g. Air-terminal-device type and model number.
- h. Air-terminal-device size.
- i. Air-terminal-device effective area in sq. ft..

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in cfm.
- b. Air velocity in fpm.
- c. Preliminary airflow rate as needed in cfm.
- d. Preliminary velocity as needed in fpm.
- e. Final airflow rate in cfm.
- f. Final velocity in fpm.
- g. Space temperature in deg F.

L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

- a. System and air-handling unit identification.
- b. Location and zone.
- c. Room or riser served.
- d. Coil make and size.
- e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in cfm.
- b. Entering-water temperature in deg F.
- c. Leaving-water temperature in deg F.
- d. Water pressure drop in feet of head or psig.
- e. Entering-air temperature in deg F.
- f. Leaving-air temperature in deg F.

M. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:

1. Unit Data:
  - a. Unit identification.
  - b. Location.
  - c. Unit make and model number.
  - d. Compressor make.
  - e. Compressor model and serial numbers.
2. Test Data (Indicated and Actual Values):
  - a. Inlet-duct static pressure in inches wg.
  - b. Outlet-duct static pressure in inches wg.
  - c. Entering-air, dry-bulb temperature in deg F.
  - d. Leaving-air, dry-bulb temperature in deg F.
  - e. Condenser entering-water temperature in deg F.
  - f. Condenser leaving-water temperature in deg F.
  - g. Condenser-water temperature differential in deg F.
  - h. Condenser entering-water pressure in feet of head or psig.
  - i. Condenser leaving-water pressure in feet of head or psig.
  - j. Condenser-water pressure differential in feet of head or psig.
  - k. Control settings.
  - l. Voltage at each connection.
  - m. Amperage for each phase.
  - n. Kilowatt input.
  - o. Crankcase heater kilowatt.
  - p. Number of fans.
  - q. Condenser fan rpm.
  - r. Condenser fan airflow rate in cfm.
  - s. Condenser fan motor make, frame size, rpm, and horsepower.
  - t. Condenser fan motor voltage at each connection.
  - u. Condenser fan motor amperage for each phase.

N. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:
  - a. Unit identification.
  - b. Location.
  - c. Service.
  - d. Make and size.
  - e. Model and serial numbers.
  - f. Water flow rate in gpm.
  - g. Water pressure differential in feet of head or psig.
  - h. Required net positive suction head in feet of head or psig.
  - i. Pump rpm.
  - j. Impeller diameter in inches.
  - k. Motor make and frame size.
  - l. Motor horsepower and rpm.
  - m. Voltage at each connection.
  - n. Amperage for each phase.
  - o. Full-load amperage and service factor.
  - p. Seal type.

2. Test Data (Indicated and Actual Values):

- a. Static head in feet of head or psig.
- b. Pump shutoff pressure in feet of head or psig.
- c. Actual impeller size in inches.
- d. Full-open flow rate in gpm.
- e. Full-open pressure in feet of head or psig.
- f. Final discharge pressure in feet of head or psig.
- g. Final suction pressure in feet of head or psig.
- h. Final total pressure in feet of head or psig.
- i. Final water flow rate in gpm.
- j. Voltage at each connection.
- k. Amperage for each phase.

O. Vibration Measurement Reports:

1. Date and time of test.
2. Vibration meter manufacturer, model number, and serial number.
3. Equipment designation, location, equipment, speed, motor speed, and motor horsepower.
4. Diagram of equipment showing the vibration measurement locations.
5. Measurement readings for each measurement location.
6. Calculate isolator efficiency using measurements taken.
7. Description of predominant vibration source.

P. Sound Measurement Reports: Record sound measurements on octave band and dBA test forms and on an NC or RC chart indicating the decibel level measured in each frequency band for both "background" and "HVAC system operating" readings. Record each tested location on a separate NC or RC chart. Record the following on the forms:

1. Date and time of test. Record each tested location on its own NC curve.
2. Sound meter manufacturer, model number, and serial number.
3. Space location within the building including floor level and room number.
4. Diagram or color photograph of the space showing the measurement location.
5. Time weighting of measurements, either fast or slow.
6. Description of the measured sound: steady, transient, or tonal.
7. Description of predominant sound source.

Q. Indoor-Air Quality Measurement Reports for Each HVAC System:

1. HVAC system designation.
2. Date and time of test.

3. Outdoor temperature, relative humidity, wind speed, and wind direction at start of test.
4. Room number or similar description for each location.
5. Measurements at each location.
6. Observed deficiencies.

R. Instrument Calibration Reports:

1. Report Data:
  - a. Instrument type and make.
  - b. Serial number.
  - c. Application.
  - d. Dates of use.
  - e. Dates of calibration.

3.18 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. Randomly check the following for each system:
  - a. Measure airflow of at least 10 percent of air outlets.
  - b. Measure water flow of at least 5 percent of terminals.
  - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
  - d. Measure sound levels at two locations.
  - e. Measure space pressure of at least 10 percent of locations.
  - f. Verify that balancing devices are marked with final balance position.
  - g. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Architect.
3. Architect shall randomly select measurements documented in the final report to be rechecked. The 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 the 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."

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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.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.19 ADDITIONAL TESTS

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

**\*\*END OF SECTION\*\***

## TEMPERATURE CONTROLS

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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 work of this section.
- B. Related Sections include the following:
  - 1. Division 20 Section "Mechanical General Requirements."
  - 2. Division 20 Section "Basic Mechanical Materials and Methods."
  - 3. Division 23 "Testing, Adjusting, and Balancing."

1.2 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

1.3 DEFINITIONS

- A. BAS: Building Automation System
- B. CAD: Computer Aided Design.
- C. DDC: Direct-digital controls.
- D. TC: Temperature Control.

1.4 SYSTEM DESCRIPTION

- A. DDC Temperature Control System consisting of direct digital control system panels, sensors, transducers, relays, switches, data communication network, etc. and all associated control wiring and raceway systems. The new temperature controls shall interface with the existing Andover Building Automation System.
- B. BAS/DDC system programming, database and graphic display generation at the existing operator workstation.
- C. Terminal Unit DDC Controllers where shown and scheduled on the plans.
- D. IP to BACNET Communication Server for interfacing to 3rd Party BACnet controllers as shown on the plans. Provide integration into the existing BAS with point database, custom reports, time of day scheduling, and graphics.
- E. Electric control valves, dampers, operators, control wiring, etc.
- F. Electric and electronic control accessories and other control system devices.

1.5 SEQUENCE OF OPERATION

- A. Control sequences for HVAC systems, subsystems, and equipment are indicated on project drawings.

1.6 SUBMITTALS

- A. Submit under Division 20 and 23 provisions of respective project and as supplemented in this section.
- B. All control submittal requirements shall be submitted at one time with exception to control valves, automated dampers, and initial phases of work associated with fast-track projects (when required). Early submittals of control valve and automated dampers shall be incorporated with the complete temperature controls submittal.
- C. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
  - 1. Each control device labeled with setting or adjustable range of control
- D. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- E. Shop Drawings:
  - 1. Shop drawings shall be done on CAD. Minimum size 11" x 17".
  - 2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
  - 3. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
  - 4. Details of control panel faces and interior, including controls, instruments, and termination blocks and labeling.
  - 5. Written sequence of operation for each controlled system.
  - 6. Schedule of dampers including size, leakage, and flow characteristics (Refer to Design Data).
  - 7. Schedule of valves including leakage and flow characteristics (Refer to Design Data).
  - 8. Complete bill of materials to identify and quantify all control components
  - 9. Overall system schematic showing communication trunk cabling to DDC panels, peripheral devices, modems including component locations and wire termination details.
  - 10. DDC panel layouts showing connected data points and LAN connections. DDC panel terminations including power supply and remote control component termination details shall be provided.
  - 11. Point list for each DDC panel including point descriptions and addresses. This information may be incorporated with DDC panel layouts.
- F. Design Data: Provide indicated component selection and sizing criteria for the following component categories:
  - 1. Control valves:
    - a. Component tag.
    - b. Equipment served/function.

- c. Media type.
  - d. Design flow rate (GPM).
  - e. Selected valve GPM (Pressure Independent Control Valves)
  - f. Valve size.
  - g. Line size to valve connection (excluding reducers).
  - h. Type (ball).
  - i. Configuration (2-way).
  - j. Normal position (normally open, normally closed, floating).
  - k. Actuator spring range (where applicable).
  - l. Actuator power requirement.
  - m. Valve shut-off rating (ft. head) of (psi)
  - n. Valve body pressure/temperature rating.
  - o. Valve manufacturer/model number.
  - p. Actuator manufacturer/model number.
2. Dampers:
- a. Component tag.
  - b. Equipment served/function.
  - c. Overall damper size (inch height x inch width).
  - d. Quantity of damper sections with respective size(s):
  - e. Material and gauge of thickness.
  - f. Mounting orientation (horizontal or vertical).
  - g. Blade configuration (parallel or opposed)
  - h. Pressure drop (in. w.g.).
  - i. Shut-off rating/differential pressure rating (in. w.g).
  - j. Leakage rating (CFM/sq. at 4 in. w.g).
  - k. Normal position (normally open, normally closed, floating).
  - l. Actuator spring range (where applicable).
  - m. Actuator power requirement.
  - n. Actuator torque requirement.
  - o. Actuator quantity.
  - p. Damper manufacturer/model number.
  - q. Actuator manufacturer/model number.
3. Flow measuring probes - Air:
- a. Component tag.
  - b. Equipment served/function.
  - c. Duct dimension (inch height x inch width) if applicable.
  - d. Fan inlet diameter (inch) if applicable)
  - e. Probe quantity.
  - f. Probe length.
  - g. Flow rate (CFM).
  - h. Flow velocity (FPM).
  - i. Probe manufacturer/model number.
  - j. Transmitter manufacturer/model number.
- G. Samples: Temperature sensor cover for each color required and guards if required.
- H. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- I. Submit field reports indicating operating conditions after detailed check out of systems at Date of Substantial Completion.
- J. Project Record Documents: Include the following:

1. Revise Shop Drawings to reflect actual installation and operating sequences.
2. Record actual locations of control components, including control units and sensors.
3. Submit the electronic files for all as-built shop drawings on diskette in pdf format.

K. Software and Firmware Operational Documentation: Include the following:

1. DDC panel keypad operating instructions and DDC panel control override features where applicable.
2. Device address list.
3. Program Software Backup: On a magnetic media or compact disc, complete with data files.

L. Maintenance Manuals: Include the following:

1. Product data with installation details, maintenance instructions and lists of spare parts for each type of control device.
2. Keypad illustrations and step-by-step procedures indexed for each operator function where applicable.
3. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
4. Calibration records and list of set points.

1.7 REFERENCES

- A. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.
- B. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- C. ANSI/NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
- D. NEMA DC 3 - Low-Voltage Room Thermostats.
- E. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.
- F. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure fittings.
- G. ANSI/ASTM B32 - Solder Metal.
- H. ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- I. ASTM B75 - Seamless Copper Tube for General Engineering Purposes.
- J. ASTM D1693 - Environmental Stress - Cracking of Ethylene Plastics.
- K. UL 1820 - Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics Only.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is an approved installer of the automatic control system manufacturer for both installation and maintenance of units required for this Project.
- B. Manufacturer Qualifications: A firm experienced in manufacturing automatic temperature-control systems similar to those indicated for this Project and with a record of successful in-service performance.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated or optional to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

1.10 COORDINATION

- A. Coordinate work under Division 20 and 23 provisions and as supplemented in this section.
- B. Coordinate location of space temperature sensors and other exposed control sensors with plans and room details before installation.
- C. Coordinate installation of system components with installation of mechanical systems and equipment to achieve compatibility.
- D. Ensure installation of components is complementary to installation of similar components in other systems.
- E. Coordinate control wiring requirements, including actual terminal block numbers, with mechanical equipment manufacturers or suppliers.
- F. Coordinate equipment with Division 28 Section "Fire Alarm" to achieve compatibility with equipment that interfaces with that system.
- G. Ensure control system installation is complete, checked, tested and functioning properly prior to system balancing and Owner/Engineer system checkout.
- H. Cooperate fully with the Test and Balance Contractor and provide labor to operate the temperature control system as required to meet the scope of work defined in Division 23 Section "Testing, Adjusting and Balancing."

1.11 WARRANTY

- A. Provide warranty per Division 20 Section "General Mechanical Requirements" and as supplemented in this section.
- B. Provide 24 hour per day emergency service during warranty period, with maximum response period of four (4) hours. Provide phone number(s) for quick assistance by a Service Engineer regarding hardware or software problems.

- C. Provide scheduled maintenance service during warranty period to inspect, calibrate, and adjust controls. Make a minimum of one eight hour service call every three months. Notify Owner prior to each scheduled inspection trip. Submit written reports upon completion of service.
- D. Provide any software or firmware revisions for controllers provided with project which are released by the DDC system manufacturer during the warranty period, at no additional cost to the Owner.

#### 1.12 POSTED OPERATING INSTRUCTIONS

- A. Provide panel related as-built documents in protective binder or clear plastic display envelope for each control panel. These instructions shall include such items as as-built control diagrams and sequence of operation, simplified narrative instructions and materials necessary to aid in the operation of the equipment at the local control panels.

#### 1.13 SPECIAL TOOLS

- A. Deliver two sets of any special tools required for operation, adjustment, resetting or maintenance, not including PC Laptop.

#### 1.14 PROTECTION OF PROPRIETARY INFORMATION

- A. All proprietary manuals and software non-disclosure agreement, where applicable, shall be submitted by the proprietary equipment manufacturer to the Owner for approval and signature during the warranty period.

### PART 2 - PRODUCTS

#### 2.1 DESCRIPTION OF THE BUILDING AUTOMATION SYSTEM (BAS)

- A. The district-wide Andover building automation system (BAS) shall be a fully integrated, distributed data processing system incorporating direct digital control (DDC) for the control and monitoring of heating, ventilating and air conditioning (HVAC) equipment and other related systems.
- B. Microprocessor based DDC panels shall be directly connected to HVAC equipment sensors and actuators. A data communication network shall allow data exchange between existing and new DDC panels and each building's existing Network Controller (Andover Controls). Each building's existing Network Controller is connected to the owner's Ethernet and communicates with the owner's existing central BAS server.
- C. DDC panels (controllers) that are currently at i2 level shall be re-used and remain "as is", using the existing Sequence of Operations. Lower revision controllers shall be upgraded to i2 level controllers as shown in contract documents. Provide for any additional sequence of operation changes shown on the Contract Documents that would revise these Sequences. New controllers may mount into the existing back-panels if mounting requirements are met.
- D. Provide BAS front-end PC software upgrades necessary for the upgrade of DDC controllers to i2 level and/or any software upgrade released during the contract period.
- E. Provide revisions to existing graphics to include new work and provide new graphics where required and shown in the Contract Documents. Refer to Section 3.
- F. Provide IP to BACNET Communication Server for interfacing to 3rd Party BACnet controllers as shown on the plans. Provide integration into existing BAS with graphics. Coordinate IP drop requirements with the Troy School District IT Staff for connectivity.
- G. Approved Manufacturer – System / Installer (Location):

1. Andover Controls Corp. / Mechanical Controls & Maintenance, Inc. aka MCMI (Sterling Heights, MI).

## 2.2 DDC DATA COMMUNICATIONS NETWORK

- A. Data communication network shall be provided to allow data transmission between all DDC panels and between the DDC panels and the DDC Network Controller.
- B. The BAS/DDC system-wide communication network shall consist of a primary peer-to-peer network, and at the Contractor's option, secondary sub-networks linked to the primary network. The primary network shall support peer-to-peer communications between primary network DDC panels. The existing Building Network Controller is connected to the primary network. The secondary sub-networks shall interface with the primary network through the primary network DDC panels. At least one DDC panel connected to the primary peer-to-peer network shall be provided in each mechanical room, or as indicated on the drawings.
- C. Data communications media shall be twisted pair wires.
- D. The communications network shall allow shared point and control information between DDC panels without dependence on the existing Building Network Controller. All required repeaters, hubs, active links, gateways, etc. and associated power supplies shall be provided as required to provide shared point and control information between DDC panels.
- E. Failure of any individual DDC panel shall not cause the loss of communications between peer DDC panels.
- F. All data transmitted must be positively acknowledged as received or negatively acknowledged as not received. Negative acknowledgments shall cause a retransmission of the data. Network connected devices must send a "functioning" message each network cycle. Lack of a "functioning" message after successive retries shall constitute a device failure and shall be recognized as such by the network.
- G. Error recovery and communication initialization routines shall be resident in each network connected device.

## 2.3 DDC NETWORK CONTROLLER (EXPAND EXISTING AS REQUIRED)

- A. Field-verify the existing DDC Network Controller capability for each building, as required to accommodate integration to new HVAC equipment per project scope.
- B. If network controller is near memory capacity, provide a new DDC Network Controller to accommodate integration to new HVAC equipment per project scope.
- C. Provide new network controller (as required) to interface to 3<sup>rd</sup> party Heating Hot Water and Chilled Water System communication interfaces..

## 2.4 DDC AIR TERMINAL UNIT CONTROLLERS

- A. Microprocessor based controllers capable of stand-alone operation for control of pressure independent air terminal units. Controllers shall be networked together and connected to the building's BAS/DDC network.
- B. Controllers shall have separate adjustable minimum and maximum airflow setpoints. Controllers shall work in conjunction with the air handling unit's DDC panel to provide the sequence of operation

as indicated on the drawings. Setpoints shall be adjustable through the portable programmer terminal.

- C. Provide electronic type air terminal unit damper operators compatible with the controller and the air terminal units provided.
- D. Each controller shall have an internal differential pressure transducer capable of utilizing the total and static pressure signals from the air terminal unit's velocity sensor. Velocity sensor shall be furnished by air terminal unit manufacturer.
- E. Each controller shall have electronic outputs compatible with the electronically operated air terminal unit tempering coil control valve and perimeter radiation control valve where applicable
- F. TC contractor shall provide 24 VAC power requirements including transformers.
- G. If coordinated with mechanical contractor. Controllers and damper operators shall be furnished to the air terminal unit manufacturer for factory mounting by the air terminal unit manufacturer; otherwise, controls shall be field installed.
- H. Room temperature sensors for the DDC air terminal unit controllers:
  - 1. Sensing Element: Thermistor or resistance temperature detector (RTD) type. Accuracy shall be +/- 0.5 degrees F over the range of 55 degrees F to 95 degrees F, including calibration error, repeatability, hysteresis, and yearly drift.
  - 2. Cover: Locking type.
  - 3. Provide flat-plate type sensor.
  - 4. Provide insulating base on exterior walls.

## 2.5 DIRECT DIGITAL CONTROL (DDC) PANELS

- A. Control Panels: Modular in design and consisting of stand-alone microprocessor board with ROM and fully custom programmable RAM, EPROM, and/or EEPROM memory, integral interface equipment and power surge protection. DDC panels shall be connected directly to sensors, controlled devices and the communication network.
- B. Powerfail Restart and Battery Backup: Minimum of 72 battery backup hours for complete system RAM memory and clock, with automatic battery charger or 48 hour low voltage alarm warning. Upon full system power recovery, all clocks shall be automatically synchronized, and all controlled equipment shall be automatically re-started based on correct clock time and sequence of operation.
- C. Provide fully functional communication interface ports for communication between processor, other processors, existing Building Network Controller, portable operator unit and portable programmer terminal.
- D. Panel enclosure shall be finished steel or rigid plastic with hinged door and keyed lock. Electronics shall be removable for protection during mounting of panel.

## 2.6 DDC PANEL SOFTWARE

- A. Operating system shall work in real time, provide prioritized task scheduling, control time programs, monitor DDC panel to DDC panel as well as DDC panel to existing Building Network Controller communications, scan inputs and outputs, and contain built-in diagnostics.
- B. Input/output point processing shall include the following:



1. Continuous update of input and output values and/or conditions. All connected points are to be updated at least once per second.
  2. Assignment of proper engineering units and status condition identifiers to all points.
  3. In addition to physical or "hardware" points required, "software" points shall be provided where required for command access and meaningful displays, where required by the "execution" portion of this section or where required on the DDC input/output points lists. "Software" points shall appear identical to physical points in output displays and shall be assignable to text descriptors, logical groups, reports, etc. in the same manner as physical points. "Software" points shall be assigned alarm limits in the same manner as physical points.
- C. Command control software shall manage the receipt of commands from the existing Building Network Controller, portable programmer's terminal, and from control programs.
1. Command delay, programmable from 0 to 2 minutes, shall be provided to prevent simultaneous energizing of large loads. Command delays shall be honored throughout the DDC network, not just within the DDC panel. Delays shall be assignable on an individual per point basis.
  2. Each command shall be assigned a command and residual priority to manage contentions created by multiple programs having access to the same command point. Only commands with a higher command priority than the existing residual priority shall be permitted to execute. Whenever a command is allowed to execute, its assigned residual priority shall replace the existing residual priority.
  3. A "fixed mode" option shall be supported to allow inputs to, and outputs from DDC control programs to be set to a fixed state or value. When in the "fixed mode," inputs and outputs shall be so noted in all reports.
  4. A "last user" record is to be maintained to positively identify which program or manual command is in control of a given point. The last user information shall be displayed and printed along with other point data of logical groups.
- D. Provide self-test procedure. Notify existing Building Network Controller for maintenance, performance, software, cable break, or data transmission problems. Identify variables as reliable or unreliable. Variables identified as unreliable shall use default in calculation.
- E. Provide Alarm Processing:
1. High/Low Alarm: Analog input alarm comparison with the ability to assign two individual sets of high and low limits (warning and actual alarm) to an input. Each alarm shall be assigned a unique differential to prevent a point from oscillating into and out of alarm. Alarm comparisons are to be made each scan cycle.
  2. Floating Alarm: Where analog controlled values are automatically varied by software (such as hot water temperature reset), a single set of alarm limits shall be provided for those varying values. These alarm limits shall then "float" a user definable differential above and below the varying setpoint value.
  3. Abnormal Alarm: When a digital input is not in agreement with the commanded state of its associated output point, or when a digital input is not in its normal state, an abnormal alarm shall be generated. Abnormal "on" shall cause an alarm, as well as abnormal "off." Alarm

time delay for digital inputs to prevent nuisance alarms shall be provided. Each digital input alarm time delay shall be adjustable from zero to two minutes in one-second increments.

4. Alarm lockout shall be provided to positively lock out alarms when equipment is turned off or when a true alarm is dependent on the condition of an associated point. Lockout points and lockout initiators shall be operator programmable. On initial startup of air handler and other mechanical equipment, a "timed lockout" period shall be assigned to analog points to allow them to reach a stable condition before activating alarm comparison logic. Timed lockout period shall be programmable on a per point basis from 0 to 90 minutes in one-minute increments.
5. The capability of automatically initiating commands upon the occurrence of an alarm.

F. Totalization

1. Run time shall be accumulated based on the status of digital input points. It shall be possible to totalize either on time or off time up to 10,000 hours with one-minute resolution. Run time counts shall be resident in memory and have DDC panel resident run time limits assignable through the portable programmer's terminal, portable operators unit or the existing Building Network Controller.
2. A transition counter shall be provided to accumulate the number of times a device has been cycled on or off. Counter shall be capable of accumulating 600,000 switching cycles. Limits shall be assignable to counts to provide maintenance alarm printouts.
3. Analog totalization capability shall be provided to allow the totalization of electricity, air, water and steam flow, etc. These flows shall be totalized with respect to time and converted to the appropriate energy unit. It shall be possible to automatically set time intervals for totalization, adjustable from one second to 365 days. The totalization program shall keep track of the maximum and minimum instantaneous analog value measured during the period, including the date and time at which each occurred.

G. Custom DDC Programs

1. All DDC programs shall be fully custom programmable. DDC panels or systems which require remote or factory programming are not acceptable. DDC panels or systems with programs which may not be custom modified by the user are not acceptable. "Custom" programming shall mean allowing the alteration of actual control logic, and shall not be limited to allowing only the alteration of setpoints, gains, parameters, time constants, etc.
2. Custom DDC programs shall be provided to meet the control strategies as called for in the sequences of operation on the drawings.
3. All DDC setpoints, gains, parameters, time constants, etc., associated with DDC programs shall be available to the operator for display and modification via the existing Building Network Controller and/or portable operators unit.
4. The execution interval of each DDC control loop shall be adjustable from two to 30 seconds.
5. Each DDC panel shall have resident in its memory and available to the programs a full library of DDC algorithms, intrinsic control operators, and arithmetic, logic and relational operators for implementation of control sequences. Functions to be provided shall include, but not be limited to, the following:
  - a. Mathematical: Absolute value, calculate, square root, power, sign, average, totalize.

- b. Logic: OR, AND, compare, negate.
- c. Fixed Formula: High and low select, span, rate, ramp, enthalpy, wet bulb, dew point, relative humidity, humidity ratio, and filter.
- d. Data Manipulation: Store, file and set.
- e. Control Routines: Real-time based functions, proportional control, proportional-integral control, proportional-integral-derivative control, adaptive control (self-tuning), direct-acting, reverse acting, feedforward, fixed setpoint, calculated setpoint, adjustable setpoint, lead lag, hysteresis correction, event initiation/ software interlock.

## 2.7 DDC INPUT/OUTPUT SENSORS

### A. Pressure Transmitters/Transducers

- 1. Manufacturers:
  - a. Dwyer.
  - b. Setra Systems Inc.
  - c. Vaisala.
- 2. Sensors: Appropriate sensing chamber for medium being sensed.
- 3. Wiring requirement: twisted, shielded-pair cable for wiring unless specified otherwise by the manufacturer. Some transmitters require 4-wire connections.
- 4. Air Static Pressure Transmitter: Non-directional sensor with suitable range for expected input, and temperature compensated.
  - a. Variable capacitance type with ranges not exceeding 150 percent of maximum expected input. Transmitter shall have zero and span adjustments.
  - b. Safe overpressure rating shall be minimum 5 times the range.
  - c. Temperature compensated with thermal error of not greater than 0.04 percent of full scale in temperature range of 40 to 100 degrees F.
  - d. Accuracy: One percent of full scale
  - e. Output: 4- to 20-mA. Output impedance must meet input requirements.
  - f. Building Static Pressure Range: minus 0.05- to plus 0.05-inches w.g..
  - g. 2/3 down-the-duct Static Pressure Range: 0- to 2.5-inches w.g.
  - h. Static Pressure High-limit Transmitter: 0- to 10.0-inches w.g.

### B. Current Switches:

- 1. Split-core donut transformer type for monitoring AC current, with digital output signal. Current switches used on motor side of variable frequency drives shall have low frequency detection capability.
- 2. Current switches with digital output shall have adjustable trip settings. Field adjust all current switches to trip at approximately 90% of normal motor operating amperage.
- 3. Manufacturers:
  - a. NK Technologies.
  - b. Senva.
  - c. Setra.
  - d. Veris Industries.

### C. Temperature Sensors:

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CONTROLS

1. Resistance temperature detectors (RTD) with platinum, nickel or balco element. Accuracy shall be +/- 0.5 deg F over the entire range. Range shall be as indicated below, or as appropriate to the application.
2. Single point duct mounted sensors shall have 18" rigid probe and calibrated span of 20° F - 120° F.
3. Averaging duct mounted sensors shall have 25' long averaging element and calibrated span of 20° F - 120° F.
4. Liquid immersion sensors shall have welded stainless steel thermowell for ferrous pipe, and brass wells for copper pipe. Length of sensor and thermowell shall be selected based on the diameter of the pipe to provide accurate, reliable and homogeneous sensing of the liquid temperature. Thermowell pressure rating shall meet or exceed the system minimum pressure rating. Sensors for chilled water application shall have a calibrated span of 20° F - 120° F. Sensors for heating hot water and domestic hot water application shall have a calibrated span of 100° F - 240° F.
5. Room sensors shall have locking cover and a minimum span of 40° F - 90° F. Sensors shall be mounted on extra-large stainless steel back-plate for coverage to eliminate patch/paint issues. Room sensor shall be flat-plate type. Provide insulating base on exterior walls.
6. Outside air sensors shall have watertight inlet fitting and shall be shielded from direct rays of sun.
7. Manufacturers:
  - a. Specified BAS product where available.
  - b. TCS.
  - c. Minco.
  - d. ACI.
  - e. MAMAC.

D. Carbon Dioxide Sensors:

1. Carbon dioxide sensing cell shall consist of a non-dispersive infrared carbon dioxide gas cell that uses a pulsed source and has no free air optical path. Output shall be linearized 4-20 mA with the 24 VDC input. In addition, the unit shall be capable of providing SPDT switching of an external low voltage circuit at an adjustable setpoint. The unit shall be specifically designed for the wall or duct application specified. Return air aspiration boxes shall be designed by and approved by the manufacturer. Unit shall have single point setpoint and span adjustment. The unit shall have no moving parts.
2. Power for the sensor shall be extended from a transformer or adaptor installed adjacent to the DDC controller enclosure panel, and shall be run parallel to the 4-20 mA signal cable.

Minimum requirements:

Range	0-2,000 ppm
Accuracy	3% full scale
Repeatability	1% of full scale
Max allowable drift / yr.	+/- 20 ppm
Min Calibration Interval	5 years

3. Contractor shall provide all necessary equipment and test gas for calibration and shall calibrate all CO<sub>2</sub> sensors in accordance with the manufacturer's recommendations.

4. Manufacturer:

- a. Honeywell.
- b. Schneider Electric Controls.
- c. Johnson Controls.
- d. Siemens.
- e. Vaisala.
- f. Veris.

E. Humidity Sensors:

1. Elements: Thin film capacitive type or bulk polymer resistance type, accurate within  $\pm 2\%$  RH throughout the range of 0-99% RH at 25 deg C, with linear output. Factory calibrate for maximum accuracy at mid-range of normal operating humidity. All humidity sensors shall be resistant to chlorine and other cleaning agents.
2. Room Sensors: With locking cover matching space temperature sensors used.
3. Duct Sensors: With duct probe and mounting plate.
4. Manufacturers:
  - a. GE Industrial, Sensing (formerly General Eastern).
  - b. Vaisala.

F. Outside Air Temperature/Humidity Combination Transmitters:

1. Dual transmitters housed in a single hinged enclosure with integral probes configured for exterior wall mount application with PVC sun shield. Unit shall provide separate 4-20 mA signals for temperature and humidity measurement.
2. Temperature sensor shall be 1000 OHM thin film platinum resistance temperature detector with matching 4-20 mA transmitter having independent zero and span adjustments. Accuracy shall be  $\pm 0.5$  degrees F with a range of -25 degrees F to 125 degrees F.
3. Humidity sensor shall be washable thin film type with matching 4-20 mA transmitter having independent zero and span adjustments and linear output over a span of 0-100% RH. Accuracy shall be  $\pm 2.5\%$  RH over the range 0-95% RH at 25 degrees C.
4. Manufacturer:
  - a. GE Industrial, Sensing (formerly General Eastern)
  - b. Vaisala.

2.8 AIRFLOW MEASURING PROBES – OUTSIDE AIRFLOW

- A. Duct airflow measuring probes shall be Thermal Dispersion type.
- B. Probes shall be constructed of extruded aluminum. Probes shall be provided with mounting plate, and gasket. Probe and mounting hardware shall facilitate easy removal and reinstallation of the probes.

- C. The number of sensors on each probe, and the quantity of probes provided at each location, shall comply with ASHRAE standards for duct traversing. Multiple probes provided at a single location shall be interconnected external to the duct to produce an average signal.
- D. For each airflow measurement location, the measured velocity pressure shall have accuracy within  $\pm 2\%$  of the full scale throughout the velocity range of 0-4000 fpm.
- E. Associated transmitter at each airflow measurement location shall be provided with LCD readout to indicate with airflow (in CFM) of the connected airflow measuring station.
- F. Manufacturers / Model:
  - 1. Ebtron / Gold Series.
  - 2. Air Monitor Corporation / ELECTRA-flo.

2.9 LIQUID DIFFERENTIAL PRESSURE TRANSMITTERS:

- A. Transmitters used for measuring differential pressure only:
  - 1. Each differential pressure transmitter shall be selected and calibrated for operations between 0 and 200% of the normal differential pressure. The calibration point shall be rounded upward to the nearest 10 inches of water column (for spans less than 200" W.C.) or to the nearest 5 psi for larger spans. Calibration date shall be included on an embossed tag attached to each transmitter.
  - 2. The accuracy, including linearity, hysteresis and repeatability, of the transmitter for measuring differential pressure shall be better than 2% of the span stated above throughout a 4:1 turndown.
  - 3. The transmitter shall not be damaged by pressures of up to 500 psig on either side of the transmitter and all wetted parts shall be essentially inert in the presence of up to a 40% concentration of ethylene glycol in water.
  - 4. Provide a drain valve for each side of the pressure chamber. Furnish and install mounting brackets appropriate for the installation location.
  - 5. Span and zero shall be individually adjustable.
  - 6. With LCD Display.
  - 7. Manufacturers:
    - a. Dwyer.
    - b. Setra.
    - c. Veris Industries.
- B. Indication Gauges for Differential Pressure Transmitters:
  - 1. Each transmitter shall come with an indicating gauge which reads in gpm or inches of water (whichever is the final value desired). The gauge shall be piped in parallel to the transmitter with a digital display wired directly to the output of the transmitter.

2. The accuracy, including linearity, hysteresis and repeatability, of the gauge for measuring differential pressure shall be better than 3% of the span stated above throughout its span. Calibration data shall be included on an embossed tag attached to each gauge.
3. The gauge shall not be damaged by pressures of up to 500 psig on either side of the gauge and all wetted parts shall be essentially inert in the presence of up to 40% concentration of ethylene glycol in water.
4. Scale shall be a minimum of 4.5" long. Furnish and install two bleed fittings for each gauge and mounting brackets appropriate for the installation location.

C. Three Valve Manifold:

1. Provide a three-valve manifold for each transmitter. The manifold shall not be damaged by pressures of up to 500 psig and all wetted parts shall be essentially inert in the presence of up to a 40% concentration of ethylene glycol in water.
2. The manifold shall be designed for direct mounting on the transmitter it serves and utilize two quarter turn valves to provide zeroing, blocking and normal service modes.

2.10 CONTROL VALVES AND VALVE OPERATORS

A. Pressure Dependent Characterized Ball Valves: Shall be used only as 2-way modulating for Duct-mounted Reheat Coils; air terminal units, 2-way on/off for Unit Heaters, Cabinet Unit Heaters (wall or ceiling), Convectors, and Finned Tube Radiation:

1. Up to 1 inch: Bronze body with screwed ends, stainless steel or chrome plated brass ball, characterizing disc, stainless steel stem, spring-return where noted, and resilient reinforced Teflon seats.
2. If not scheduled, reheat coil control valves shall be selected for a pressure drop close as possible to 3 psig with allowable minimum of 1.5 psig. TC Contractor shall use valves from listed manufacturers that meet the pressure drop requirements.
3. Manufacturers:
  - a. Belimo.
  - b. Bray / Delta Control Products.
  - c. Honeywell.
  - d. Schneider Electric Controls.
  - e. Johnson Controls.
  - f. Siemens

B. Globe Valves (2-way & 3-way):

1. Used for air handling equipment AHU & HVU.
2. Up to 2 inches: Bronze body, bronze trim, rising stem, renewable composition disc, single seated, screwed ends with backseating capability, repackable under pressure.
3. Over 2 inches: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc, repackable under pressure.
4. Valve stem packing shall be tetrafluorethylene, spring loaded and self-adjusting. Packless construction is acceptable.

5. Manufacturers:

- a. Belimo.
- b. Bray / Delta Control Products.
- c. Honeywell.
- d. Schneider Electric Controls.
- e. Johnson Controls.
- f. Siemens.

C. Electric Operators:

1. Operators shall be electronic type to accept signals from direct digital controller or modulating thermostat for proportional control.
2. Valves shall spring return to normal position as indicated. Terminal unit tempering coil control valve operators are not required to be spring return.
3. Select with sufficient shut-off power for system pressure and highest operating torque, and torque requirements of valves which may stick because of infrequent use.
4. Select to provide smooth proportioning control under operating conditions normal to the system.

D. Hydronic Systems:

1. Valve minimum pressure rating shall meet or exceed the system minimum pressure rating as noted for each system in Division 20 Section "Valves," and in Division 23 Section "Hydronic Piping."
2. Valve minimum temperature ratings shall be 250 deg. F.
3. For globe valves: Replaceable plugs and seats of stainless steel or brass, selected for maximum lift under application conditions.
4. Two-way and three-way valves controlling coils shall have equal percentage characteristics. Size two-way valve operators to close against pump shut off head.
5. Two-way and three-way valves controlling bypass loops and radiant loops shall have linear flow characteristics. Size two-way valve operators to close against pump shut off head.
6. Pressure Drop for pressure dependent characterized ball valves: Terminal Equipment control valves shall be selected for a pressure drop close as possible to 3 psig with allowable minimum of 2 psig where flow rates are minimal and valve Cv choices are limited. TC Contractor shall use valves from listed manufacturers that meet the pressure drop requirements.
7. Pressure Drop for pressure dependent globe valves: Primary HVAC and water control loop control valves shall be selected for a pressure drop close as possible to 5 psig, + 5% / - 25%.

2.11 NATURAL GAS SOLENOID VALVES

A. Manufacturers

1. ASCO



B. Description:

1. Action: Either normally open or normally closed in the event of electrical power failure as required by the application.
2. Size to close against the system pressure.
3. Manual override capable.
4. Heavy-duty assembly.
5. Body: Brass for copper pipe and stainless steel for ferrous pipe.
6. Seats and Discs: NBR or PTFE.
7. Solenoid Enclosure: NEMA 250, Type 4.

2.12 DAMPERS - AUTOMATED

- A. Performance: Test in accordance with AMCA 500.
- B. Frames: Galvanized steel, minimum 16 gauge, minimum 2 inches in width, welded or riveted with corner reinforcement for 12 gage structural equivalence.
- C. Blades: Galvanized steel, minimum 14 gauge, maximum blade size 8 inches wide, 60 inches long, attached to minimum 1/2 inch shafts. Dampers which are required to have a static pressure rating over 4 inch W.G. shall have minimum 3/4 inch solid shafts.
- D. Blade Seals: Synthetic elastomeric or Neoprene, mechanically attached, field replaceable.
- E. Jackshafts (where required): Minimum 1/2 inch galvanized steel.
- F. Jamb Seals: Stainless steel.
- G. Bearings: Oil impregnated sintered bronze or lubricant free, solid stainless steel. Provide thrust washers at bearings for all dampers which are to be mounted with blades in the vertical position.
- H. Linkages: Accessible for maintenance. Linkages may be located in airstream. Linkages located in damper frame shall be external to the duct, accessible for maintenance. Linkages located in the airstream shall be zinc-plated.
- I. Leakage: Less than 8 CFM per square foot based on 4 inches W.G. pressure differential.
- J. Static Pressure Rating: As scheduled on the drawings, or if not scheduled, minimum 4" W.G.
- K. Maximum Velocity: As scheduled on the drawings, or design for maximum velocity to be encountered in location where installed.
- L. Temperature Limits: -40 to 200 deg F.
- M. Manufacturers:
  1. American Warming & Ventilating.
  2. Arrow United Industries.

3. Greenheck.
4. Honeywell.
5. Johnson Controls.
6. Louvers & Dampers, Inc.
7. Ruskin.
8. Tamco.
9. Vent Products.

2.13 DAMPERS, INSULATED OUTDOOR AIR / RELIEF AIR / EXHAUST AIR - AUTOMATED

- A. Performance: AMCA certified for Air Performance and Air Leakage.
- B. Frames: Extruded aluminum, .080-inch thickness minimum, 4 inches deep minimum, thermally broken, and insulated with polystyrene or polyurethane foam insulation.
- C. Blades: Extruded aluminum, internally insulated, and thermally broken. Maximum blade size 8 inches wide, 60 inches long.
- D. Shafts: Minimum 7/16 inch hexagonal or square corrosion resistant zinc plated steel.
- E. Blade Seals: Extruded EPDM, silicone, or synthetic elastomeric, mechanically attached.
- F. Jamb Seals: Silicone, or synthetic elastomeric, mechanically attached.
- G. Bearings: Dual bearing assembly of durable synthetic polymer resulting in no metal-to-metal contact. Provide thrust washers at bearings for all dampers which are to be mounted with blades in the vertical position.
- H. Linkage: Linkage shall be installed in the frame side and shall be constructed of aluminum and/or corrosion resistant zinc plated steel.
- I. Leakage: Less than 3 CFM per square foot at 1 inch W.G. pressure differential at minus 40 deg F.
- J. Static Pressure Rating: As scheduled on the drawings, or if not scheduled, minimum 4 inches W.G.
- K. Maximum Velocity: As scheduled on the drawings, or design for maximum velocity to be encountered in location where installed.
- L. Temperature Limits: Minus 40 to 155 deg F.
- M. Manufacturers:
  1. Greenheck ICD-45.
  2. Ruskin CDTI-50BF.
  3. Tamco Series 9000 BF

2.14 DAMPER OPERATORS - ELECTRIC

- A. Electric damper motor shall be 24 or 120 volt two-position or modulating as required with spring return type and sized to operate the damper with sufficient reserve power for smooth operation from full close to full open and tight shut-off. Damper motor shall have "O ring" gaskets for weatherproof operation.
- B. Number: Sufficient to achieve unrestricted movement throughout damper range. Provide sufficient number of operators such that one operator does not operate more than the maximum square footage of damper area as recommended in standard catalog of manufacturer.
- C. Manufacturers:
  - 1. Belimo.
  - 2. Delta Control Products
  - 3. Andover Controls.

2.15 CONTROL PANELS

- A. Unitized cabinet type for each system under automatic control with DDC Controller and/or relays, devices, and related controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, pushbuttons and switches flush on cabinet panel face, or as detailed on drawings. Provide panel with locking door.
- B. ANSI/NEMA 250, general purpose utility enclosures with enameled finished face panel, or as indicated on the drawings.
- C. Panels shall be sized for a maximum fill of 50% capacity, and shall not be smaller than 24" X 24".

2.16 REFERENCE PROBE - DUCT STATIC PRESSURE

- A. Duct static pressure probe shall be capable of static pressure measurement with bi-directional flow in a duct, plenum or air handling unit. Probe shall have minimum 4" insertion depth, shall compensate for total pressure error, and shall provide an accurate, repeatable and stable static pressure value with a maximum flow of 4000 fpm.
- B. Probe shall be constructed of aluminum, with mounting flange suitable for round or flat duct surfaces. Probe shall have static pressure signal fitting.
- C. Manufacturers:
  - 1. MAMAC # A-520.
  - 2. Dwyer # A-305.
  - 3. Tek-Air # T-SPP 7100/7200.

2.17 REFERENCE PROBE - INDOOR STATIC PRESSURE

- A. Indoor pressure reference probe shall be a shielded static pressure sensor suitable for flush mounting in the ceiling, complete with multiple sensing ports, pressure impulse suppression

chamber, airflow shielding, control tubing take-off fitting, and brush finish on exposed surface. Probe shall be capable of sensing the static pressure in the proximity of the sensor to within 1% of the actual pressure value while being subjected to a maximum airflow of 1000 fpm from a radial source.

B. Manufacturers:

1. Air Monitor Corporation.
2. Tek-Air.

2.18 REFERENCE PROBE - OUTDOOR STATIC PRESSURE

A. Outdoor pressure reference probe shall be constructed of anodized aluminum, with control tubing take-off fitting, which shall be capable of sensing the outside ambient air pressure to within 2% of the actual value when subjected to radial wind velocities up to 80 miles per hour with approach angles up to 30 degrees to the horizontal.

B. Manufacturers:

1. Air Monitor Corporation.
2. Tek-Air.

2.19 THERMOSTATS – ELECTRONIC & ELECTRIC

A. Electric Low Limit Duct Thermostat (freezestat): Snap acting, auto-reset switch which trips if temperature sensed across any 12 inches of bulb length is equal to or below setpoint, fixed 5 deg F differential, range 30 deg F to 60 deg F, requiring minimum 20 feet length of bulb. Provide one thermostat for every 20 sq. ft. of coil surface. Switch shall be UL listed and rated for 10 amps at 120 VAC. Provide additional switch or contacts for connection to monitoring system.

B. Strap-on Aquastat: UL listed, with a suitable removable spring clip attaching aquastat to pipe and a snap-acting SPDT switch.

C. Low Voltage and Line Voltage Thermostats: Maximum deadband of 2 deg F, concealed temperature adjustment in public spaces, locking cover, rated for load, single-pole or two-pole as required. Provide with integral manual On/Off/Auto selector switch where indicated. Provide with locking covers when located in public areas.

D. Manufacturers:

1. Honeywell.
2. Schneider Electric Controls.
3. Johnson Controls.

2.20 EMERGENCY POWER-OFF (EPO) PUSH-BUTTON

A. ADA compliant, pushbutton switch with clear cover to prevent inadvertent closure. Push-to-activate button, two SPDT contacts rated 10 Amps at 120 VAC, and key to re-activate feature.

B. Manufacturers:

1. Safety Technology International – model SS-2212PO

## 2.21 LIMIT SWITCHES

- A. Oil tight type with operator as required providing required function. Limit switches used on dampers should be set at approximately 75% of full stroke.
- B. Manufacturers:
  1. Allen-Bradley.
  2. General Electric.
  3. Square D.
  4. Westinghouse.
  5. Micro-switch.

## 2.22 ELECTRICAL REQUIREMENTS FOR CONTROLS WORK

- A. Electrical accessories such as relays, switches, contactors and control transformers shall meet the requirements of the Division 26 Specifications of respective project.
- B. Electrical wiring and conduit shall meet the requirements of the Division 26 Specifications.
- C. All control wiring in mechanical rooms and any other exposed areas shall be run in conduit. Low voltage temperature control wiring in concealed accessible locations (i.e. above lay-in ceilings), as well as low voltage temperature control wiring within partitions, may be run using plenum rated cable, neatly tie-wrapped and fastened to the building structure (not to ceiling or ceiling support wires).
- D. Conduits carrying control wiring shall be sized for a maximum fill of 40% of capacity.
- E. Where raceway is required, two separate raceway systems shall be provided; one for A.C. wiring and the other for D.C. wiring.
- F. Data transmission cabling and equipment grounding procedures shall meet the latest FCC guidelines for electromagnetic field generation.
- G. All control wiring sizes and types shall meet or exceed the equipment manufacturer's recommendations.

## PART 3 - EXECUTION

### 3.1 INSTALLATION - CONTROL SYSTEMS

- A. Install in accordance with manufacturer's instructions.
- B. Check and verify location of temperature sensors and other exposed control sensors with plans and room details before installation. Locate room temperature sensors 48 inches above floor unless noted otherwise.
- C. The location of all control-related items to be mounted on the exterior of the building must be approved by the Architect prior to installation. Indicate proposed locations on the shop drawings.

- D. Caulk both sides of damper frames to duct walls to prevent leakage between damper frame and duct.
- E. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. Sensors used for closed loop control must be connected to the same DDC panel as the associated output signal.
- F. Provide conduit and electrical wiring where required.
- G. All wiring in altered and unaltered areas shall be run concealed. "Wiremold" in finished areas shall be allowed when wiring cannot be run concealed in walls or partitions. Minimize "wiremold" routing.
- H. Splicing of DDC sensor cabling at junction boxes shall not be acceptable.
- I. All equipment which has moving parts and is remotely started by the control system shall be provided with warning labels no less than 2 inches in height, and in bright warning color, stating that the equipment is remotely started by automatic controls. Such labels shall be posted clearly in the area of any moving parts, such as belts, fans, pumps, etc.
- J. Coil and conceal excess capillary on remote element instruments.
- K. Locate all control components and accessories such that they are easily accessible for adjustment, service and replacement.
- L. Locate, size, and support sensing elements in airstreams so that they properly sense the representative condition. Controlling, transmitting and indicating elements shall be located to sense the average condition. Safety elements shall be located to sense the extreme condition.
- M. Locate and size sensing elements in liquid lines so that they are in moving liquid and not in stagnant or turbulent locations. Wells shall not obstruct the flow of the liquid being measured. Pipes one inch and smaller shall be increased at least one pipe size at the point of insertion.
- N. Locate, support and install all control components and accessories so that they will not be subject to vibration, excessive temperatures, dirt, moisture or other harmful conditions beyond their rated limitations.
- O. Where insulation is penetrated due to the installation of sensing elements or tubing, reseal the openings air and vapor tight. Provide brackets for devices to be located on insulated surfaces so as to clear the finished surface of the insulation and to avoid puncturing the vapor seal.
- P. Provide all necessary relays, switches, linkages, control devices, accessories and connections as required for a complete and operational control system as specified herein and shown.
- Q. All electric valve and damper operators shall be capable of moving from full closed to full open, or vice versa, within 120 seconds.
- R. Flow meters shall be installed with at least 10 diameters of straight pipe length upstream and five diameters of straight pipe length downstream. Power supply to flow meters shall be 115 VAC from the auxiliary DDC panel, and power connection for each device shall be installed with a lockable local service disconnect. Flow meter transmitters/displays shall be mounted 4 feet above finished floor and shall be located at the DDC panel array unless the maximum available cable length is exceeded. All meter components, including sensors, shall be mounted in accessible locations.

### 3.2 TC CONTRACTOR DESIGN & INSTALLATION COORDINATION MEETINGS

- A. Temperature Controls Shop Drawing Pre-submittal Meeting: TC Contractor's option to schedule a meeting at the Engineer's Office to review project design documentation for clarification purposes to

aid in the TC Contractor development of TC/BAS shop drawings. For simple clarification items, TC Contractor may contact Engineer via telephone to discuss. For project scope questioning items, TC Contractor shall utilize the formal Request for Information (RFI) process.

- B. Temperature Controls Shop Drawing Submittal Meeting: Project Design Engineer's option to schedule a meeting at the Engineer's Office to review the TC Contractor's formally submitted drawings to address Engineer's comments and concerns that indicate TC Contractor's shop drawings vary from project design intent. This meeting can be avoided if TC Contractor's shop drawing submittal is complete and Engineer is confident that documents are going to lead to an installation that meets project design intent.
- C. Temperature Controls Installation Technician Meeting: Project Design Engineer's option to schedule a meeting at the project site to meet and discuss project expectations with the TC Contractor's field installation technician and/or project manager. Discussion may include
  - 1. Shop drawing review comments to ensure installation technician has the most up-to-date TC submittal.
  - 2. Graphics generation requirements including special Owner requirements and schedule for completion.
  - 3. Owner training agenda and scheduling.
  - 4. TC/BAS system acceptance procedures.

### 3.3 IDENTIFICATION AND MARKING

- A. All sensors, relays, switches, etc. shall be marked with the same identification number as used on the as-built shop drawings. Use Brother P-touch label maker or similar with black text on clear or white super adhesive tape. If label applied in wet environment, spray label with clear enamel for waterproofing.
- B. Wire shall be color coded according to functional use. Identify color coding format on record drawings.
- C. Identify each wire as to ID number at each control panel, field device, and splice.
- D. All control panels and auxiliary enclosures shall be supplied with engraved phenolic nameplate permanently attached identifying it as control panel number, system served, area served, fed from receptacle panel number, circuit number, etc.
- E. Temperature control conduit and junction box covers shall be painted Andover INFINET "orange" to signify that it is used for temperature controls. All junction box covers shall be painted orange and the conduit shall be painted with an orange mark (approximately 6 inches long) every 36" to 48", and on both sides of all penetrations.

### 3.4 GRAPHIC DISPLAY GENERATION

- A. Provide the following graphic displays as a minimum for operator interface to the networked systems, arranged in logical penetration paths. Modify, copy, or expand the existing graphics associated with building as required to allow operator interface to newly installed equipment. Remove graphics associated with equipment that may have been eliminated with project scope of work:
  - 1. Floor plans for each floor within each building, with display of present values of space conditions sensed by connected space sensors, display of the name of the air handler

associated with each space sensor, display of the room number in which the sensor is located and color coding to indicate whether the sensed space condition is within the acceptable range, is too high, or is too low. TC Contractor shall confirm Owner desired room names prior to graphics generation which may differ from the room names indicated on construction documents.

2. Schematic diagram for each HVAC system. Each system schematic display shall include at least the following:
  - a. Schematic arrangement of ductwork, fans, dampers, coils, valves, piping, pumps, equipment etc.
  - b. System name.
  - c. Area served.
  - d. Present value or status of all inputs, along with present setpoint.
  - e. Present percent open for each damper, valve, etc. based on commanded position.
  - f. Reset schedule parameters for all points, where applicable.
  - g. Present occupancy mode.
  - h. Present economizer mode, where applicable.
  - i. Present outside air temperature.
  - j. Associated space conditions and setpoints, where applicable.
  - k. Status of application programs (e.g., warm-up, night cycle, duty cycle, etc.).
  - l. Color coding to indicate normal and abnormal values, alarms, etc.
3. Manual override capability for each on/off or open/closed controlled digital output (for fans, pumps, 2-position dampers and valves, etc.) and each modulating analog output (for dampers, valves, VFD speed modulation type points, etc.) shall be provided. Graphic display of output point auto or manual override status shall be provided.
4. Sequence of operation in written (text) format for each HVAC system.
5. Overall BAS system schematic.
6. System management graphic for each network device and/or DDC panel.

### 3.5 OWNER INSTRUCTION AND TRAINING

- A. Provide a minimum of twenty-four (24) hours of on-site instruction and training to the Owner on the operation of the control systems for the initial installation. Instruction and training hours shall not include travel time to and from the site.
- B. Instruction and training shall be performed by a competent Contractor representative familiar with the control systems operation, maintenance and calibration.
- C. Training shall take place after check, test, start-up of temperature controls system at a time mutually agreed upon by the Owner and Contractor.

### 3.6 CALIBRATION AND START-UP

- A. After installation and connection of control components, test, adjust and re-adjust as required all control components in terms of function, design, systems balance and performance. Make systems ready for environmental equipment acceptance tests.
- B. After environmental equipment has been accepted and after the systems have operated in normal service for two weeks, check the adjustment on control components and recalibrate where required. Components not in calibration shall be recalibrated to function as required, or shall be replaced. Control devices, linkages, and other control components shall be calibrated and adjusted for stable



and accurate operation in accordance with the design intent and to obtain optimum performance from the equipment controlled. Cause every device to automatically operate as intended to ensure its proper functionality.

3.7 ACCEPTANCE PROCEDURE

- A. Upon successful completion of start-up and recalibration as indicated in this section, the Architect shall be requested in writing to inspect the satisfactory operation of the control systems.
- B. Demonstrate operation of all control systems, including each individual component, to the Owner and Architect.
- C. After correcting all items appearing on the punch list, make a second written request to the Owner and Architect for inspection and approval.
- D. After all items on the punch list are corrected and formal approval of the control systems is provided by the Architect, the Contractor shall indicate to the Owner in writing the commencement of the warranty period.

**\*\*END OF SECTION\*\***

## FUEL GAS PIPING

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 20 Section "Mechanical General Requirements."
  - 2. Division 20 Section "Basic Mechanical Materials and Methods."

#### 1.2 SUMMARY

- A. This Section includes facility fuel gas piping.

#### 1.3 DEFINITIONS

- A. Gas Main: Utility's natural gas piping.
- B. Gas Distribution: Piping from gas main to individual service-meter assemblies.

- C. Service-Meter Assembly: Piping, valves, service meter, and specialties.
- D. Point of Delivery: Piping outlet from service-meter assembly.
- E. Fuel Gas Piping: Piping that conveys fuel gas from point of delivery to fuel gas utilization devices inside the building.
- F. PE: Polyethylene.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
  - 1. Piping and Valves: Performance requirements are scheduled on the Drawings.
  - 2. Exception: Fuel Gas Piping Installed within Ceilings Used as Plenums: 150 psig.

#### 1.5 SYSTEMS DESCRIPTIONS

#### 1.6 SUBMITTALS

- A. Product Data: For the following:
  - 1. Specialty valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
  - 2. Pressure regulators. Include pressure rating, capacity, and settings of selected models.
- B. Welding certificates.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For natural gas specialties and accessories to include in operation and maintenance manuals.

#### 1.7 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Electrical Components and Devices: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
- C. NFPA Standard: Comply with NFPA 54, "National Fuel Gas Code."

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and legally dispose of liquids from drips in existing gas piping. Handle cautiously to avoid spillage and ignition. Notify fuel gas supplier. Handle flammable liquids used by Installer with proper precautions and do not leave on premises from end of one day to beginning of next day.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

- D. Protect stored PE pipes and valves from direct sunlight.

#### 1.9 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Gas System Pressure: Not more than 5.0 psig.
- C. Design values of fuel gas supplied for these systems are as follows:
  - 1. Nominal Heating Value: 1000 Btu/cu. ft.
  - 2. Nominal Specific Gravity: 0.6.

#### 1.10 COORDINATION

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
  - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without Architect's written permission.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- C. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

### 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 BLACK STEEL PIPE AND FITTINGS

- A. Black Steel Pipe: ASTM A 53/A 53M; Type E or S; Grade B; Schedule 40. Wall thickness of wrought-steel pipe shall comply with ASME B36.10M.
  - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
  - 2. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
  - 3. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.
  - 4. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.

5. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
6. Joint Compound and Tape: Suitable for natural gas.
7. Steel Flanges and Flanged Fittings: ASME B16.5.
8. Gasket Material: Thickness, material, and type suitable for natural gas.

## 2.3 PIPING SPECIALTIES

- A. Flexible Connectors: ANSI Z21.24, copper alloy.
- B. Quick-Disconnect Devices: ANSI Z21.41, convenience outlets and matching plug connector.
- C. Y-Pattern Strainers:
  1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
  2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
  3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
  4. CWP Rating: 125 psig.
- D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

## 2.4 JOINING MATERIALS

- A. Refer to Division 20 Section "Basic Mechanical Materials and Methods."

## 2.5 SPECIALTY VALVES

- A. Valves, NPS 3 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
- B. Valves, NPS 4 and Larger: Flanged ends according to ASME B16.5 for steel flanges.
- C. Gas Valves, NPS 3 and Smaller: Bronze or brass body with AGA or CSA stamp, UL listed or FM approved for service, ball type with chrome-plated brass ball and lever handle, or butterfly valve with stainless-steel disc and fluorocarbon elastomer seal and lever handle; 125-psig minimum pressure rating.
  1. Manufacturers:
    - a. Conbraco Industries, Inc.
    - b. Crane Valves.
    - c. Jomar International Ltd.
    - d. Legend Valve and Fitting, Inc.
    - e. Milwaukee Valve Company.
    - f. NIBCO INC.
    - g. Watts Water Technologies, Inc.; Watts Regulator Co.
  2. Tamperproof Feature: Include design for locking.
- D. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

1. Manufacturers:
  - a. Flowserve Nordstrom.
  - b. Homestead Valve; a division of Olson Technologies, Inc.
  - c. Milliken Valve Company.
  - d. R&M Energy Systems, A Unit of Robbins & Myers, Inc.; Resun.
2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Operator: Square head or lug type with tamperproof feature where indicated.
7. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.
8. Pressure Class: 125 psig.

### PART 3 - EXECUTION

#### 3.1 EXCAVATION

- A. Refer to Division 31 Section "Earthwork" for excavating, trenching, and backfilling.

#### 3.2 EXAMINATION

- A. Examine roughing-in for fuel gas piping system to verify actual locations of piping connections before equipment installation.
  1. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.3 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to NFPA 54 the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with NFPA 54 the International Fuel Gas Code requirements for prevention of accidental ignition.

#### 3.4 SERVICE-METER ASSEMBLY INSTALLATION

- A. Include gas valve or plug valve, strainer, and service meter for each assembly.
- B. Install gas valve or plug valve and strainer upstream from each service pressure regulator.
- C. Install service pressure regulators with vent outlet turned down and with corrosion-resistant-metal insect screen.
- D. Install pressure gage upstream and downstream from each service pressure regulator. Pressure gages are specified in Division 20 Section "Meters and Gages."

- E. Install service meters downstream from service pressure regulators.
  - 1. Service meters with connections larger than NPS 1 supported from piping or set on concrete bases.

### 3.5 SERVICE ENTRANCE PIPING

- A. Extend fuel gas piping and connect to fuel gas distribution for service entrance to building.
  - 1. Exterior fuel gas distribution system piping, service pressure regulator, and service meter will be provided by gas utility.
  - 2. Refer to Article entitled "Codes, Permits and Fees" in Division 20 Section "Mechanical General Requirements" for additional requirements.
- B. Install dielectric fitting downstream from and adjacent to each service meter unless meter is supported from service-meter bar with integral dielectric fitting. Install shutoff valve downstream from and adjacent to dielectric fitting. Dielectric fittings are specified in Division 20 Section "Basic Mechanical Materials and Methods."

### 3.6 PIPING SYSTEM INSTALLATION

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Basic piping installation requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."
- D. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels, unless indicated to be exposed to view.
- E. Concealed Locations:
  - 1. Above Inaccessible Ceiling Locations: Gas piping with welded joints may be installed in inaccessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves or unions above inaccessible ceilings.
  - 2. Above Accessible Ceiling Locations: Gas piping with welded joints may be installed in accessible ceiling spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves or unions above ceilings used as plenums.
  - 3. In Floor Channels: Gas piping may be installed in floor channels, subject to approval of authorities having jurisdiction. Channels must have cover and be open to space above cover for ventilation.
  - 4. Underground Beneath Building: Gas piping may be installed in protective conduit in accordance with Chapter "Gas Piping Installations" in the International Fuel Gas Code.
  - 5. In Partitions: Do not install concealed piping in solid partitions, unless installed in a chase or casing.
    - a. Exception: Piping passing through partitions or walls.

6. In Walls: Gas piping with welded joints and protective wrapping specified in Part 2 "Protective Coating" Article may be installed in masonry walls, subject to approval of authorities having jurisdiction.
  7. Prohibited Locations: Do not install gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
- F. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing.
1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.
- G. Install fuel gas piping at uniform grade of 0.1 percent slope upward toward risers.
- H. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- I. Connect branch piping from top or side of horizontal piping.
- J. Install strainer on inlet of each automatic and electrically operated valve.
- K. Install pressure gage upstream and downstream from each line pressure regulator. Pressure gages are specified in Division 20 Section "Meters and Gages."
- L. Locate valves for easy access.
- M. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.
- N. Install flanges when connecting to valves, specialties, and equipment having NPS 2-1/2 and larger connections.
- O. Install gas valve or plug valve and strainer upstream from each line pressure regulator or appliance pressure regulator.
- P. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.
- Q. Install containment conduits for gas piping below slabs, within building, in gastight conduits extending minimum of 4 inches outside building, and vented to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end. Prepare and paint outside of conduits with coal-tar, epoxy-polyamide paint according to SSPC-Paint 16.
- 3.7 JOINT CONSTRUCTION
- A. Basic piping joint construction is specified in Division 20 Section "Basic Mechanical Materials and Methods."
  - B. Use materials suitable for fuel gas.
  - C. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.



3.8 HANGER AND SUPPORT INSTALLATION

- A. Pipe hanger and support and equipment support materials and installation requirements are specified in Division 20 Section "Hangers and Supports."
- B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
  - 1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
  - 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
  - 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
  - 4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
  - 5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.
- C. Support vertical steel pipe at each floor and at spacing not greater than 15 feet.

3.9 CONNECTIONS

- A. Drawings indicate general arrangement of fuel gas piping, fittings, and specialties.
- B. Install piping adjacent to appliances to allow service and maintenance.
- C. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 72 inches of each appliance. Install union downstream from valve.
- D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance using gas.

3.10 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each service meter, pressure regulator, and specialty valve.
  - 1. Text: In addition to name of identified unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
  - 2. Nameplates, pipe identification, and signs are specified in Division 20 Section "Mechanical Identification."
  - 3. Trace Wire: Yellow insulated, minimum 18 AWG wire, having copper or other approved conductor, with insulation suitable for direct burial, installed adjacent to underground nonmetallic piping, with aboveground access to tracer wire at each end of pipe.

3.11 PAINTING

- A. Use materials and procedures in Division 09 painting Sections.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
  - 1. Alkyd System: MPI EXT 5.1D.

- a. Prime Coat: Alkyd anticorrosive metal primer.
    - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
    - c. Topcoat: Exterior alkyd enamel (semigloss).
    - d. Color: Gray.
  - C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.
- 3.12 FIELD QUALITY CONTROL
- A. Perform tests and inspections.
  - B. Tests and Inspections:
    - 1. Test, inspect, and purge natural gas according to NFPA 54 the International Fuel Gas Code and authorities having jurisdiction.
  - C. Additional Testing: Subject welded fuel gas piping installed within ceiling spaces used as plenums to test pressure of 150 psig for a minimum of 2 hours.
  - D. Natural-gas piping will be considered defective if it does not pass tests and inspections.
  - E. Prepare test and inspection reports.

**\*\*END OF SECTION\*\***

## HYDRONIC PIPING

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  1. Division 07 Section "Through-Penetration Firestop Systems" for materials and methods for sealing pipe penetrations through fire and smoke barriers.
  2. Division 07 Section "Joint Sealants" for materials and methods for sealing pipe penetrations through exterior walls.
  3. Division 20 Section "Mechanical General Requirements."
  4. Division 20 Section "Basic Mechanical Materials and Methods" for general piping materials and installation requirements.
  5. Division 20 Section "Hangers and Supports" for pipe supports, product descriptions, and installation requirements. Hanger and support spacing is specified in this Section.

6. Division 20 Section "Pipe Flexible Connectors, Expansion Fittings and Loops."
7. Division 20 Section "Meters and Gages" for thermometers, flow meters, flow measuring devices, and pressure gages.
8. Division 20 Section "Mechanical Identification" for labeling and identifying hydronic piping.
9. Division 23 Section "General-Duty Valves for HVAC" for general-duty gate, globe, ball, butterfly, and check valves.
10. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.
11. Division 23 Section "Temperature Controls" for temperature-control valves and sensors.
12. Division 23 Section "Piping Systems Flushing and Chemical Cleaning."
13. Division 23 Section "HVAC Water Treatment."
14. Division 33 Section "Underground Hydronic Distribution Piping" for preinsulated piping systems.

## 1.2 DEFINITIONS

- A. CPVC: Chlorinated polyvinyl chloride.
- B. HDPE: High density polyethylene.
- C. PP: Polypropylene.
- D. PVC: Polyvinyl chloride.
- E. PTFE: Polytetrafluoroethylene.
- F. RTRF: Reinforced thermosetting resin (fiberglass) fittings.
- G. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

## 1.3 PERFORMANCE REQUIREMENTS

- A. Where not indicated on the Drawings, hydronic piping components and installation shall be capable of withstanding the following minimum working pressures and temperatures:
  1. Hot-Water Heating Piping: 125 psig at 200 deg F.
  2. High Temperature Heating Hot Water Piping: 300 psig at 350 deg F.
  3. Chilled-Water Piping: 125 psig at 200 deg F.
  4. Dual-Temperature Heating and Cooling Water Piping: 125 psig at 200 deg F
  5. Heat Pump Loop Piping: 125 psig at 150 deg F.
  6. Condenser-Water Piping: 125 psig at 150 deg F.

7. Glycol Cooling-Water Piping: 125 psig at 150 deg F.
8. Engine Cooling Water Piping: 125 psig at 150 deg F.
9. Condensate-Drain Piping: 150 deg F.
10. Blowdown-Drain Piping: 200 deg F.
11. Air-Vent Piping: 200 deg F.
12. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

#### 1.4 SYSTEMS DESCRIPTIONS

- A. Hydronic piping system materials are scheduled on the Drawings.
- B. Refer to Application Schedule on the Drawings for valve types to be used. Where specific valve types are not indicated, the following requirements apply:
  1. Hot-Water-Piping, Balancing Duty: Calibrated balancing valves.
  2. Drain Duty: Hose-end drain valves.

#### 1.5 SUBMITTALS

- A. Product Data: For each type of the following:
  1. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
  2. Air control devices.
  3. Chemical treatment.
  4. Hydronic specialties.
  5. Plastic pipe and fittings with solvent cement.
- B. Shop Drawings: Detail, at minimum 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
- C. Qualification Data: For Installer.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in operation and maintenance manuals.
- F. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.6 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- B. Installer Qualifications:
  - 1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
- C. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be as recommended by the manufacturer of the grooved components.

1.7 EXTRA MATERIALS

- A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.
- B. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- C. DWV Copper Tubing: ASTM B 306, Type DWV.
- D. Wrought-Copper Socket Fittings: ASME B16.22.
- E. Wrought-Copper Unions: ASME B16.22.
- F. Grooved Mechanical-Joint Fittings and Couplings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anvil International, Inc.; Gruvlok Manufacturing; Advanced Copper Method.
    - b. Tyco Fire & Building Products; Grinnell Mechanical Products; Model 672.
    - c. Victaulic Company; Style 606 and Style 607.
  - 2. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
  - 3. Grooved-End-Tube Couplings: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, prelubricated EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.
- G. Copper or Bronze Pressure-Seal Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Apollo Valves; by Conbraco Industries; ApolloXpress.
    - b. Elkhart Products Corporation; an Aalberts Industries Company; Xpress.
    - c. NIBCO Inc.; Press System.
    - d. Viega North America; ProPress System.
  2. Housing: Copper.
  3. O-Rings and Pipe Stops: EPDM.
  4. Tools: Manufacturer's special tools.
  5. Maximum 200-psig working-pressure rating at 250 deg F.
- H. Copper, Mechanically Formed Tee Option: For forming T-branch on copper water tube. Mechanically formed tee fittings may be used up to half size of main.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. T-DRILL Industries Inc.

## 2.2 STEEL PIPE AND FITTINGS

- A. Schedule 40 Steel Pipe: ASTM A 53/A 53M or ASTM A 106, Type E or S, Grade A or B. Include ends matching joining method.
1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
  2. Malleable-Iron Unions: ASME B16.39, Class 150, hexagonal-stock body, with ball-and-socket, metal-to-metal, bronze seating surface and female threaded ends.
  3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.
  4. Cast-Iron Flanges: ASME B16.1, Class 125.
  5. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125.
  6. Fittings: ASTM A234 ANSI B16.9, steel butt weld to match pipe wall thickness, Class 300.
  7. Flanges: Class 300 forged steel welding neck to match pipe wall thickness and valve flanges, ANSI B16.5. Orifice plate flanges shall be raised face welding neck type with ring joint gaskets and flange taps. Coordinate orifice plate flanges with orifice plate flow elements.

## 2.3 JOINING MATERIALS

- A. Refer to Division 20 Section "Basic Mechanical Materials and Methods."

2.4 TRANSITION FITTINGS

A. HDPE Plastic-to-Grooved Steel Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Anvil International, Inc.; Gruvlok Manufacturing; Fig. 7307.
  - b. Victaulic Company; Style 997.
2. Ductile iron coupling with integral rows of gripping teeth on the HDPE side of the coupling and conventional key section on grooved side designed to engage standard roll or cut grooved steel pipe.

B. HDPE Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Anvil International, Inc.; Gruvlok Manufacturing; Fig. 7312.
  - b. Victaulic Company; Style 994 Vic-Flange.
2. Ductile iron flange adapter having integral gasket and designed to permit direct connection of ANSI Class 125 and 150 steel or bronze flanged components into HDPE systems.

2.5 VALVES

- A. General Service Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC."

2.6 SPECIALTY VALVES

A. Balance Valves:

1. Balance Valves NPS 6 and Larger: Lug type butterfly valves with aluminum bronze disc, AISI 300 Series stainless steel stem, resilient replaceable seat for service at not less than 250 deg F and memory stops. Refer to Division 23 Section "General-Duty Valves for HVAC" for additional requirements.
  - a. Provide lubricated enclosed screw or worm gear operator with handwheel for sizes 6 inches and larger.
  - b. Pressure rating shall meet or exceed system minimum pressure rating.
2. Flow Measuring: Use Flow Measuring Devices as specified in Division 20 Section "Meters and Gages."
3. Balance Valves for Sizes Less than NPS 6 Combination balance valve and flow measuring device as specified in this Section.

B. Combination, Balancing Valves and Flow Measuring Devices NPS 2 and Smaller:

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



- a. Griswold Controls.
    - b. Hydronic Components, Inc. (HCi).
    - c. Nexus Valve.
    - d. PRO Hydronic Specialties, LLC.
    - e. Tour & Andersson; TA Hydronics Series available through Victaulic Company of America.
  2. Body: Brass or bronze, ball, or plug type with calibrated orifice or venturi.
  3. Ball: Brass, or stainless steel.
  4. Plug: Resin.
  5. Seat: PTFE.
  6. End Connections: Threaded or socket.
  7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
  8. Handle Style: Lever, with memory stop to retain set position.
  9. WOG Rating: Minimum 400 psig.
  10. Maximum Operating Temperature: 250 deg F.
- C. Combination, Balancing Valves and Flow Measuring Devices NPS 2-1/2 through NSP 4:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Griswold Controls.
    - b. Hydronic Components, Inc. (HCi).
    - c. Nexus Valve.
    - d. PRO Hydronic Specialties, LLC.
    - e. Tour & Andersson; TA Hydronics Series available through Victaulic Company of America.
  2. Body: Cast-iron or steel body, ball, plug, or butterfly pattern with calibrated orifice or venturi.
  3. Stem Seals: EPDM O-rings.
  4. Disc: Glass and carbon-filled PTFE.
  5. Seat: PTFE.
  6. End Connections: Flanged or grooved.
  7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
  8. Handle Style: Lever, with memory stop to retain set position.
  9. WOG Rating: Minimum 200 psig.

10. Maximum Operating Temperature: 225 deg F.
- D. Contractor Option for Combination, Balancing Valves and Flow Measuring Devices NPS 2 and Smaller: Preassembled coil hook up kits may be used.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Griswold Controls.
    - b. Hydronic Components, Inc. (HCi).
    - c. Nexus Valve.
    - d. PRO Hydronic Specialties, LLC.
    - e. Tour & Andersson; TA Hydronics Series available through Victaulic Company of America.
- E. Diaphragm-Operated, Pressure-Reducing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Amtrol, Inc.
    - b. Armstrong Pumps, Inc.
    - c. Apollo Valves; by Conbraco Industries, Inc.
    - d. Bell & Gossett; Xylem Inc.
    - e. Spence Engineering Company, Inc.
    - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  2. Body: Bronze or brass.
  3. Disc: Glass and carbon-filled PTFE.
  4. Seat: Brass.
  5. Stem Seals: EPDM O-rings.
  6. Diaphragm: EPT.
  7. Low inlet-pressure check valve.
  8. Valve Seat and Stem: Noncorrosive.
  9. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
- F. Diaphragm-Operated Safety Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Amtrol, Inc.
    - b. Anderson Greenwood & Co.; Kunkle Valve Division.
    - c. Armstrong Pumps, Inc.
    - d. Apollo Valves; by Conbraco Industries, Inc.
    - e. Bell & Gossett; Xylem Inc.
    - f. Spence Engineering Company, Inc.

- g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - 2. Body: Bronze or brass.
  - 3. Disc: Glass and carbon-filled PTFE.
  - 4. Seat: Brass.
  - 5. Stem Seals: EPDM O-rings.
  - 6. Diaphragm: EPT.
  - 7. Wetted, Internal Work Parts: Brass and rubber.
  - 8. Valve Seat and Stem: Noncorrosive.
  - 9. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
- G. Automatic Flow-Control Valves:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Griswold Controls.
    - b. PRO Hydronic Specialties, LLC.
  - 2. Body: Brass or ferrous metal.
  - 3. Piston and Spring Assembly: Stainless steel, tamper proof, self cleaning, and removable.
  - 4. Combination Assemblies: Include bronze or brass-alloy ball valve.
  - 5. Identification Tag: Marked with zone identification, valve number, and flow rate.
  - 6. Size: Same as pipe in which installed.
  - 7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
  - 8. Minimum Pressure Rating: 300 psig.
  - 9. Maximum Operating Temperature: 250 deg F.

## 2.7 CONTROL VALVES

- A. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Temperature Controls."
- B. Calibrated orifice balancing valves shall not be required on devices where pressure independent characterized control valves (PICCV's) are installed.

2.8 AIR CONTROL DEVICES

A. Manual Air Vents: Use ball-valve-type hose-end drain valves, refer to Division 20 Section "Valves."

B. Automatic Air Vents:

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

C. Diaphragm-Type Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Amtrol, Inc.
  - b. Armstrong Pumps, Inc.
  - c. Bell & Gossett; Xylem Inc.
  - d. Taco, Inc.
2. Tank: Welded steel, rated for 125-psig working pressure and 240 deg F maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Diaphragm: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

D. Combination Air and Dirt Separators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Spirotherm, Inc.; VDN Series.

2. Body: Fabricated steel; constructed for 150-psig maximum working pressure and 250 deg F maximum operating temperature. Separator shall have body extended below pipe connections for dirt separation and include removable lower head.
3. Air and Dirt Separation Mechanism: Internal copper core tube with continuous wound copper medium permanently attached followed by continuous wound copper wire permanently affixed.
4. Venting Chamber: With integral full port, float actuated brass venting mechanism. Include valved side tap to flush floating dirt or liquids and for quick bleeding of air during system fill.
5. Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
6. Blowdown Connection: Threaded.
7. Size: Match system flow capacity.

## 2.9 STEEL, HYDRONIC BUFFER TANKS

- A. Manufacturers:
  1. Adamson Global Technology Corporation.
  2. Armstrong Pumps, Inc.
  3. Cemline Corporation.
  4. Highland Tank & Mfg. Co.
  5. Taco, Inc.
- B. Description: Steel, vertical pressure-rated tank with cylindrical sidewalls.
- C. Construction: ASME code, steel, constructed with nontoxic welded joints, for 125-psig working pressure, and internal baffle to prevent short circuiting.
- D. Connections and Tappings: Factory-fabricated steel, welded to tank before testing and labeling.
  1. NPS 2 and Smaller: ASME B1.20.1, with female thread.
  2. NPS 2-1/2 and Larger: ASME B16.5, flanged.
- E. Include connections and tappings for the following:
  1. Inlet.
  2. Outlet.
  3. Factory mounted air vent.
- F. Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank before testing and labeling.
- G. Exterior Coating: Primer paint and factory installed 1/2-inch thick elastomeric thermal insulation.

## 2.10 HYDRONIC PIPING SPECIALTIES

- A. Diverting Fittings: 125-psig working pressure; 250 deg F maximum operating temperature; cast-iron body with threaded ends, or wrought copper with soldered ends. Indicate flow direction on fitting.
- B. Flexible connectors and expansion fittings are specified in Division 20 Section "Pipe Flexible Connectors, Expansion Fittings and Loops."

2.11 HYDRONIC PIPING STRAINERS

A. Manufacturers:

1. Keckley.
2. Metraflex.
3. Mueller Steam Specialty.
4. Nibco, Inc.
5. Spence.
6. Sure Flow Equipment Inc.
7. Watts Water Technologies, Inc.
8. Yarway.
9. Anvil International, Inc.; Gruvlok Manufacturing (for grooved piping).
10. Tyco Fire & Building Products, Grinnell Mechanical Products (for grooved piping)
11. Victaulic Company; (for grooved piping).

B. Y-Pattern Strainers, Bronze:

1. CWP: 200 psig minimum, unless otherwise indicated.
2. SWP: 125 psig minimum, unless otherwise indicated.
3. Body: Bronze for NPS 2 and smaller.
4. End Connections: Threaded or soldered.
5. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
6. Drain:
  - a. Pipe plug for sizes NPS 2 and smaller.
  - b. Factory-installed, hose-end drain valve for sizes NPS 2-1/2 and larger.

C. Y-Pattern Strainers, Cast and Ductile Iron:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger; grooved ends may be used on grooved piping.
3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

4. CWP: 200 psig minimum, unless otherwise indicated.
5. SWP: 125 psig minimum, unless otherwise indicated.
6. Drain:
  - a. Pipe plug for sizes NPS 2 and smaller.
  - b. Factory-installed, hose-end drain valve for sizes NPS 2-1/2 and larger.

D. Basket Strainers, Cast Iron:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP: 200 psig minimum, unless otherwise indicated.
5. SWP: 125 psig minimum, unless otherwise indicated.
6. Drain: Factory-installed, hose-end drain valve.

2.12 STAINLESS STEEL STRAINERS

A. Manufacturers:

1. Keckley.
2. Metraflex.
3. Mueller Steam Specialty.
4. Nibco, Inc.
5. Spence.
6. Sure Flow Equipment Inc.
7. Watts Water Technologies, Inc.
8. Yarway.

B. Y-Pattern Strainers:

1. Body: ASTM A 351, Type 316 stainless steel, with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.

3. Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.
4. Tapped blowoff plug.
5. SWP Rating: 250-psig steam working pressure.

C. Basket Strainers:

1. Body: ASTM A 351, Type 316 stainless steel, with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.
4. SWP Rating: 250-psig steam working pressure.

2.13 CHEMICAL TREATMENT

- A. Bypass Chemical Feeder: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.
  1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.
- B. Ethylene and Propylene Glycol: Industrial grade with corrosion inhibitors and environmental-stabilizer additives for mixing with water in systems indicated to contain antifreeze or glycol solutions.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.



SECTION 232113  
HYDRONIC  
PIPING

- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Install piping, other than drain piping, at a uniform grade of 0.2 percent upward in direction of flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install valves according to Division 23 Section "General-Duty Valves for HVAC."
- Q. 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.
- R. Install calibrated balancing valves in the return water line of each heating or cooling element and elsewhere as required to facilitate system balancing.
- S. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- T. 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.
- U. Install pressure-reducing valves on hot-water generators and elsewhere as required to regulate system pressure.
- V. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- W. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- X. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and where indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
- Y. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 20 Section "Pipe Flexible Connectors, Expansion Fittings and Loops."
- Z. Identify piping as specified in Division 20 Section "Mechanical Identification."

3.2 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 20 Section "Hangers and Supports." Comply with the following requirements for maximum spacing of supports.
- B. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
  - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
  - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
  - 4. Spring hangers to support vertical runs.
  - 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
  - 6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
  - 1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
  - 2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
  - 3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
  - 4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
  - 5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
  - 6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
  - 7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
  - 8. NPS 6: Maximum span, 17 feet; minimum rod size, 1/2 inch.
  - 9. NPS 8: Maximum span, 19 feet; minimum rod size, 5/8 inch.
  - 10. NPS 10: Maximum span, 20 feet; minimum rod size, 3/4 inch.
  - 11. NPS 12: Maximum span, 23 feet; minimum rod size, 7/8 inch.
  - 12. NPS 14: Maximum span, 25 feet; minimum rod size, 1 inch.
  - 13. NPS 16: Maximum span, 27 feet; minimum rod size, 1 inch.
  - 14. NPS 18: Maximum span, 28 feet; minimum rod size, 1-1/4 inches.
  - 15. NPS 20: Maximum span, 30 feet; minimum rod size, 1-1/4 inches.

- D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
7. NPS 4 to NPS 5: Maximum span, 10 feet minimum rod size, 1/2-inch.
8. NPS 6: Maximum span, 10 feet minimum rod size, 5/8-inch.
9. NPS 8: Maximum span, 10 feet minimum rod size, 3/4-inch.

- E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

### 3.3 PIPE JOINT CONSTRUCTION

- A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

### 3.4 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 at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.
- C. Glycol Systems:
1. Install automatic air vents on expansion tanks and install high capacity automatic air vents on air separators. Route vent piping to spill over glycol fill station.
  2. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- D. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
- E. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.
- F. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above the floor. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.

- G. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
  - 1. Install tank fittings that are shipped loose.
  - 2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.
- H. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

### 3.5 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 20 Section "Meters and Gages."

### 3.6 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
  - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
  - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
  - 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
  - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
  - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
  - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
  - 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
  - 3. Isolate expansion tanks and determine that hydronic system is full of water.
  - 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum

yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 2 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
  6. Prepare written report of testing.
- C. Perform the following before operating the system:
1. Open manual valves fully.
  2. Inspect pumps for proper rotation.
  3. Remove disposal fine-mesh strainers in pump suction diffusers.
  4. Set makeup pressure-reducing valves for required system pressure.
  5. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
  6. Set temperature controls so all coils are calling for full flow.
  7. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
  8. Verify lubrication of motors and bearings.

**\*\*END OF SECTION\*\***

## HYDRONIC PUMPS

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 20 Section "Mechanical General Requirements."
  - 2. Division 20 Section "Basic Mechanical Materials and Methods."

#### 1.2 DEFINITIONS

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

#### 1.3 SUBMITTALS

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

- C. Operation and Maintenance Data: For all pumps and accessories to include in Operation and Maintenance manuals.

#### 1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
- C. UL Compliance: Comply with UL 778 for motor-operated water pumps.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- B. Store pumps in dry location.
- C. Retain protective covers for flanges and protective coatings during storage.
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- E. Comply with pump manufacturer's written rigging instructions.

#### 1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

### PART 2 - PRODUCTS

#### 2.1 GENERAL PUMP REQUIREMENTS

- A. Pump Units: Factory assembled and tested.
- B. Motors: Comply with requirements in Division 20 Section "Motors".
- C. Selection:
  - 1. Base non-overloading characteristics for pumps upon nameplate horsepower, at any point on performance curve.
  - 2. Shaft first critical speed shall not be less than 25 percent greater than operating speed.
  - 3. Maximum impeller diameter shall not be greater than 90 percent of "cut water" diameter for a given casing and no smaller than the smallest published diameter for casing. Do not base acceptable maximum diameter calculation on percentage of impeller diameter range for a given casing.
  - 4. Pump speed shall be limited to 1800 RPM except as scheduled.
  - 5. Select at the point of maximum efficiency for a given impeller-casing combination. Deviations shall be within 3 percent of maximum efficiency on the increasing capacity side of the maximum efficiency point and 7 percent on the decreasing capacity side of the maximum efficiency point.

6. Select pump at a point no greater than 85 percent of end of curve flow.
7. Maximum pump suction velocity:
  - a. In-line: 12 fps.
  - b. End suction: 13 fps.
  - c. Double suction: 15 fps.

## 2.2 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.

## 2.3 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS (SMALL)

- A. Manufacturers:
  1. Armstrong Pumps Inc.
  2. Bell & Gossett; Xylem Inc.; Series PL.
  3. Grundfos Pumps Corporation.
  4. Taco, Inc.; Series 1400.
- B. Description: Factory-assembled and –tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; and designed for installation with pump and motor shafts mounted horizontally.
  1. Pump Construction: Bronze fitted.
    - a. Casing: Radially split, cast iron, with threaded companion-flange connections.
    - b. Impeller: Glass-reinforced corrosion-resistant material; keyed to shaft.
    - c. Shaft: High-strength alloy steel.
    - d. Seal: Mechanical, carbon/silicon carbide seal.
    - e. Bearings: Permanently oil-lubricated type.
  2. Motor-Single speed, with oil-lubricated bearings, unless otherwise indicated; and directly mounted to pump casing. Comply with requirements in Division 20 Section “Motors.”
- C. Capacities and Characteristics: Refer to Schedule on Drawings.

## 2.4 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

- A. Manufacturers:
  1. Armstrong Pumps Inc.; Series 4360 and 4380.
  2. Bell & Gossett; Xylem Inc.; Series 80.
  3. Grundfos Pumps Corporation.



4. Taco, Inc.; Series 1900, KV.

B. Description: Factory-assembled and tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and companion-flange connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
3. Pump Shaft: Steel with copper-alloy shaft sleeve, or stainless steel.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N seal for all glycol systems and all water systems 225 deg F and below; EPT seals for water systems above 225 deg F. Include water slinger on shaft between motor and seal.

D. Motor: Single speed, with permanently or grease lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing. Comply with requirements in Division 20 Section "Motors"

E. Capacities and Characteristics: Refer to Schedule on Drawings.

## 2.5 AUTOMATIC CONDENSATE PUMP UNITS

A. Manufacturers:

1. Little Giant Pump Co.; Subsidiary of Tecumseh Products Co.
2. Hydromatic Pump Company.

B. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve and a 72-inch- minimum, electrical power cord with plug.

## 2.6 AUTOMATIC CONDENSATE PUMP UNITS (PLENUM APPLICATIONS)

A. Manufacturers:

1. Hartell Pumps Div.; Milton Roy Co.; Model A2-X-1965.

B. Description: Packaged units with corrosion-resistant pump, dual-voltage thermally protected motor, cast aluminum tank with cover, and automatic controls. Include auxiliary safety switch and factory- or field-installed check valve.

## 2.7 PUMP SPECIALTY FITTINGS

A. Suction Diffuser: Angle pattern, minimum 175-psig pressure rating, cast-iron body and end cap for NPT or flanged connections or ductile iron body and end cap for grooved connections, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and integral locating boss for field-fabricated support.

1. Manufacturers:

- a. Armstrong Pumps, Inc.
- b. Bell & Gossett; Xylem Inc.
- c. Grundfos Pumps Corporation/PACO.
- d. Mueller Steam Specialty Company.
- e. Taco; Fabricated Products Division.
- f. Anvil International, Inc. (grooved only).
- g. Victaulic Co. of America (grooved only).

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

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

#### 3.2 PUMP INSTALLATION

- A. Comply with HI 1.4, HI 2.4.
- B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- D. Support in-line centrifugal pumps greater than 1/2 HP independent of piping. Use continuous-thread hanger rods and hangers of sufficient size to support pump weight. Do not support pump from motor housing plate.
- E. Refer to Division 20 Section "Mechanical Vibration Controls" for vibration isolation devices.
- F. Refer to Division 20 Section "Hangers and Supports" for hanger and support materials.
- G. Set base-mounted pumps on concrete bases. Disconnect flexible coupling before setting. Do not reconnect flexible couplings until alignment procedure is complete.
  - 1. Support pump baseplate on rectangular stainless steel blocks and shims, or on wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
  - 2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.
  - 3. Install pumps on inertia bases where required. Refer to Division 20 Section "Mechanical Vibration Controls" for vibration isolation devices.
- H. Automatic (Cooling Coil) Condensate Pump Units: Install units for collecting condensate and extend to open drain.

### 3.3 ALIGNMENT

- A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.
- B. Comply with pump and coupling manufacturers' written instructions.
- C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation HI 2.1-2.5, "Vertical Pumps for Nomenclature, Definitions, Application and Operation." Laser align to a tolerance of 0.0005 inches maximum.
- D. After alignment is correct, tighten foundation bolts evenly but not too firmly.
- E. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

### 3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- D. Install check valve and throttling valve on discharge side of pumps. Triple-duty valves are not allowed.
- E. Install Y-type strainer or suction diffuser and shutoff valve on suction side of pumps as indicated on drawings.
- F. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
- G. Install pressure gages on pump suction and discharge or at integral pressure-gageappings, or install single gage with multiple-input selector valve.
- H. Install check valve and gate or ball valve on each condensate pump unit discharge.
- I. Install electrical connections for power, controls, and devices.
- J. Ground equipment according to Division 26 Section "Grounding and Bonding."
- K. Connect wiring according to Division 26 Section "Conductors and Cables."

### 3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service for each pump supplied. Written report of the start-up shall be provided to the Owner and Engineer upon completion of services.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. Check piping connections for tightness.
  - 3. Clean strainers on suction piping.

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4. Perform the following startup checks for each pump before starting:
  - a. Verify bearing lubrication.
  - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
  - c. Verify that pump is rotating in the correct direction.
5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.6 DEMONSTRATION

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

**\*\*END OF SECTION\*\***

## REFRIGERANT PIPING

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  1. Division 07 Section "Roof Accessories" for roof curbs, piping supports, and roof penetration boots.
  2. Division 07 Section "Through-Penetration Firestop Systems" for materials and methods for sealing pipe penetrations through fire and smoke barriers.
  3. Division 07 Section "Joint Sealants" for materials and methods for sealing pipe penetrations through exterior walls.
  4. Division 20 Section "Mechanical General Requirements.
  5. Division 20 Section "Basic Mechanical Materials and Methods."
  6. Division 20 Section "Hangers and Supports" for pipe supports and installation requirements.
  7. Division 20 Section "Mechanical Identification" for labeling and identifying refrigerant piping.
  8. Division 20 Section "Meters and Gages" for thermometers and pressure gages.
  9. Division 23 Section "Temperature Controls" for thermostats, controllers, automatic-control valves, and sensors.

## 1.2 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant:
  - 1. Suction Lines for Air-Conditioning Applications: 300 psig.
  - 2. Suction Lines for Heat-Pump Applications: 535 psig.
  - 3. Hot-Gas and Liquid Lines: 535 psig.

## 1.3 SYSTEMS DESCRIPTIONS

- A. Suction Lines NPS 4 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.
- B. Hot-Gas and Liquid Lines NPS 4 and Smaller: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.
- C. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

## 1.4 SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
  - 1. Thermostatic expansion valves.
  - 2. Solenoid valves.
  - 3. Hot-gas bypass valves.
  - 4. Filter dryers.
  - 5. Strainers.
  - 6. Pressure-regulating valves.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
  - 1. Shop Drawing Scale: Minimum 1/4 inch equals 1 foot.
  - 2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."
- C. UL Standard: Provide products complying with UL 207, "Refrigerant-Containing Components and Accessories, Nonelectrical"; or UL 429, "Electrically Operated Valves."

1.6 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.7 COORDINATION

- A. Coordinate layout and installation of refrigerant 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 installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."
- D. Coordinate pipe sleeve installations for penetrations in exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 07 Section "Through-Penetration Firestop Systems" for materials and methods for sealing pipe penetrations through fire and smoke barriers.
- E. Coordinate pipe fitting pressure classes with products specified in related Sections.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 280, Type ACR.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.

2.2 VALVES AND SPECIALTIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Climate & Industrial Controls Group; Parker-Hannifin Corp.; Refrigeration & Air Conditioning Division.
  - 2. Danfoss Electronics, Inc.
  - 3. Emerson Electric Company; Alco Controls Div.
  - 4. Henry Valve Company.
  - 5. Sporlan Valve Company.

B. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

C. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

D. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.



9. Maximum Operating Temperature: 275 deg F.
- E. Service Valves:
1. Body: Forged brass with brass cap including key end to remove core.
  2. Core: Removable ball-type check valve with stainless-steel spring.
  3. Seat: Polytetrafluoroethylene.
  4. End Connections: Copper spring.
  5. Working Pressure Rating: 500 psig.
- F. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by an NRTL.
1. Body and Bonnet: Plated steel.
  2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
  3. Seat: Polytetrafluoroethylene.
  4. End Connections: Threaded.
  5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
  6. Working Pressure Rating: 400 psig.
  7. Maximum Operating Temperature: 240 deg F.
  8. Manual operator.
- G. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
  2. Screen: 100-mesh stainless steel.
  3. End Connections: Socket or flare.
  4. Working Pressure Rating: 500 psig.
  5. Maximum Operating Temperature: 275 deg F.
- H. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
  2. Drain Plug: Brass hex plug.
  3. Screen: 100-mesh monel.
  4. End Connections: Socket or flare.

- 5. Working Pressure Rating: 500 psig.
- 6. Maximum Operating Temperature: 275 deg F.

### PART 3 - EXECUTION

#### 3.1 PIPING SYSTEM INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Refer to Division 23 Section "Temperature Controls" and Sequence of Operation on the Drawings for solenoid valve controllers, control wiring, and sequence of operation.
- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
- M. Install refrigerant piping in protective conduit where installed belowground.
- N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- O. Slope refrigerant piping as follows:
  - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
  - 2. Install horizontal suction lines with a uniform slope downward to compressor.
  - 3. Install traps and double risers to entrain oil in vertical runs.
  - 4. Liquid lines may be installed level.

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- P. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- Q. Install pipe sleeves at penetrations in exterior walls and floor assemblies.
- R. Seal penetrations through fire and smoke barriers according to Division 07 Section "Through-Penetration Firestop Systems."
- S. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- T. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
- U. Seal pipe penetrations through exterior walls according to Division 07 Section "Joint Sealants" for materials and methods.
- V. Identify refrigerant piping and valves according to Division 20 Section "Mechanical Identification."

3.2 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube." Brazing filler metals are specified in Division 20 Section "Basic Mechanical Materials and Methods."
- D. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 VALVE AND SPECIALTY INSTALLATION

- A. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- B. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
  - 1. Solenoid valves.
  - 2. Thermostatic expansion valves.
  - 3. Hot-gas bypass valves.
  - 4. Compressor.

3.4 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor products are specified in Division 20 Section "Hangers and Supports."
- B. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.

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2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
  3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
  4. Spring hangers to support vertical runs.
  5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
1. NPS 3/4, and soft copper tubing: Continuous support v-shaped plastic pipe channel, maximum hanger spacing 8 feet.
  2. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
  3. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
  4. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
  5. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
  6. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
  7. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
  8. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.
- D. Support multifloor vertical runs at least at each floor.
- 3.5 FIELD QUALITY CONTROL
- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
1. Comply with ASME B31.5, Chapter VI.
  2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
  3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
    - a. Fill system with nitrogen to the required test pressure.
    - b. System shall maintain test pressure at the manifold gage throughout duration of test.
    - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.6 SYSTEM CHARGING

- A. Charge system using the following procedures:
  - 1. Install core in filter dryers after leak test but before evacuation.
  - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
  - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
  - 4. Charge system with a new filter-dryer core in charging line.

3.7 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
  - 1. Open shutoff valves in condenser water circuit.
  - 2. Verify that compressor oil level is correct.
  - 3. Open compressor suction and discharge valves.
  - 4. Open refrigerant valves except bypass valves that are used for other purposes.
  - 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

**\*\*END OF SECTION\*\***

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 20 Section "Mechanical General Requirements."
  - 2. Division 20 Section "Basic Mechanical Materials and Methods."
  - 3. Division 23 Section "Piping Systems Flushing and Chemical Cleaning."

#### 1.2 DEFINITIONS

- A. CPVC: Chlorinated Polyvinyl Chloride.
- B. EEPROM: Electrically erasable, programmable read-only memory.
- C. EPDM: Ethylene-propylene-diene monomer.
- D. FMP: Fluoroelastomer.
- E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- F. MDA: Michigan Department of Agriculture.
- G. RO: Reverse osmosis.

- H. TDS: Total dissolved solids.
- I. PTFE: Polytetrafluoroethylene.
- J. UV: Ultraviolet.

### 1.3 PERFORMANCE REQUIREMENTS

- A. Furnish the services of a firm specializing in hydronic piping system water treatment work.
  - 1. This firm shall furnish and administer glycol for systems using glycol/water mix.
- B. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.
- C. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
- D. Closed, chilled water systems shall have the following water qualities:
  - 1. pH: Maintain a value within 9.0 to 10.5.
  - 2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
  - 3. Boron: Maintain a value within 100 to 200 ppm.
  - 4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
  - 5. Soluble Copper: Maintain a maximum value of 0.20 Insert number ppm.
  - 6. TDS: Maintain a maximum value of 5000 mmhos.
  - 7. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
  - 8. Microbiological Limits:
    - a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
    - b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
    - c. Ammonia: Maintain a maximum value of 20 ppm.
    - d. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
    - e. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
    - f. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.
- E. Closed hot-water heating systems with aluminum boilers shall have the following water qualities:
  - 1. pH: Maintain a value within 6.5 to 8.5, or as recommended by boiler manufacturer.
  - 2. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
  - 3. Soluble Copper: Maintain a maximum value of 0.20 Insert number ppm.
  - 4. TDS: Maintain a maximum value of 5000 mmhos.

5. Microbiological Limits:
- a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
  - b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
  - c. Ammonia: Maintain a maximum value of 20 ppm.
  - d. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
  - e. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
  - f. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

F. Passivation for Galvanized Steel: For the first 60 days of operation.

- 1. pH: Maintain a value within 7 to 8.
- 2. Calcium Carbonate Hardness: Maintain a value within 100 to 300 ppm.
- 3. Calcium Carbonate Alkalinity: Maintain a value within 100 to 300 ppm.

#### 1.4 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:

- 1. Bypass feeders.
- 2. Water meters.
- 3. Inhibitor injection timers.
- 4. pH controllers.
- 5. TDS controllers.
- 6. Biocide feeder timers.
- 7. Chemical solution tanks.
- 8. Injection pumps.
- 9. Ozone generators.
- 10. UV-irradiation units.
- 11. Chemical test equipment.
- 12. Chemical material safety data sheets.

B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.

- 1. Wiring Diagrams: Power and control wiring.

C. Field quality-control test reports.



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- D. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in operation and maintenance manuals.
1. Submit under provisions of Division 20 Section "Mechanical General Requirements" and as supplemented in this Section.
  2. Submit following operation and maintenance data as minimum for purified water system.
    - a. Furnish complete instruction manuals for installation, operation, maintenance, and lubrication requirements for each component of mechanical and electrical equipment or system.
    - b. Each instruction manual shall include, but not be limited to, the following:
      - 1) Diagrams and illustrations.
      - 2) Detailed description of the function of each principal component of the system.
      - 3) Performance and nameplate data.
      - 4) Installation instructions.
      - 5) Procedures for starting.
      - 6) Proper adjustment.
      - 7) Test procedures and recording of operation data.
      - 8) Procedures for operating.
      - 9) Shutdown and restart instructions.
      - 10) Emergency operating instructions and trouble-shooting guide.
      - 11) Safety precautions.
      - 12) Maintenance and overhaul instructions which shall include detailed assembly drawings with part numbers, recommended spare parts list, instructions for ordering spare parts (including suppliers names), and complete preventive maintenance instructions required to ensure satisfactory performance and longevity of the equipment.
      - 13) Lubrication instructions, which shall list points to be greased or oiled, shall recommend type, grade, and temperature range of lubricants, and shall recommend frequency of lubrication.
      - 14) List of electrical relay settings and control and alarm contact settings.
      - 15) Electrical interconnection wiring diagram for equipment furnished, including all control.
    - c. Manual shall be complete in all respects for all equipment, controls, accessories, and associated appurtenances.
    - d. Each O&M Manual shall be transmitted to the Owner's representative and Architect prior to installation of the equipment and all equipment shall be serviced by the manufacturer in accordance with the manufacturer's recommendations prior to operation. A service record shall be maintained on each item of equipment and shall be delivered to the Owner's representative and Architect prior to final acceptance of the project.
- E. Other Informational Submittals:
1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.
  2. An analytical review of make-up water characteristics for each treated system operating conditions, including such items as Langlier/Ryzner Indexes. Based on this review, provide a definitive description of treatment system developed to achieve specified objectives and

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include generic terms to describe product formulation content and function. Detailed proprietary formulation data is not required. However, manufacturer's standard published literature is not usually acceptable.

3. A step-by-step procedure to be followed by the Contractor during flushing, purging, disinfecting, draining, disposal, pretreatment and treatment operations. The intent of the step-by-step procedure is two-fold.
  - a. To assure that all essential permanent provisions to accomplish the above work are included during the course of construction.
  - b. To allow the Owner to accomplish the source procedures as subsequent maintenance operations.
4. Passivation Confirmation Report: Verify passivation of galvanized-steel surfaces, and confirm this observation in a letter to Architect.

F. Provide OSHA equivalent materials form for hazardous substances.

1.5 QUALITY ASSURANCE

- A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.
- B. The water treatment supplier shall have an MDA Pesticide Applicator License in effect at the time of the bid and during the treatment period. The water treatment specialist shall be MDA Certified as a Pesticide Applicator in category 5B. Copies of Certifications shall be included in the suppliers transmittals.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
- D. Regulatory Requirements: Conform to applicable codes for addition of non-potable chemicals to building mechanical systems, and for delivery to public sewage systems.

1.6 OWNER'S INSTRUCTIONS

- A. Provide a coordinated water treatment training program oriented to the needs common to operating personnel and maintenance personnel and to the needs of maintenance personnel only, sufficiently prior to acceptance of the work, upon mutually satisfactory arrangement with the Architect.
- B. Provide a total of not less than eight "field" hours encompassing mechanical, electrical, chemical, pollution and safety aspects, sufficient for personnel to operate and maintain systems and consistently achieve specified objectives, with subsequently scheduled guidance by the water treatment laboratory.
- C. Water treatment laboratory chemical engineer, complemented by instrument engineer, supplemented by Contractor's staff, shall comprise the training staff.
- D. Training materials shall include "survey," limits control program, shop drawings, operating and maintenance manuals, safe handling of chemicals, chemical testing, use of log sheets and demonstrations of installed and functioning systems.
- E. On completion of the installation of the entire purified water system, conduct a thorough check and test of all components in the system. During this period, instruct the Owner's personnel in the

theory, operation, and maintenance of the system. When this work is finished, start up the system and operate it for as long as necessary to complete two consecutive days of operation at the specified performance levels. During this period, continue to instruct the Owner's personnel.

#### 1.7 MAINTENANCE SERVICE

- A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for cooling, chilled-water piping, heating, hot-water piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, and shall include the following:
1. Provide piping/plumbing recommendation to optimize chemical program results.
  2. Initial water analysis and HVAC water-treatment recommendations.
  3. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
  4. Quarterly field service and consultation for closed systems and monthly field service and consultation for open systems.
  5. Customer report charts and log sheets.
  6. Laboratory technical analysis.
  7. Analyses and reports of all chemical items concerning safety and compliance with government regulations.
- B. Glycol manufacturer shall provide testing services every six months of samples submitted by the Owner. Fluid shall be tested at no charge for: glycol percent, pH, reserve alkalinity, dissolved metals, magnesium, calcium, chlorides, acidity, and inhibitor components. Testing service shall be for the life of the fluid.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers/Suppliers: Unless otherwise specified, and subject to compliance with requirements, provide products by one of the following:
1. Enerco Corporation (Doug White 517-627-8444 or 800-292-5908) – Base Bid
  2. Ashland Specialty Chemical Company; Drew Industrial Div.
  3. Eldon Water (Patrick Racine, Christa Blades, or Pierre Beausoleil, 888-712-4000).
  4. GE Power & Water; Water & Process Technologies.
  5. Mitco Custom Water Treatment (Gordon Chapin, 800-516-2175).
  6. Nalco Company (734-751-2387).
  7. H-O-H Chemicals, Inc.(H.V. Burton Co., 734-261-4220)

## 2.2 MANUAL CHEMICAL-FEED EQUIPMENT

- A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.

1. Capacity: 2 gal.
2. Minimum Working Pressure: 125 psig.

## 2.3 AUTOMATIC CHEMICAL-FEED EQUIPMENT

- A. Water Meter:

1. AWWA C700, oscillating-piston, magnetic-drive, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: 150 psig.
4. Maximum Pressure Loss at Design Flow: 3 psig.
5. Registration: Gallons or cubic feet.
6. End Connections: Threaded.
7. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac; and that will close at adjustable increments of total flow.

- B. Inhibitor Injection Timers:

1. Microprocessor-based controller with LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Division 23 Section "Temperature Controls."
2. Programmable timers with infinite adjustment over full range, and mounted in cabinet with hand-off-auto switches and status lights.
3. Test switch.
4. Hand-off-auto switch for chemical pump.
5. Illuminated legend to indicate feed when pump is activated.
6. Programmable lockout timer with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.
7. LCD makeup totalizer to measure amount of makeup and bleed-off water from two water meter inputs.

- C. pH Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 14 units. Incorporate solid-state integrated circuits and digital LCD display in NEMA 250, Type 12

enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Division 23 Section "Temperature Controls."

2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal pH indication.
5. High or low pH alarm light, trip points field adjustable; with silence switch.
6. Hand-off-auto switch for acid pump.
7. Internal adjustable hysteresis or deadband.

D. TDS Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 5000 micromhos. Incorporate solid-state integrated circuits and digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Division 23 Section "Temperature Controls."
2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal conductance indication.
5. High or low conductance alarm light, trip points field adjustable; with silence switch.
6. Hand-off-auto switch for solenoid bleed-off valve.
7. Bleed-off valve activated indication.
8. Internal adjustable hysteresis or deadband.
9. Bleed Valves:
  - a. Cooling Systems: Forged-brass body, globe pattern, general-purpose solenoid with continuous-duty coil, or motorized valve.
  - b. Steam Boilers: Motorized ball valve, steel body, and TFE seats and seals.

E. Biocide Feeder Timer:

1. Microprocessor-based controller with digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Division 23 Section "Temperature Controls."
2. 24-hour timer with 14-day skip feature to permit activation any hour of day.
3. Precision, solid-state, bleed-off lockout timer and clock-controlled biocide pump timer. Prebleed and bleed lockout timers.

4. Solid-state alternator to enable use of two different formulations.
5. 24-hour display of time of day.
6. 14-day display of day of week.
7. Battery backup so clock is not disturbed by power outages.
8. Hand-off-auto switches for biocide pumps.
9. Biocide A and Biocide B pump running indication.

F. Chemical Solution Tanks:

1. Tanks: Chemical-resistant reservoirs fabricated from high-density opaque polyethylene.
  - a. Molded cover with recess for mounting pump.
  - b. Capacity: 50 gal.
2. Containment: Low profile, forkliftable, spill pallet or containment basin with volume large enough to hold contents of largest tank.
  - a. Construction: High-density polyethylene.
  - b. Grates: Removable with non-slip surface.
  - c. Include work ramp for facilitating loading of tanks onto spill pallet or containment basin.

G. Chemical Solution Injection Pumps:

1. Self-priming, positive-displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
2. Adjustable flow rate.
3. Metal and thermoplastic construction.
4. Built-in relief valve.
5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Division 20 Section "Motors."

H. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.

I. Injection Assembly:

1. Corporation-stop injectors on piping mains in locations identified by water treatment specialist.
2. Assembly Pressure/Temperature Rating: Minimum 600 psig at 200 deg F.

## 2.4 CHEMICAL TREATMENT TEST EQUIPMENT

- A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing pH, TDS, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure boilers, and oxidizing biocide test for open cooling systems.
  - B. Sample Cooler:
    - 1. Tube: Sample.
      - a. Size: NPS 1/4 tubing.
      - b. Material: ASTM A 666, Type 316 stainless steel.
      - c. Pressure Rating: Minimum 2000 psig.
      - d. Temperature Rating: Minimum 850 deg F.
    - 2. Shell: Cooling water.
      - a. Material: ASTM A 666, Type 304 stainless steel.
      - b. Pressure Rating: Minimum 250 psig.
      - c. Temperature Rating: Minimum 450 deg F.
    - 3. Capacities and Characteristics:
      - a. Tube: Sample.
        - 1) Flow Rate: 0.25 gpm.
        - 2) Entering Temperature: 400 deg F.
        - 3) Leaving Temperature: 88 deg F.
        - 4) Pressure Loss: 6.5 psig.
      - b. Shell: Cooling water.
        - 1) Flow Rate: 3 gpm.
        - 2) Entering Temperature: 70 deg F.
        - 3) Pressure Loss: 1.0 psig.
  - C. Corrosion Test-Coupon Assembly (Corrosion Racks): Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.
    - 1. Two-station rack for closed-loop systems.
    - 2. Four-station rack for open systems.
    - 3. Include 1-inch diameter, chemical resistant acrylic flowmeter suitable for 1 to 20 gpm at exit of coupon rack.
- ## 2.5 CHEMICALS
- A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 "Performance Requirements" Article.

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- B. Inhibited Propylene Glycol: Single nationally marketed brand of propylene glycol, inhibited for industrial applications, and readily available in bulk quantities from a firm offering free testing and advisory service to bulk users as to inhibitor replenishment needs. Premix inhibited glycol solution and deionized water to specified concentration. Automotive anti-freeze is unacceptable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Dow Chemical; Dowfrost HD.
  - b. Eldon Water
  - c. Houghton Chemical Corporation.
  - d. Interstate Chemical Company; Intercool P300.
  - e. Nalco Company.
  - f. PVS-Nolwood Chemicals, Inc.; Chill PGHD.

- C. For Aluminum Boilers: Use one of the following:

1. Inhibited Propylene Glycol: Single nationally marketed brand of propylene glycol, specially inhibited for use in systems with aluminum boilers, and readily available in bulk quantities from a firm offering free testing and advisory service to bulk users as to inhibitor replenishment needs. Premix inhibited glycol solution and deionized water to specified concentration. Automotive anti-freeze is unacceptable.
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Houghton Chemical Corporation; SAFE-T-THERM AL.
2. Uninhibited Virgin Propylene Glycol: Single nationally marketed brand of propylene glycol readily available in bulk quantities from a firm offering free testing and advisory service to bulk users. Premix glycol solution and deionized water to specified concentration and add multi-metal corrosion inhibitor as recommended by boiler manufacturer. Automotive anti-freeze is unacceptable.
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Dow Chemical.
    - 2) Eldon Water
    - 3) Interstate Chemical Company.
    - 4) Nalco Company.
    - 5) PVS-Nolwood Chemicals, Inc.
3. Multi-Metal Corrosion Inhibitor and Dispersant: Neutral pH formulation designed to provide corrosion inhibition of ferrous, stainless, copper, and aluminum alloys in closed recirculating water systems, and also containing polymeric dispersants and sequestrants to aid in maintaining clean internal surfaces.
  - a. Dispersant Package: Quadpolymer/phosphonate blend.
  - b. Molybdenum Tracer: For ease of testing and control.
  - c. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Fernox USA.



- 2) H-O-H Water Technology, Inc.
- 3) Rhomar Water Management, Inc.; Pro-Tek AL.
- 4) Sentinel Performance Solutions Ltd.

### PART 3 - EXECUTION

#### 3.1 WATER ANALYSIS

- A. Perform an analysis of supply water to determine quality of water available at Project site.

#### 3.2 INSTALLATION

- A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.
- B. Install water testing equipment on wall near water chemical application equipment.
- C. Install meters and equipment requiring service at a maximum 60 inches above finished floor.
- D. Install interconnecting control wiring for chemical treatment controls and sensors.
- E. Mount sensors and injectors in piping circuits.
- F. Bypass Feeders: Install in closed hydronic systems, including hot-water heating, chilled water and dual-temperature water, and equipped with the following:
  1. Install bypass feeder in a bypass circuit on main header having pressure differential greater than or equal to 20 psig, unless otherwise indicated on Drawings.
  2. Install water meter in makeup water supply.
  3. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
  4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
  5. Install a swing check on inlet after the isolation valve.
- G. Install automatic chemical-feed equipment for fluid-cooler spray water and include the following:
  1. Install makeup water softener.
  2. Install water meter in makeup water supply and bleed line.
  3. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.
    - a. Pumps shall operate for timed interval on contact closure at water meter in makeup water supply connection. Injection pump shall discharge into boiler feedwater tank or feedwater supply connection at boiler.
  4. Install test equipment and provide test-kit to Owner. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.

5. Install TDS controller with sensor and bleed valves.
  - a. Bleed valves shall cycle to maintain maximum TDS concentration.
6. Install pH sensor and controller with injection pumps and solution tanks.
  - a. Injector pumps shall operate to maintain required pH.
7. Install biocide feeder alternating timer with two sets of injection pumps and solution tanks.
  - a. Injection pumps shall operate to feed biocide on an alternating basis.
8. Install ozone generator with diffusers in condenser-water piping.
  - a. Ozone generator shall operate continuously with condenser-water flow.
9. Install UV-irradiation lamps in condenser-water piping.
  - a. UV lights shall operate continuously with condenser-water flow.
- H. Install glycol feed system in accordance with manufacturer's instructions.

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Division 20 Section "Basic Mechanical Materials and Methods."
- D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Division 20 Section "Valves."
- E. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers required in makeup water connections to potable-water systems.
- F. Confirm applicable electrical requirements in Division 26 Sections for connecting electrical equipment.
- G. Ground equipment according to Division 26 Section "Grounding and Bonding."
- H. Connect wiring according to Division 26 Section "Conductors and Cables."

### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.

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1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
  2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
  3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
  4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
  5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
  7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
  8. Repair leaks and defects with new materials and retest piping until no leaks exist.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare test report advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article for each required characteristic. Sample boiler water at four -week intervals following the testing noted above to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section.
- F. At four -week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article.
- G. Comply with ASTM D 3370 and with the following standards:
1. Silica: ASTM D 859.
  2. Steam System: ASTM D 1066.
  3. Acidity and Alkalinity: ASTM D 1067.
  4. Iron: ASTM D 1068.

5. Water Hardness: ASTM D 1126.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment. Refer to Division 20 Section "Mechanical General Requirements."

**\*\*END OF SECTION\*\***

# PIPING SYSTEMS FLUSHING AND CHEMICAL CLEANING

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## 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.
- B. Related Sections include the following:
  1. Division 20 Section "Mechanical General Requirements."
  2. Division 20 Section "Basic Mechanical Materials and Methods."
  3. Division 22 Section "Domestic Water Piping," for disinfection of potable water piping.
  4. Division 23 Section "Hydronic Piping."
  5. Division 23 Section "HVAC Water Treatment."

### 1.2 SUMMARY

- A. This Section includes chemical cleaning for the following piping systems:
  1. Heating hot water.
  2. Chilled water.

### 1.3 DEFINITIONS

- A. Cleaning: Recirculating water containing chemical cleaning and passivation compounds.

- B. Flushing: Using approved water on a once through basis.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Furnish the services of a firm specializing in piping system chemical cleaning and water treatment work.
  - 1. For chemical cleaning: This firm shall select the required type and quantity, based on system volume, of cleaning compound, and method of application.
- B. Passivation for Galvanized Steel: Open loop only, for the first two weeks of operation.

#### 1.5 SUBMITTALS

- A. Product Data:
  - 1. Proposed cleaning chemicals and quantities.
  - 2. Proposed passivation chemicals and quantities.
  - 3. Analyses and reports of all chemical items concerning safety and compliance with government regulations.
- B. Shop Drawings: Reduced scale plans indicating locations of velocity measurements.
- C. Field quality-control test reports.
- D. Other Informational Submittals:
  - 1. Proposed, step-by-step, chemical cleaning procedure.
  - 2. Circulation pump suction and discharge pressure at start and completion of chemical cleaning operations.
  - 3. Passivation Confirmation Report: Verify passivation of galvanized-steel surfaces, and confirm this observation in a letter to Architect.

#### 1.6 QUALITY ASSURANCE

- A. Service Provider Qualifications: An experienced piping systems cleaning service provider capable of applying cleaning compounds as specified in this Section.
- B. Conduct safety meetings with Owner's Representative and personnel involved in the cleaning process.
- C. Assume responsibility for damage, necessary subsequent cleaning, flushing, and inspection of Work under the Contract which results from improper flushing and cleaning operations including failure to flush all dead-ends.

#### 1.7 COORDINATION

- A. Schedule flushing and chemical cleaning activities immediately after piping system pressure testing and immediately prior to piping system chemical treatment work to minimize internal oxidization or flash corrosion of piping systems.

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- B. Coordinate chemical cleaning work with other work to avoid accidental chemical discharge, spillage, or spray out, and electrolytically originated system damage resulting from concurrent chemical cleaning and arc welding.
- C. Coordinate with work performed under other Sections to provide in-place temporary strainers, spool pieces, flushing hose connections, cross-over piping, and isolation and drain valves.
- D. Chillers shall not be cleaned with any chloride component.
- E. Boilers shall be flushed and cleaned to remove rust and oil deposits.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. System Cleaning Chemicals: Subject to compliance with requirements, provide products by one of the following:
  - 1. Enerco Corporation – Base Bid
  - 2. PVS-Nolwood Chemicals, Inc.; PVS CHILL CLP Cleaner.
  - 3. Nalco Company; Nalco 2578.
  - 4. Mitco Custom Water Treatment.
  - 5. H-O-H Chemicals, Inc.
  - 6. GE Power & Water; Water & Process Technologies.

2.2 MATERIALS

- A. Cleaning chemicals shall be as recommended by manufacturer and compatible with piping system components and connected equipment.
- B. Cleaning and passivation chemical shall consist of an inorganic phosphate, yellow metal corrosion inhibitor (Tolytriazole), dispersant, and oil emulsifier.
- C. Provide additional temporary and permanent piping, equipment, and materials required for chemical cleaning work.
- D. Use potable water for flushing and cleaning operations, unless directed otherwise by the Architect.

PART 3 - EXECUTION

3.1 ACCEPTABLE SERVICE PROVIDER

- A. Subject to compliance with requirements, provide chemical cleaning service by one of the following:
  - 1. Enerco Corporation (Doug White 517-627-8444 or 800-292-5908) – Base Bid
  - 2. GE Power & Water; Water & Process Technologies.

3. Mitco Custom Water Treatment (Gordon Chapin, 800-516-2175).
4. Nalco Company (Brian Irwin or Tony Mackovski, 248-344-7564).
5. H-O-H Chemicals, Inc/[H.V. Burton Co.
6. Eldon Water (Patrick Racine, Christa Blades, or Pierre Beausoleil, 888-712-4000).

### 3.2 PREPARATION

- A. Prior to flushing and cleaning activities, drain the system of all water used for hydrostatic testing.
- B. Temporarily connect dead-end supply and return piping as necessary to result in recirculating system in which no lines are left static for purposes of flushing and cleaning. Refer to System Piping Diagrams on the Drawings for suggested locations of temporary connections for flushing and cleaning purposes.
- C. Select three locations for monitoring flow rates.

### 3.3 INITIAL FLUSHING

- A. Remove loose dirt, mill scale, metal chips, weld beads, rust and other deleterious substances without damage to system components.
- B. Bypass factory cleaned equipment, unless acceptable means of protection are provided and subsequent inspection of water boxes and other "hide-out" areas takes place.
- C. Isolate or protect clean system components including pumps and pressure vessels and remove components which may be damaged.
- D. Open valves, drains, vents and strainers at all system levels.
- E. Remove plugs, caps, spool pieces and components to facilitate early discharge from system.
- F. Sectionalize system if possible to obtain debris carrying velocity of 6 FPS.
- G. Connect dead-end supply and return headers as necessary or provide terminal drains in end caps.
- H. Install temporary strainers where necessary to protect down-stream equipment.
- I. Supply and remove flushing water and drainage by fire hoses, garden hoses, temporary and permanent piping and Contractor's booster pumps.
- J. Flush for not less than one hour.
- K. Inspect system including basins to determine if debris accumulation requires dewatering and cleaning prior to next phase work.

### 3.4 FLUSHING AND CHEMICAL CLEANING PROCEDURES

- A. Remove without chemical or mechanical damage to system components adherent dirt (organic soil), oil and grease (hydrocarbons), welding and soldering flux, mill varnish, pipe compounds,



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rust (iron oxide), and other deleterious substances not removed by initial flushing. Removal of tightly adherent mill scale is not required.

- B. Fill system with fresh water and add manufacturer's recommended volume of system cleaner to remove grease and petroleum products from piping. Circulate solution for 24 hours at a minimum velocity of 6 fps.
  - 1. Utilize defoamers to preclude damage to existing work and adjacent electrical equipment.
  - 2. Utilize heat to maximize effectiveness of compounds or use live steam injection where practical and safe. Do not raise cleaning water temperature in excess of controlled limits.
- C. Monitor flow rates and clean strainers as required to maintain minimum specified velocity during the entire circulation and chemical cleaning period.
- D. Cleaning of new piping systems shall be completed prior to connection of systems to existing services.
- E. Install temporary strainer screens between pipe flange faces where necessary to protect primary system from branch connections during chemical cleaning procedures.
- F. Following chemical cleaning:
  - 1. Remove, clean, and reinstall strainer baskets.
  - 2. Blow down and clean low points, dirt legs, and traps.
- G. Drain systems:
  - 1. Check with local authorities concerning discharge requirements and submit copies of letters or reports.
  - 2. If acceptable, drain system to sanitary drainage system.
  - 3. Do not under any circumstances drain to storm drainage system or open drainage ditch.
  - 4. If discharge requirements do not allow discharge to sanitary sewer, secure the services of a licensed disposal Contractor.
  - 5. Disposal Contractors:
    - a. Dynecol.
    - b. SQS Environmental.
- H. Perform final flush to remove any remaining debris and chemical from the system:
  - 1. Flush dead ends and isolated pre-cleaned equipment.
  - 2. Operate valves to dislodge debris in valve body.
  - 3. Flush for not less than 1 hour.

3.5 PLACING INTO OPERATION

- A. Clean strainers.
- B. Dewater and clean new sumps, basins, storage vessels and pressure vessels.
- C. Disassemble, inspect, clean, repair, replace and reassemble any critical component or questionable item. Bellows style, and hose and braid flexible connectors left in place shall be removed and cleaned.
- D. Preliminarily adjust control valves.
- E. Install clean primary filter elements, if necessary, as determined by both pressure differential across filter and visual inspection of filter elements.
- F. Close-up and fill system as soon as possible to minimize corrosion of untreated surfaces.
- G. Vent air from system and adjust fill valve.
- H. Immediately after completion of flushing and chemical cleaning, fill systems with potable water and make ready for chemical treatment as specified in Division 23 Section "HVAC Water Treatment."

3.6 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. Withdraw, inspect, and test samples of water from each system after flushing and chemical cleaning is completed, to ensure system is free of contaminants.

**\*\*END OF SECTION\*\***

# METAL DUCTS

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## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  1. Division 20 Section "Mechanical General Requirements."
  2. Division 23 Section "Nonmetal Ducts" for fabric ducts, fibrous-glass ducts, thermoset FRP ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
  3. Division 23 Section "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
  4. Division 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 SUMMARY

- A. This Section includes metal ducts for supply, return, outside, relief air, and exhaust air-distribution systems in pressure classes from minus 6- to plus 6-inch wg.
- B. Products Installed but Not Furnished Under This Section:
  - 1. Terminal boxes which are to be furnished by the Laboratory Airflow Controls Contractor shall be installed by the Mechanical Contractor. Refer to Division 23 Section "Laboratory Airflow Controls."

1.3 DEFINITIONS

- A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.
- B. Low Pressure: Up to 2 inch WG and velocities less than 1,500 fpm. Construct for 2 inch WG positive or negative static pressure.
- C. Medium Pressure: Greater than 2 inch WG to 6 inch WG and velocities greater than 1,500 fpm and less than 2,500 fpm. Construct for 6 inch WG positive or negative static pressure.
- D. High Pressure: Greater than 6 inch WG to 12 inch WG and velocities greater than 2,500 fpm. Construct for 12 inch WG positive or negative static pressure.
- E. FRP: Fiberglass-reinforced plastic.
- F. PVC: Polyvinyl Chloride.

1.4 SYSTEM DESCRIPTION

- A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.5 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Application Schedule" Article.

1.6 SUBMITTALS

- A. Shop Drawings: Drawn to 1/4 inch equals 1 foot scale. Show fabrication and installation details for metal ducts. Shop drawings shall be reviewed and approved by the Architect prior to any fabrication.
  - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
  - 2. Duct layout indicating sizes and pressure classes.
  - 3. Elevations of top and bottom of ducts.
  - 4. Dimensions of main duct runs from building grid lines.

5. Fittings.
  6. Reinforcement and spacing.
  7. Seam and joint construction.
  8. Penetrations through fire-rated and other partitions.
  9. Equipment installation based on equipment being used on Project.
  10. Duct accessories, including access doors and panels.
  11. Hangers and supports, including methods for duct and building attachment, vibration isolation.
- B. Delegated-Design Submittal:
1. Sheet metal thicknesses.
  2. Joint and seam construction and sealing.
  3. Reinforcement details and spacing.
  4. Materials, fabrication, assembly, and spacing of hangers and supports.
- C. Coordination Drawings: Reflected ceiling 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. Ceiling suspension assembly members.
  2. Other systems installed in same space as ducts.
  3. Ceiling- and wall-mounting access doors and panels required to provide access to dampers and other operating devices.
  4. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- D. Welding certificates.
- E. Field quality-control test reports.
- 1.7 QUALITY ASSURANCE
- A. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
  2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
  3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. NFPA Compliance:
1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."

2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

- C. Comply with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations," Ch. 3, "Duct System," for range hood ducts, unless otherwise indicated.

#### 1.8 COORDINATION

- A. Sheet metal trades shall cooperate fully with the Laboratory Airflow Controls Trades and shall attend all field installation training sessions.
- B. Sheet metal trades shall cooperate fully with the Test and Balance Contractor and provide all miscellaneous caps and any other materials required for structural integrity and leakage testing of the complete duct system in whole or in part. Refer to Division 23 Section "Testing, Adjusting and Balancing."
1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
- C. Sheet metal trades shall participate in the above ceiling coordination program. Refer to Division 01 requirements.

#### 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. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. PVC-Coated Galvanized Steel: Acceptable by authorities having jurisdiction for use in fabricating ducts with UL 181, Class 1 listing. Lock-forming-quality, galvanized sheet steel complying with ASTM A 653/A 653M and having G60 coating designation. Factory-applied PVC coatings shall be 4 mils thick on exterior sheet metal surfaces of ducts and fittings exposed to corrosive conditions and minimum 1 mil thick on interior surfaces.
- D. PVC-Coated Galvanized Steel: Acceptable by authorities having jurisdiction for use in fabricating ducts with UL 181, Class 1 listing. Lock-forming-quality, galvanized sheet steel complying with ASTM A 653/A 653M and having G60 coating designation. Factory-applied PVC coatings shall be 4 mils thick on sheet metal surfaces of ducts and fittings exposed to corrosive conditions and 4 mils thick on opposite surfaces.
- E. PVC-Coated Galvanized Steel: Acceptable by authorities having jurisdiction for use in fabricating ducts with UL 181, Class 1 listing. Lock-forming-quality, galvanized sheet steel complying with ASTM A 653/A 653M and having G60 coating designation. Factory-applied PVC coatings shall be 4 mils thick on interior sheet metal surfaces of ducts and fittings exposed to corrosive conditions and minimum 1 mil thick on exterior surfaces.

- F. Carbon-Steel Sheets: ASTM A 366/A 366M, cold-rolled sheets; commercial quality; with oiled, matte finish for exposed ducts.
- G. Stainless Steel: ASTM A 480/A 480M, Type 316, and having a No. 2D finish for concealed ducts and No. 4 for exposed ducts.
- H. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- I. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
- J. Tie Rods: For rectangular ducts having a side dimension of 48 inches or greater. Galvanized steel, 3/8-inch minimum diameter.

## 2.3 DUCT LINER

- A. Fibrous-Glass Liner: Comply with NFPA 90A or NFPA 90B and with NAIMA AH124.
  - 1. Manufacturers:
    - a. CertainTeed Corp.; Insulation Group.
    - b. Johns Manville International, Inc.
    - c. Knauf Fiber Glass GmbH.
  - 2. Materials: ASTM C 1071, Type I, flexible; surfaces exposed to airstream shall be coated to prevent erosion of glass fibers.
    - a. Thickness: [1 inch] [1-1/2 inches] [2 inches].
    - b. Density: 1-1/2 pounds per cubic foot.
    - c. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
    - d. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
    - e. Maximum Operating Temperature: 250 deg F when tested according to ASTM C 411.
    - f. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
    - g. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.
      - 1) Tensile Strength: Indefinitely sustain a 50-lb- tensile, dead-load test perpendicular to duct wall.
      - 2) Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch into airstream.
      - 3) Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.
  - 3. Noise reduction coefficient (NRC): Sound absorption coefficients shall not be less than those in the table below as tested by ASTM C423 using an ASTM E795 Type A mounting.

Thickness Inches (mm)	Sound absorption coefficients at octave band center frequencies, Hz						NRC
	125	250	500	1000	2000	4000	

1	(25)	.08	.31	.59	.84	.91	.90	.70
1-1/2	(38)	.10	.47	.83	.93	.97	.96	.80
2	(51)	.24	.64	.96	1.03	1.00	.99	.90

## 2.4 SEALANTS 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. Elastomeric Sealant Tape: 3 inches wide; modified butyl adhesive backed.
  - 1. Manufacturers:
    - a. Hardcast; Foil-Grip 1402 and Foil-Grip 1402-181BFX.
- C. Water-Based Joint and Seam Sealant:
  - 1. Manufacturers:
    - a. Hardcast; Flex-Grip 550 and Versa-Grip 181.
    - b. Polymer Adhesives; No. 11.
    - c. United McGill.
  - 2. Application Method: Brush on.
  - 3. Solids Content: Minimum 65 percent.
  - 4. Shore A Hardness: Minimum 20.
  - 5. Water resistant.
  - 6. Mold and mildew resistant.
  - 7. VOC: Maximum 75 g/L (less water).
  - 8. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
  - 9. Service: Indoor or outdoor.
  - 10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Solvent-Based Joint and Seam Sealant:
  - 1. Manufacturers:
    - a. Hardcast; Sure-Grip 404.
    - b. United McGill.
  - 2. Application Method: Brush on.
  - 3. Base: Synthetic rubber resin.
  - 4. Solvent: Toluene and heptane.



5. Solids Content: Minimum 60 percent.
  6. Shore A Hardness: Minimum 60.
  7. Water resistant.
  8. Mold and mildew resistant.
  9. VOC: Maximum 395 g/L.
  10. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
  11. Service: Indoor or outdoor.
  12. Substrate: Compatible with galvanized sheet steel, stainless steel, or aluminum sheets.
- E. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
  2. Type: S.
  3. Grade: NS.
  4. Class: 25.
  5. Use: O.
- F. Gaskets: Chloroprene elastomer, 40 durometer, 1/8 inch thick, full face, one piece vulcanized or dovetailed at joints.
- G. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
  2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
  3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

## 2.5 HANGERS AND SUPPORTS

- A. Building Attachments: Concrete inserts, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
- B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
1. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
  2. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
  3. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

4. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.
- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials. Attachments for stainless steel and PVC-coated duct shall be stainless steel.
- D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.
  1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
  2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
  3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.
- E. Load Rated Cable Suspension System for Noncorrosive Environments: Tested to five times the Safe Working Loads and verified by the SMACNA Testing and Research Institute.
  1. Cable: Aircraft quality 7 x 7 and 7 x 19 wire rope.
    - a. Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
    - b. Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
  2. Fastener: One-piece, die-cast zinc housing with Type 302 S26 stainless steel hardened and tempered springs, and oil impregnated, sintered, hardened and tempered steel locking wedges.
  3. End Fixings: Loop, stud or toggle; or plain end suitable for wire rope beam clamp.
  4. Manufacturers:
    - a. Ductmate Industries, Inc.; Clutcher and EZ-Lock.
    - b. Duro Dyne Corp.; Dyna-Tite System.
    - c. Gripple Inc.; Hang-Fast System.
- F. Stainless Steel Load Rated Cable Suspension System for Corrosive Environments: Tested to five times the Safe Working Loads and verified by the SMACNA Testing and Research Institute.
  1. Cable: Aircraft quality stainless steel 7 x 7 and 7 x 19 wire rope.
    - a. Stainless steel complying with ASTM A 492.
  2. Fastener: One-piece, stainless steel housing with Type 302 S26 stainless steel hardened and tempered springs, and ceramic locking wedges.
  3. End Fixings:
    - a. Loop End: Type 316L/A4 stainless steel.
    - b. Stud or Toggle End: Type 304L/A2 stainless steel.
    - c. Plain end suitable for stainless steel wire rope beam clamp.
  4. Manufacturers:
    - a. Ductmate Industries, Inc.; Clutcher and EZ-Lock.
    - b. Duro Dyne Corp.; Dyna-Tite System.

c. Gripple Inc.; Hang-Fast System.

- G. Welded Supports: Structural steel shapes with zinc rich paint. Equivalent, proprietary design, rolled steel structural support systems may be used in lieu of mill rolled structural steel.

## 2.6 ROOF MOUNTED DUCT SUPPORTS

- A. General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted duct.
- B. Support: Assembly of bases, and vertical and horizontal members, for roof installation without membrane penetration.

1. Manufacturer:

- a. B-Line Systems, Inc.; a division of Cooper Industries.
- b. ERICO/Michigan Hanger Co.
- c. MIRO Industries.
- d. Portable Pipe Hangers.

2. Bases: Two or more plastic, stainless steel, or recycled rubber.

3. Vertical Members: Two or more protective-coated-steel channels.

4. Horizontal Member: Protective-coated-steel channel.

## 2.7 RECTANGULAR DUCT FABRICATION

- A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.

1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.

2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

3. Internal Tie Rod: Ducts having a side dimension of 48 inches or greater only.

- B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's and SMACNA guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.

1. Manufacturers:

- a. Ductmate Industries, Inc.
- b. Nexus Inc.
- c. Ward Industries, Inc.

- C. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.

2.8 APPLICATION OF LINER IN RECTANGULAR DUCTS

- A. 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.
- B. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
- C. Butt transverse joints without gaps and coat joint with adhesive.
- D. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
- E. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.
- F. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm or greater.
- G. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
  - 1. Fan discharges.
  - 2. Intervals of lined duct preceding unlined duct.
  - 3. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm or where indicated.
- H. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
  - 1. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
- I. 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.

2.9 ROUND AND FLAT-OVAL DUCT AND FITTING FABRICATION

- A. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.
- B. Round and Flat-Oval, Spiral Lock-Seam Ducts:
  - 1. Manufacturers:
    - a. Eastern Sheet Metal (ESM).
    - b. LaPine Metal Products.
    - c. Lindab Inc.
    - d. McGill AirFlow Corporation.
    - e. SEMCO Incorporated.
    - f. SET Duct Manufacturing, Inc.
    - g. Tangent Air, Inc.
    - h. Universal Spiral Air.

- C. Round, Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" or SMACNA "Industrial Duct Construction Standards" as required based on pressure class.
  - 1. Round fittings shall be factory fabricated welded design. Use of field fabricated fittings (welded design) shall only be permitted when factory fabricated fittings are unavailable.
- D. Flat-Oval, Spiral Lock-Seam Ducts: Fabricate supply ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" or SMACNA "Industrial Duct Construction Standards" as required based on pressure class.
  - 1. Flat-oval fittings shall be factory fabricated welded design. Use of field fabricated fittings (welded design) shall only be permitted when factory fabricated fittings are unavailable.
- E. Duct Joints:
  - 1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
  - 2. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
  - 3. Ducts Larger Than 72 Inches in Diameter: Companion angle flanged joints per SMACNA "HVAC Duct Construction Standards--Metal and Flexible," Figure 3-2.
  - 4. Bolts and fasteners for galvanized steel duct shall be carbon steel, zinc coated per ASTM A153. Bolts and fasteners for stainless steel and polyvinyl chloride coated steel duct shall be stainless steel.
  - 5. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.
    - a. Manufacturers:
      - 1) AccuDuct Mfg. Inc.
      - 2) Ductmate Industries, Inc.
      - 3) Eastern Sheet Metal (ESM).
      - 4) Lindab Inc.
      - 5) Universal Spiral Air.
  - 6. Flat-Oval Ducts: Prefabricated connection system consisting of two flanges and one synthetic rubber gasket.
    - a. Manufacturers:
      - 1) AccuDuct Mfg. Inc.
      - 2) Ductmate Industries, Inc.
      - 3) Eastern Sheet Metal (ESM).
      - 4) McGill AirFlow Corporation.
      - 5) SEMCO Incorporated.
      - 6) Universal Spiral Air.
- F. Low Pressure Ductwork (plus or minus 2 inches W.G. Static Pressure Class)
  - 1. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible provide single thickness turning vanes.

2. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.
- G. Medium and High Pressure Ductwork (For Static Pressure Class Greater than plus or minus 2 inches W.G.)
1. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible provide single thickness turning vanes.
  2. Transform duct sizes gradually, not exceeding 15 degrees divergence and 30 degrees convergence.
  3. Fabricate continuously welded medium and high pressure round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Joints shall be minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.
  4. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.
- H. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.
- I. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.
- J. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:
1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
  2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg:
    - a. Ducts 3 to 36 Inches in Diameter: 0.034 inch.
    - b. Ducts 37 to 50 Inches in Diameter: 0.040 inch.
    - c. Ducts 52 to 60 Inches in Diameter: 0.052 inch.
    - d. Ducts 62 to 84 Inches in Diameter: 0.064 inch.
  3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg:
    - a. Ducts 3 to 26 Inches in Diameter: 0.034 inch.
    - b. Ducts 27 to 50 Inches in Diameter: 0.040 inch.
    - c. Ducts 52 to 60 Inches in Diameter: 0.052 inch.
    - d. Ducts 62 to 84 Inches in Diameter: 0.064 inch.
  4. Flat-Oval Mitered Elbows: Welded construction with same metal thickness as longitudinal-seam flat-oval duct.

5. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.
6. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
7. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
8. Round Elbows Larger Than 14 Inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.
9. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick with 2-piece welded construction.
10. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.
11. Flat-Oval Elbow Metal Thickness: Same as longitudinal-seam flat-oval duct specified above.
12. Pleated Elbows for Sizes through 14 Inches in Diameter and Pressures through 10-Inch wg: 0.022 inch.

## 2.10 DOUBLE-WALL DUCT AND FITTING FABRICATION

### A. Manufacturers:

1. Eastern Sheet Metal (ESM).
2. LaPine Metal Products.
3. Lindab Inc.
4. McGill AirFlow Corporation.
5. SEMCO Incorporated.
6. SET Duct Manufacturing, Inc.
7. Tangent Air Inc.
8. Universal Spiral Air.

### B. Ducts: Fabricate double-wall (insulated) ducts with an outer shell and an inner duct. Dimensions indicated are for inner ducts.

1. Outer Shell: Base metal thickness on outer-shell dimensions. Fabricate outer-shell lengths 2 inches longer than inner duct and insulation and in metal thickness specified for single-wall duct.
2. Insulation: 1-inch- thick fibrous glass, unless otherwise indicated. Terminate insulation where double-wall duct connects to single-wall duct or uninsulated components, and reduce outer shell diameter to inner duct diameter.
  - a. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
3. Solid Inner Ducts: Use the following sheet metal thicknesses and seam construction:

- a. Ducts 3 to 8 Inches in Diameter: 0.019 inch with standard spiral-seam construction.
    - b. Ducts 9 to 42 Inches in Diameter: 0.019 inch with single-rib spiral-seam construction.
    - c. Ducts 44 to 60 Inches in Diameter: 0.022 inch with single-rib spiral-seam construction.
    - d. Ducts 62 to 88 Inches in Diameter: 0.034 inch with standard spiral-seam construction.
  4. Perforated Inner Ducts: Fabricate with 0.028-inch- thick sheet metal having 3/32-inch-diameter perforations, with overall open area of 23 percent.
    - a. Provide 1 mil mylar liner between acoustical insulation and perforated inner liner.
  5. Maintain concentricity of inner duct to outer shell by mechanical means. Prevent dislocation of insulation by mechanical means.
- C. Fittings: Fabricate double-wall (insulated) fittings with an outer shell and an inner duct.
1. Solid Inner Ducts: Use the following sheet metal thicknesses:
    - a. Ducts 3 to 34 Inches in Diameter: 0.028 inch.
    - b. Ducts 35 to 58 Inches in Diameter: 0.034 inch.
    - c. Ducts 60 to 88 Inches in Diameter: 0.040 inch.
  2. Perforated Inner Ducts: Fabricate with 0.028-inch- thick sheet metal having 3/32-inch-diameter perforations, with overall open area of 23 percent.

### PART 3 - EXECUTION

#### 3.1 DUCTWORK APPLICATION SCHEDULE

- A. Ductwork materials and performance requirements are scheduled on the Drawing.

#### 3.2 DUCTWORK APPLICATION SCHEDULE

- A. Ductwork materials and performance requirements are scheduled on the Drawing.

#### 3.3 DUCT INSTALLATION

- A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
- B. Install round and flat-oval ducts in lengths not less than 12 feet unless interrupted by fittings.
- C. Install ducts with fewest possible joints.
- D. Install fabricated fittings for changes in directions, size, and shape and for connections.
- E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.
- F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.



- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
- J. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.
- K. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
- L. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.
- N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, and sleeves. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories."
- O. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.
- P. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."
  - 1. Intermediate level.

### 3.4 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.

### 3.5 DUCT SEALING

- A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated. Ducts must be properly cleaned and sealed in strict accordance with sealant manufacturer's instructions.
  - 1. Seal Class: Refer to Application Schedule on the Drawings.

2. Seal ducts before external insulation is applied.
3. After pressure testing, remake leaking joints until leakage is equal to or less than maximum allowable. Refer to Application Schedule on the Drawings for allowable leakage rates.

### 3.6 HANGING AND SUPPORTING

- A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
- B. Support vertical ducts at maximum intervals of 16 feet and at each floor.
- C. Install concrete inserts before placing concrete.
- D. Support ductwork from building structure, not from roof deck, floor slab, pipe, other ducts, or equipment.
- E. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
- F. Install roof mounted duct supports in accordance with manufacturer's instructions. Provide additional membrane layer or walkpads under support bases as required.
- G. Use load rated cable suspension system for round duct in exposed locations.

### 3.7 CONNECTIONS

- A. Make connections to equipment with flexible connectors according to Division 23 Section "Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

### 3.8 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

### 3.9 FIELD QUALITY CONTROL

- A. Duct System Cleanliness Tests:
  1. Visually inspect duct system to ensure that no visible contaminants are present.
- B. Duct system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.10 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing."

**\*\*END OF SECTION\*\***

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 20 Section "Mechanical General Requirements."
  - 2. Division 23 Section "Duct Accessories" for dampers, duct-mounting access doors and panels, turning vanes, and flexible ducts.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including duct closure, reinforcements, and hangers and supports, shall comply with SMACNA's "Fibrous Glass Duct Construction Standards" and performance requirements and design criteria indicated.
  - 1. Static-Pressure Classes:
    - a. Supply Ducts (except in Mechanical Rooms): 1-inch wg.
    - b. Supply Ducts (Upstream from Air Terminal Units): 2-inch wg.
    - c. Supply Ducts (Downstream from Air Terminal Units): 1-inch wg.
    - d. Supply Ducts (in Mechanical Equipment Rooms): 2-inch wg.
    - e. Return Ducts (Negative Pressure): 1-inch wg.
    - f. Exhaust Ducts (Negative Pressure): 1-inch wg.

#### 1.3 DEFINITIONS

- A. Thermal Conductivity and Apparent Thermal Conductivity (k-Value): As defined in ASTM C 168. In this Section, these values are the result of the formula  $Btu \times in./h \times sq. ft. \times deg F$  at temperature differences specified. Values are expressed as Btu.
  - 1. Example: Apparent Thermal Conductivity (k-Value): 0.26.

1.4 SUBMITTALS

- A. Product Data: For the following:
  - 1. Fabric ducts.
- B. Shop Drawings: Drawn to 1/4 inch equals 1 foot. Show fabrication and installation details for nonmetal ducts.
  - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
  - 2. Duct layout indicating sizes and pressure classes.
  - 3. Elevations of top and bottom of ducts.
  - 4. Dimensions of main duct runs from building grid lines.
  - 5. Fittings.
  - 6. Reinforcements and spacing.
  - 7. Seam and joint construction.
  - 8. Penetrations through fire-rated and other partitions.
  - 9. Equipment installation based on equipment being used on Project.
  - 10. Duct accessories, including access doors and panels.
  - 11. Hangers and supports, including methods for duct and building attachment, vibration isolation.
- C. Delegated-Design Submittal:
  - 1. Duct materials and thicknesses.
  - 2. Joint and seam construction and sealing.
  - 3. Reinforcement details and spacing.
  - 4. Design Calculations: Calculations for selecting hangers and supports.
- D. Coordination Drawings: Reflected ceiling 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. Ceiling suspension assembly members.
  - 2. Other systems installed in same space as ducts.
  - 3. Ceiling- and wall-mounting access doors and panels required to provide access to dampers and other operating devices.
  - 4. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- A. Welding certificates.

- B. Field quality-control reports.

## 1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
  - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
- B. NFPA Compliance:
  - 1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
  - 2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- C. UL Compliance: UL listed and labeled as complying with UL 181.

## 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 FABRIC DUCTS

- A. Manufacturers:
  - 1. Ductsox Corporation.
  - 2. FabricAir, Inc.
- B. Performance Requirements: Classified by UL in accordance with the 25/50 flame spread/smoke developed requirements of NFPA 90A.
- C. Material: Air diffusers shall be constructed of a woven fire retardant fabric complying with the following physical characteristics:
  - 1. Fabric Construction: Fabric shall be constructed of a polyester that includes 55 percent recycled content (80 percent post-industrial and 20 percent post-consumer), treated with a machine wash-able anti-microbial agent by the fabric manufacturer, of a non-linting filament yarn to meet the requirements of ISO Class 3 environment, and 100percent flame retardant.
  - 2. Weight: 6.8 oz./sq yd in accordance with ASTM D3776
  - 3. Color: Standard color as selected by Architect.
  - 4. Fabric Porosity: 2 (+2/-1) cfm/sq ft in accordance with ASTM D737, Frazier.
  - 5. Temperature Range: 0 deg F to 180 deg F.
  - 6. Fire Retardancy: Classified by Underwriters Laboratories in accordance with the flame spread/smoke developed requirements NFPA 90, ICC AC167 and UL 2518.

7. Antimicrobial agent shall be proven 99 percent effective after 10 laundry cycles in accordance with AATCC Test Method 100.

D. System Fabrication Requirements:

1. Textile system constructed in modular lengths (zippered) with proper securing clips, inlets, end caps, and mid-sections.
2. Integrated air dispersion shall be:
  - a. Linear Vents:
    - 1) Air dispersion accomplished by linear vent and permeable fabric. Linear vents must be sized in 1 CFM per linear foot increments (based on 0.5 inch static pressure), starting at 1 CFM through 90 CFM per linear foot. Linear vent is to consist of an array of open orifices rather than a mesh style vent to reduce maintenance requirements of mesh style vents. Linear vents should also be designed to minimize dusting on fabric surface.
    - 2) Size of vent openings and location of linear vents to be specified and approved by manufacturer.
  - b. Fixed Nozzles:
    - 1) Air dispersion accomplished by using conical aerodynamic nozzles and permeable fabric. Diameter of nozzles and nozzle height shall be minimum 1/2 inch. Due to exact requirements of throw and maximum level of noise alternative flow models are not acceptable.
    - 2) Color of nozzles must match color of fabric. Unless otherwise specifically mentioned on drawings or otherwise in this specification, suppliers standard table is used for selection of color.
    - 3) Location and number of nozzles shall be specified and approved by manufacturer.
3. Inlet connection to metal duct via fabric draw band with anchor patches as supplied by manufacturer. Anchor patches shall be secured to metal duct via. zip screw fastener (supplied by contractor).
4. Inlet connection includes zipper for easy removal and maintenance.
5. Lengths shall include required intermediate zippers as specified by manufacturer.
6. System shall include adjustable flow devices to balance turbulence, airflow and distribution as needed. Flow restriction device shall include ability to adjust the airflow resistance from 0.06 to 0.60 in wg static pressure.
7. End cap includes zipper for easy maintenance.
8. Each section of fabric duct shall include identification labels documenting order number, section diameter, section length, piece number, code certifications and other pertinent information.

E. Design Parameters:

1. Designed for 0.5 inch water gage, yielding maximum operating pressure of 3.1 inches water gage.

2. Fabric diffusers limited to design temperatures between 10 deg F and 180 deg F.
3. Design cfm, static pressure, and diffuser length shall be designed or approved by manufacturer.
4. Do not use fabric diffusers in concealed locations.
5. Use fabric diffusers for positive pressure air distribution components of the mechanical ventilation system only.

F. Suspension Hardware:

1. 3x1 Extruded Track Suspension: (Available for duct diameters from 10-inches to 48-inches) System shall consist of a 3x1 hanger used in conjunction with an extruded track suspension system. System shall include a 3 Row connection to fabric system at 10, 12, and 2 o'clock locations. The powder-coated aluminum hangers are secured and connected to a single (1 Row) extruded aluminum track every 3 feet and connect to the fabric system at the 10 and 2 o'clock locations with detachable D-Clasps. The fabric system will also have intermediate track tabs located at 12 o'clock and between the hangers to attach directly to the extruded track suspension system located 3 inches above top-dead-center location of the fabric system. Hardware to include 8-foot sections of track, splice connectors, track end caps, and vertical cable support kits consisting of a length of cable with a locking stud end and Gripple quick cable connectors. Radius aluminum track must be included for all radius sections.
2. Internal Hoop System and Extruded Track Suspension System: (Available for duct diameters from 8-inches to 60 inches). System consists of metallic internal hoops spaced 5 feet apart and attached to the interior of the fabric duct at the 4, 8, and 12 o'clock positions. Suspension system consists of 8 foot sections of extruded track, couplers, end caps, locking cable drop supports or surface mount clips, and gliders spaced every 24 inches. Furnish T-bar connection hardware where required.

2.3 HANGERS AND SUPPORTS

- A. Building Attachments: Concrete inserts, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
- B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
  1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
  2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
  3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.
- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials. Attachments for stainless steel and PVC-coated duct shall be stainless steel.
- D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.
  1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
  2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.

3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.
- E. Load Rated Cable Suspension System: Tested to five times the Safe Working Loads and verified by the SMACNA Testing and Research Institute.
  1. Cable: Aircraft quality zinc coated 7 x 7 and 7 x 19 wire rope.
  2. Fastener: One-piece, die-cast zinc housing with Type 302 S26 stainless steel hardened and tempered springs, and oil impregnated, sintered, hardened and tempered steel locking wedges.
  3. End Fixings: Loop, stud or toggle; or plain end suitable for wire rope beam clamp.
  4. Manufacturers:
    - a. Ductmate Industries, Inc.; Clutcher and EZ-Lock.
    - b. Duro Dyne Corp.; Dyna-Tite System.
    - c. Gripple Inc.; Hang-Fast System.
- F. Welded Supports: Structural steel shapes with zinc rich paint. Equivalent, proprietary design, rolled steel structural support systems may be used in lieu of mill rolled structural steel.

### PART 3 - EXECUTION

#### 3.1 APPLICATION AND INSTALLATION

- A. Install nonmetal duct where indicated and as detailed on Drawings.
- B. Install ducts with fewest possible joints.
- C. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
- D. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- E. Install ducts with a clearance of 1 inch.
- F. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
- G. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts with sheet metal flanges. Overlap opening on 4 sides by at least 1-1/2 inches.
- H. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers and sleeves. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories."

#### 3.2 HANGER AND SUPPORT INSTALLATION

- A. Duct Attachments: Support horizontal ducts with trapeze-type hangers.
- B. Hangers: Suspend duct attachments from building attachments with one of the following hanger types:
  1. Galvanized sheet metal strips, a minimum of 0.034 by 1 inch wide.



2. Galvanized-steel rods, 1/4 inch in diameter, threaded along entire length.
  3. Load rated cable suspension system.
- C. Attach hangers to joints and reinforcing channels that occur within required hanger spacing. Attach hangers to transmit load to sides and bottom channels and no more than 6 inches from sides of ducts.
  - D. Support equipment and metal duct components and accessories independent of ducts.
  - E. Support terminal components separately.
  - F. Install sheet metal sleeves to support dampers. For motorized dampers, extend sleeves to support operators.
  - G. Install concrete inserts before placing concrete.
  - H. 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.
- 3.3 FIELD QUALITY CONTROL
- A. Perform tests and inspections.
  - B. Duct System Cleanliness Tests:
    1. Visually inspect duct system to ensure that no visible contaminants are present.
  - C. Duct system will be considered defective if it does not pass tests and inspections.
  - D. Prepare test and inspection reports.
- 3.4 START UP
- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing."

**\*\*END OF SECTION\*\***

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  1. Division 20 Section "Mechanical General Requirements."
  2. Division 23 Section "Testing, Adjusting, and Balancing" for duct test holes.
  3. Division 23 Section "Temperature Controls" for motorized control dampers.
  4. Division 28 Section "Fire Alarm" for duct-mounting fire and smoke detectors.

1.2 DEFINITIONS

- A. NVLAP: National Voluntary Laboratory Accreditation Program.
- B. Low Pressure: Up to 2 inch WG and velocities less than 1,500 fpm. Construct for 2 inch WG positive or negative static pressure.
- C. Medium Pressure: Greater than 2 inch WG to 6 inch WG and velocities greater than 1,500 fpm and less than 2,500 fpm. Construct for 6 inch WG positive or negative static pressure.
- D. High Pressure: Greater than 6 inch WG to 12 inch WG and velocities greater than 2,500 fpm. Construct for 12 inch WG positive or negative static pressure.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
  - 1. For turning vanes, include data for pressure loss generated sound power levels.
  - 2. For duct silencers, include pressure drop and dynamic insertion loss data.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
  - 1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
    - a. Special fittings.
    - b. Manual volume damper installations.
    - c. Control damper installations.
    - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
    - e. Duct security bars.
    - f. Wiring Diagrams: 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.
- D. Source quality-control reports.
- E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

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."
- B. Comply with AMCA 500-D testing for damper rating.

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 for each temperature rating.

## 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 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. Stainless Steel: ASTM A 480/A 480M, Types 304 and 316 as indicated.
- D. Aluminum Sheets: ASTM B 209, 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, 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 minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.
- H. Tie Rods: Stainless steel, 1/4-inch diameter for lengths 36 inches or less; 3/8-inch diameter for lengths longer than 36 inches for use in ducts in humid or corrosive atmospheres.
- I. Bird Screens: No. 2 mesh, 0.063 inch diameter galvanized wire screen with open area of not less than 72 percent. Conceal sharp edges by adding metal edging consisting of rod, flat or angle iron, or 16 gage galvanized sheet steel turned over at least 3/4 inch on both sides.

### 2.3 BACKDRAFT DAMPERS

- A. Manufacturers:
  1. American Warming and Ventilating.
  2. Greenheck.
  3. Ruskin Company.
- B. Description: Multiple-blade, parallel action counterbalanced, with blades of maximum 6-inch 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. Performance: Based on tests in accordance with AMCA Standard 500:

1. Pressure drop not to exceed 0.15 inch wg at face velocity of 2500 fpm.
  2. Leakage not to exceed 9.2 cfm per square foot at 1 inch wg differential and temperature of 70 deg F.
- D. Frame: 0.052-inch- thick, galvanized sheet steel or 0.063-inch- thick extruded aluminum, with welded corners and mounting flange.
- E. Blades: 0.025-inch- thick, roll-formed aluminum or 0.050-inch- thick aluminum sheet.
- F. Blade Seals: Manufacturer's standard seal material.
- G. Blade Axles: Nonferrous or galvanized steel.
- H. Tie Bars and Brackets: Aluminum or galvanized steel.
- 2.4 LOW PRESSURE MANUAL VOLUME DAMPERS
- A. Manufacturers:
1. American Warming and Ventilating.
  2. Arrow United Industries.
  3. Greenheck.
  4. Krueger.
  5. Louvers and Dampers.
  6. Nailor Industries Inc.
  7. Ruskin Company.
  8. Vent Products Company, Inc.
  9. Young Regulator 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. Except for dampers in round ductwork sized 12 inches and smaller, provide end bearings.
- C. Rectangular Volume Dampers: Multiple-opposed-blade design, AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications.
- D. Round Volume Dampers 16-inch Diameter and Smaller: Single-blade design, AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications.

- E. Round Volume Dampers Larger than 16-inch Diameter: Multiple-opposed-blade design AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications.
  - F. Damper Materials:
    - 1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
    - 2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.
    - 3. Blade Axles: Galvanized steel.
    - 4. Bearings: Oil-impregnated bronze, molded synthetic, or stainless-steel sleeve type.
    - 5. Tie Bars and Brackets: Galvanized steel.
  - G. Jackshaft: 1-inch- 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.
  - H. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.
- 2.5 MEDIUM OR HIGH PRESSURE MANUAL VOLUME DAMPERS
- A. Manufacturers:
    - 1. American Warming and Ventilating.
    - 2. Greenheck.
    - 3. Louvers and Dampers.
    - 4. Nailor Industries Inc.
    - 5. Ruskin Company.
    - 6. Vent Products Company, Inc.
  - B. General Description: Factory fabricated, galvanized steel or extruded aluminum construction, 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.
  - C. Rectangular Volume Dampers: Multiple-opposed-blade design, AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications. Construction and assembly such that no noise producing blade vibration occurs at velocities 20 percent greater than maximum system design velocity.
  - D. Round Volume Dampers 16-inch Diameter and Smaller: Single-blade, or multiple-opposed-blade design, AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff,

and suitable for horizontal or vertical applications. Construction and assembly such that no noise producing blade vibration occurs at velocities 20 percent greater than maximum system design velocity.

- E. Round Volume Dampers Larger than 16-inch Diameter: Multiple-opposed-blade design, AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications. Construction and assembly such that no noise producing blade vibration occurs at velocities 20 percent greater than maximum system design velocity.
- F. Damper Materials:
  - 1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
  - 2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.
  - 3. Aluminum Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
  - 4. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
  - 5. Blade Axles: Galvanized steel or stainless steel.
  - 6. Bearings: Oil-impregnated bronze, molded synthetic, or stainless-steel sleeve type.
  - 7. Tie Bars and Brackets: Aluminum or galvanized steel.
- G. Jackshaft: 1-inch- 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.
- H. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

## 2.6 LOW LEAKAGE MANUAL VOLUME DAMPERS

- A. Low-Leakage, Steel, Manual Volume Dampers:
  - 1. Manufacturers:
    - a. American Warming and Ventilating.
    - b. Greenheck.
    - c. Louvers and Dampers; a division of Mestek, Inc.
    - d. Nailor Industries Inc.
    - e. Ruskin Company.
    - f. Vent Products Company, Inc.
  - 2. Low-leakage rating and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

3. Suitable for horizontal or vertical applications.
  4. Frames:
    - a. Angle shaped.
    - b. Galvanized-steel channels, 0.064 inch thick.
    - c. Mitered and welded corners.
    - d. Flanges for attaching to walls and flangeless frames for installing in ducts.
  5. Blades:
    - a. Multiple or single blade.
    - b. Opposed-blade design.
    - c. Stiffen damper blades for stability.
    - d. Galvanized, roll-formed steel, 0.064 inch thick.
  6. Blade Axles: Galvanized steel.
  7. Bearings:
    - a. Stainless-steel sleeve.
    - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
  8. Blade Seals: Neoprene.
  9. Jamb Seals: Cambered aluminum.
  10. Tie Bars and Brackets: Galvanized steel.
  11. Accessories:
    - a. Include locking device to hold single-blade dampers in a fixed position without vibration.
- B. Low-Leakage, Aluminum, Manual Volume Dampers:
1. Manufacturers:
    - a. American Warming and Ventilating.
    - b. Greenheck.
    - c. Louvers and Dampers; a division of Mestek, Inc.
    - d. Nailor Industries Inc.
    - e. Ruskin Company.
    - f. Vent Products Company, Inc.
  2. Low-leakage rating and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
  3. Suitable for horizontal or vertical applications.
  4. Frames: Angle-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.



5. Blades:
  - a. Multiple or single blade.
  - b. Opposed-blade design.
  - c. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
  - d. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
6. Blade Axles: Galvanized steel.
7. Bearings:
  - a. Stainless-steel sleeve.
  - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Blade Seals: Neoprene.
9. Jamb Seals: Cambered aluminum.
10. Tie Bars and Brackets: Galvanized steel.
11. Accessories:
  - a. Include locking device to hold single-blade dampers in a fixed position without vibration.

C. Jackshaft:

1. Size: 1-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

D. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.7 MANUAL VOLUME DAMPERS (IRIS STYLE)

A. Manufacturers:

1. Continental Fan Manufacturing, Inc.; IRIS Series.
2. Fantech; Systemair Group; IR Series.
3. Ruskin Company; VFBD35.

- B. Description: Round manual volume damper complete with pressure ports, constructed of galvanized steel, fitted with a neoprene gasket, and using interlocking steel plates and calibrated control lever to form an adjustable aperture.

2.8 MOTORIZED CONTROL DAMPERS

- A. Refer to Division 23 Section "Temperature Controls."

2.9 BLAST GATES

- A. Manufacturers:
  - 1. Dixie Sheet Metal.
  - 2. LaPine Metal Products.
  - 3. Semco.
- B. Full-body style, factory fabricated of minimum 18 gage, galvanized sheet metal.

2.10 FIRE DAMPERS (CURTAIN STYLE)

- A. Manufacturers:
  - 1. Air Balance, Inc.
  - 2. Greenheck.
  - 3. NCA Manufacturing, Inc.
  - 4. Nailor Industries Inc.
  - 5. Ruskin Company.
- B. Dynamic fire dampers with curtain style blades, and labeled according to UL 555, maximum velocity 2000 fpm, maximum static pressure 4 inches w.g.
- C. Fire Rating:
  - 1. 1-1/2 hours for 2 hour rated walls.
  - 2. 3 hours for 4 hour rated walls.
- D. Frame: Type B or Type C Curtain type with blades outside airstream; fabricated with roll-formed, galvanized steel in gages required by manufacturer's UL listing; with mitered and interlocking corners.
- E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
  - 1. Thickness: Equal to or thicker than the duct connected to it, and of length to suit application.
  - 2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.

- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- H. Fusible Links: Replaceable, 165 deg F rated.

2.11 FIRE DAMPERS (MULTIPLE BLADE TYPE)

- A. Manufacturers:
  - 1. Greenheck.
  - 2. NCA Manufacturing, Inc.
  - 3. Nailor Industries Inc.
  - 4. Ruskin Company.
- B. Dynamic fire dampers with multiple blades, and labeled according to UL 555, maximum velocity of 2000 fpm, maximum static pressure 4 inches w.g.
- C. Fire Rating:
  - 1. 1-1/2 hours for 2 hour rated walls.
  - 2. 3 hours for 4 hour rated walls.
- D. Frame: Fabricated with roll-formed, galvanized steel in gages required by manufacturer's UL listing; with mitered and interlocking corners.
- E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
  - 1. Thickness: Equal to or thicker than the duct connected to it, and of length to suit application.
  - 2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.
- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. Blades: Parallel operation, single-piece airfoil type construction with 0.078 inch equivalent thickness, or 0.064 inch thick, roll-formed, triple v-groove.
- H. Axles: 1/2 inch plated steel hex.
- I. Bearings: Stainless steel, or oil-impregnated bronze sleeve type, pressed into frame.
- J. Linkage: Concealed in frame.
- K. Fusible Links: Replaceable, 165 deg F rated.

2.12 SMOKE DAMPERS

- A. Manufacturers:

1. Air Balance, Inc.
  2. Greenheck.
  3. Nailor Industries Inc.
  4. NCA Manufacturing, Inc.
  5. Ruskin Company.
- B. General Description: Smoke dampers with airfoil blades, labeled according to UL 555S, with minimum Class II leakage rating.
- C. Smoke Detector: Integral, factory wired for single-point connection.
- D. Frame and Blades: 16 gage, galvanized sheet steel.
- E. Mounting Sleeve: Factory-installed, galvanized sheet steel.
1. Thickness: Equal to or thicker than the duct connected to it, and of length to suit application.
- F. Rated pressure and velocity to exceed design airflow conditions.
- G. Damper Actuators: Electric modulating or two-position action as required.
1. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
  2. Size for torque required for damper seal at load conditions.
  3. Overload Protection: Microprocessor or an electronic based motor controller providing burnout protection if stalled before full rotation is reached. The actuator shall be electronically cut off at full open to eliminate noise generation with the holding noise level to be inaudible.
  4. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
  5. Power Requirements (Two-Position Spring Return): 24 or 120 V ac.
  6. Power Requirements (Proportional): Maximum (running) 12 VA at 24-V ac or 8 W at 24-V dc. Maximum (holding) 5VA at 24-V ac or 3 W at 24-V dc holding.
  7. Proportional Actuators (24V ac/dc): Control signal shall be 0-10vdc, 2-10vdc or 4-20mA as required to operate with associated controller. Include position feedback signal for 0-10vdc, 2-10vdc or 4-20mA as required to be monitored by associated controller.
  8. Actuator timing shall meet 15 sec.
  9. Temperature Rating: Actuator shall have a UL555S listing by the damper manufacturer for 250 deg F.
- H. Damper Actuators: Pneumatic modulating or two-position action.

1. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing.
  2. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
  3. Actuator Degradation Temperature: Not to exceed 250 deg F .
  - I. Damper blade position end switches: Factory installed damper position switch package for both full open and full closed indication (equivalent to Ruskin SP100 switch package).
  - J. Test Switch: Damper Remote mounted momentary "test" push-button mounted 3-position "normal/closed/override" toggle switch rated for 24V or 120V as required to allow testing and/or maintenance of motorized dampers.
    1. For pneumatic actuators, include factory installed electric/pneumatic (EP) switch for testing function.
    2. Include damper remote mounted "open" and "closed" indication lights on switch plate for connection to factory installed damper blade position end switches.
- 2.13 COMBINATION FIRE AND SMOKE DAMPERS
- A. Manufacturers:
    1. Air Balance, Inc.
    2. Greenheck.
    3. Nailor Industries Inc.
    4. NCA Manufacturing, Inc.
    5. Ruskin Company.
  - B. General Description: Combination fire and smoke dampers shall be labeled according to UL 555 and UL 555S. Leakage shall not exceed 10 cfm per square foot at 1 inch WG differential pressure (Leakage Class II).
  - C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.
  - D. Fire Rating:
    1. 1-1/2 hours for 2 hour rated walls.
    2. 3 hours for 4 hour rated walls.
  - E. Smoke Detector: Integral, factory wired for single-point connection.
  - F. Frame and Blades: 0.064-inch- thick, galvanized sheet steel.
  - G. Mounting Sleeve: Factory-installed, galvanized sheet steel.
    1. Thickness: Equal to or thicker than the duct connected to it, and of length to suit application.

- H. Rated pressure and velocity to exceed design airflow conditions.
- I. Damper Actuators: Electric modulating or two-position action as required.
  - 1. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
  - 2. Size for torque required for damper seal at load conditions.
  - 3. Overload Protection: Microprocessor or an electronic based motor controller providing burnout protection if stalled before full rotation is reached. The actuator shall be electronically cut off at full open to eliminate noise generation with the holding noise level to be inaudible.
  - 4. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
  - 5. Power Requirements (Two-Position Spring Return): 24 or 120 V ac.
  - 6. Power Requirements (Proportional): Maximum (running) 12 VA at 24-V ac or 8 W at 24-V dc. Maximum (holding) 5VA at 24-V ac or 3 W at 24-V dc holding.
  - 7. Proportional Actuators (24V ac/dc): Control signal shall be 0-10vdc, 2-10vdc or 4-20mA as required to operate with associated controller. Include position feedback signal for 0-10vdc, 2-10vdc or 4-20mA as required to be monitored by associated controller.
  - 8. Actuator timing shall meet 15 sec.
  - 9. Temperature Rating: Actuator shall have a UL555S listing by the damper manufacturer for 250 deg F.
- J. Damper Actuators: Pneumatic modulating or two-position action.
  - 1. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing.
  - 2. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
  - 3. Actuator Degradation Temperature: Not to exceed 250 deg F.
- K. Manual Heat Responsive Fuse Link with Reset and Damper Blade Position End Switches: Factory installed manual heat responsive fuse link with reset switch / damper position switch package for both full open and full closed indication (equivalent to Ruskin TS150 switch package).
- L. Test Switch: Damper Remote mounted momentary "test" push-button mounted 3-position "normal/closed/override" toggle switch rated for 24V or 120V as required to allow testing and/or maintenance of motorized dampers.
  - 1. Include damper remote mounted "open" and "closed" indication lights on switch plate for connection to factory installed damper blade position end switches.

2.14 TURNING VANES

A. Manufactured Turning Vanes:

1. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.
2. Double-vane or airfoil-shaped, curved blades of galvanized sheet steel set into vane runners suitable for duct mounting.
3. Generated sound power level shall not exceed 54 decibels in octave band 4 at 2000 fpm in a 24-inch by 24-inch duct.
4. Manufacturers:
  - a. Aero/Dyne Company; H-E-P Turning Vanes.
  - b. Ductmate Industries, Inc.
  - c. Duro Dyne Corp.
  - d. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Acoustic Turning Vanes:

1. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.
2. Double-vane curved blades of galvanized sheet steel with perforated faces and fibrous-glass fill set into vane runners suitable for duct mounting.
3. Manufacturers:
  - a. Ductmate Industries, Inc.
  - b. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

2.15 DUCT-MOUNTING ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class. Doors may be field fabricated in accordance with SMACNA Standards, or commercially produced.

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 butt or piano hinge and cam latches.

1. Manufacturers:
  - a. Air Balance, Inc.
  - b. Greenheck.
  - c. Nailor Industries Inc.
  - d. Ruskin Company.
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 Square: Secure with two sash locks.
  - b. Up to 18 Inches Square: Two hinges and two compression locks.

- c. Up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
    - d. Sizes 24 by 48 Inches and Larger: One additional hinge.
  - C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch thickness. Include cam latches.
    - 1. Manufacturers:
      - a. Ductmate Industries, Inc.
      - b. Flexmaster U.S.A., Inc.
    - 2. Frame: Galvanized sheet steel, with spin-in notched frame.
  - D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.
  - E. Insulation: 1-inch-thick, fibrous-glass or polystyrene-foam board.
- 2.16 DUCT ACCESS PANEL ASSEMBLIES
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1. Ductmate Industries, Inc.
    - 2. Flame Gard, Inc.
    - 3. 3M.
  - B. Labeled according to UL 1978 by an NRTL.
  - C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.
  - D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.
  - E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
  - F. Minimum Pressure Rating: 10-inch wg, positive or negative.
- 2.17 FLEXIBLE CONNECTORS
- A. Manufacturers:
    - 1. ADSCO Manufacturing LLC.
    - 2. Duro Dyne Corp.
    - 3. Senior Flexonics Pathway.
    - 4. Ventfabrics, 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- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- 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..
  - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
  - 3. Service Temperature: Minus 40 to plus 200 deg F.
- 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..
  - 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
  - 3. Service Temperature: Minus 50 to plus 250 deg F.
- F. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
  - 1. Minimum Weight: 16 oz./sq. yd..
  - 2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
  - 3. Service Temperature: Minus 67 to plus 500 deg F.
- G. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
  - 1. Minimum Weight: 14 oz./sq. yd..
  - 2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
  - 3. Service Temperature: Minus 67 to plus 500 deg F.

## 2.18 FLEXIBLE DUCTS, LOW AND MEDIUM PRESSURE

- A. Manufacturers:
  - 1. Flexmaster Type 8M, UL 181, Class 1.
  - 2. Automation Industries Thermaflex.
  - 3. Hart & Cooley.
- B. Flexible Ducts: Interlocking spiral of galvanized steel or aluminum construction or fabric supported by helically wound spring steel wire or flat steel bands; rated to 6 inches WG positive and 4 inches WG negative for low and medium pressure ducts.
- C. Insulated Flexible Ducts: Flexible duct wrapped with flexible glass fiber insulation, enclosed by a fire retardant polyethylene vapor barrier jacket; maximum 0.23 K value at 75 deg F .

- D. Acoustical performance tested 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:

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 minimum:

Octave Band Hz.	2	3	4	5	6	7
6" diameter	8	32	38	35	39	25
8" diameter	13	32	36	35	36	21
12" diameter	15	29	28	33	26	14

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 minimum:

Octave Band Hz.	2	3	4	5	6	7
6" diameter	6	8	7	8	9	13
8" diameter	9	6	6	7	8	10
12" diameter	9	7	6	6	8	11

The self generated sound power levels (LW) dB are 10-12 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 Hz.	2	3	4	5	6	7
6" diameter	42	31	23	18	17	21
8" diameter	41	34	27	19	18	21
12" diameter	53	44	36	27	21	22

- E. Flexible Duct Fittings: Galvanized steel, twist-in design with damper. Size as indicated.
- F. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches to suit duct size.

## 2.19 FLEXIBLE DUCT ELBOW SUPPORTS

- A. Manufacturer:
- Automation Industries Thermaflex; FlexFlow Elbow.
  - Smart Air & Energy Solutions; SMART Flow Elbow.
- B. Elbow supports shall be constructed of durable composite material and be fully adjustable to support flexible duct diameters 6 inches through 16 inches.
- C. Elbow supports shall be UL listed for use in return air plenum spaces.

## 2.20 DUCT ACCESSORY HARDWARE

- A. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

## 2.21 FINISHES

- A. Chemical Resistant Coating: P-403 manufactured by Heresite Chemical Company.

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 and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts and PVC coated ducts; and aluminum accessories in aluminum ducts.
- C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers in ducts with liner in a manner that avoids damage to and erosion of duct liner.
- E. 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.
- F. Install fire and smoke dampers according to UL listing.
- G. Install duct security bars. Construct duct security bars from 0.164-inch steel sleeve, continuously welded at all joints and 1/2-inch- diameter steel bars, 6 inches o.c. in each direction in center of sleeve. Weld each bar to steel sleeve and each crossing bar. Weld 2-1/2-by-2-1/2-by-1/4-inch steel angle to 4 sides and both ends of sleeve. Connect duct security bars to ducts with flexible connections. Provide 12-by-12-inch hinged access panel with cam lock in duct in each side of sleeve.
- H. Install duct silencers rigidly to ducts.
- I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
  - 1. On both sides of duct coils.
  - 2. Upstream from duct filters.
  - 3. At outdoor-air intakes and mixed-air plenums.
  - 4. At drain pans and seals.
  - 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
  - 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
  - 7. Control devices requiring inspection.
  - 8. Elsewhere as indicated.

- J. Install access doors with swing against duct static pressure.
- K. Install duct-mounting, rectangular access doors with long dimension at right angles to direction of airflow and of largest standard size which can be accommodated in duct. Maximum size: 21 by 14 inches.
- L. Install pressure relief doors vertically and level in accordance with manufacturer's instructions, between the fan and first operable damper.
- M. Label access doors according to Division 20 Section "Mechanical Identification."
- N. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.
- O. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- P. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- Q. Connect diffusers or light troffer boots to low pressure ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- R. Connect flexible ducts to metal ducts with draw bands.
- S. Install flexible duct elbow supports at each diffuser, grille, or register, and elsewhere as indicated.
- T. Install turning vanes in rectangular duct elbows in excess of 45 degrees, and where indicated:
  - 1. Use manufactured double-vane turning vanes unless otherwise specified.
  - 2. Seat outboard-most vane in heel of duct elbow.
  - 3. Provide vanes for all runner punchings, practice of eliminating every other vane is prohibited.
  - 4. Use single-vane turning vanes in low pressure square elbows.

### 3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. Operate dampers to verify full range of movement.
  - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
  - 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
  - 4. Inspect turning vanes for proper and secure installation.
  - 5. Operate remote damper operators to verify full range of movement of operator and damper.

3.3 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 23 Section "Testing, Adjusting, and Balancing."

\*\*END OF SECTION\*\*

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 20 Section "Mechanical General Requirements."
  - 2. Division 20 Section "Motors."
  - 3. Division 23 Section "Common Work Results for HVAC" for common mechanical drive requirements for fans and air moving equipment.

#### 1.2 SUMMARY

- A. This Section includes replacement fans for air-handling units and similar equipment.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. AMCA Compliance:
  - 1. Operating Limits: Classify according to AMCA 99.

#### 1.4 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
  - 1. Certified fan performance curves with system operating conditions indicated.

2. Certified fan sound-power ratings.
  3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
  4. Material thickness and finishes, including color charts.
  5. Dampers, including housings, linkages, and operators.
- 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. Wiring Diagrams: Power, signal, and control wiring.
  2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
  3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
- C. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For centrifugal fans to include in operation and maintenance manuals.
- 1.5 QUALITY ASSURANCE
- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
  - B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- 1.6 DELIVERY, STORAGE, AND HANDLING
- A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.
  - B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.
  - C. Lift and support units with manufacturer's designated lifting or supporting points.
- 1.7 COORDINATION
- A. Coordinate size and location of structural-steel support members.
  - B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.8 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. Belts: One set for each belt-driven unit.
  2. Sheaves: For fan speed adjustment, sheave size determined at time of air quantity balancing operation, one set for each multiple belt-driven, non-VFC unit.
  3. Fan Wall Array: Fan/motor cartridge for emergency replacement, one for each type of assembly provided on the project.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Acme Engineering & Mfg. Corp.
  2. Aerovent; a Twin City Fan Company.
  3. Chicago Blower Corporation.
  4. Loren Cook Company.
  5. Penn Barry; a unit of Tomkins PLC.
  6. Trane.
- B. General: Select fans to avoid instability in service and compute outlet areas to outlet velocities in accordance with AMCA Standards. Maintain fan duty point to the right of the peak static pressure point farthest from shut-off and at approximately 60 percent overall efficiency.
- C. Description: AMCA certified, factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure.
- D. Housings: Formed panels to make curved-scroll housings with shaped cutoff, with doors or panels to allow access to internal parts and components.
1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
  2. Horizontally split, bolted-flange housing.
  3. Spun inlet cone with flange.
  4. Outlet flange.
- E. Fan Wheels: Airfoil, backward-inclined, or forward-curved as indicated on Drawings.



1. Airfoil Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange; heavy backplate; hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate; and cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
2. Backward-Inclined Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
3. Forward-Curved Wheels: Black-enameled or galvanized steel construction with inlet flange, backplate, shallow blades with inlet and tip curved forward in direction of airflow, mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.

F. Accessories:

1. Scroll Access Doors: For fans larger than 18 inches in diameter, shaped to conform to scroll, with quick-opening latches and gaskets.
2. Cleanout Door: Quick-opening, latch-type gasketed door allowing access to fan scroll, of same material as housing.
3. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
4. Companion Flanges: Rolled flanges for duct connections of same material as housing.
5. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
6. Discharge Dampers: Assembly with opposed blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
7. Inlet Screens: Grid screen of same material as housing.
8. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
9. Spark-Resistant Construction: AMCA 99.
10. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
11. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

G. Motors: Comply with requirements in Division 20 Section "Motors."

1. Enclosure Type: Totally enclosed, fan cooled.

H. Capacities And Characteristics:

1. Refer to schedules on the Drawings.
2. Sound Power Level Ratings:

- a. Ducted Fans: Rated in accordance with AMCA 301, when tested in accordance with AMCA 300.
- b. Nonducted Fans: Rated in zones at 5 feet from acoustic center of fan and in accordance with AMCA 301, tested in accordance with AMCA 300 and converted to AMCA 302.

I. Fan Construction:

1. Housing Material: Reinforced steel. Metal thickness not less than minimum specified by AMCA for the class of service.
2. Special Housing Coating: Powder-baked enamel.
3. Wheel Material: Steel. Metal thickness not less than minimum specified by AMCA for the class of service.
4. Vibration Isolators: Spring isolators having a static deflection of 1 inch.
5. Spark Arrestance Class: C.
6. Refer to schedules on Drawings for additional requirements.

2.2 PLENUM/PLUG FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Acme Engineering & Mfg. Corp.
  2. Aerovent; a Twin City Fan Company.
  3. Chicago Blower Corporation.
  4. Greenheck.
  5. Loren Cook Company.
  6. PennBarry; a unit of Tomkins PLC.
  7. Trane.
- B. General: Select fans to avoid instability in service and compute outlet areas to outlet velocities in accordance with AMCA Standards. Maintain fan duty point to the right of the peak static pressure point farthest from shut-off and at approximately 60 percent overall efficiency.
- C. Description: AMCA certified, factory-fabricated, -assembled, -tested, and -finished, unhoused, belt-driven centrifugal plenum/plug fans consisting of wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure.
- D. Airfoil Wheels: Single-width-single-inlet construction with smooth-curved inlet flange; heavy backplate; hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate; and cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
- E. Accessories:

1. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
- F. Motors: Comply with requirements in Division 20 Section "Motors."
  1. Enclosure Type: Totally enclosed, fan cooled.
- G. Capacities And Characteristics:
  1. Refer to schedules on the Drawings.
  2. Sound Power Level Ratings:
    - a. Ducted Fans: Rated in accordance with AMCA 301, when tested in accordance with AMCA 300.
    - b. Nonducted Fans: Rated in zones at 5 feet from acoustic center of fan and in accordance with AMCA 301, tested in accordance with AMCA 300 and converted to AMCA 302.
- H. Fan Construction:
  1. Wheel Material: Steel. Metal thickness not less than the minimum specified by AMCA for the class of service.
  2. Vibration Isolators: Spring isolators having a static deflection of 1 inch.
  3. Spark Arrestance Class: C.
  4. Refer to schedules on Drawings for additional requirements.

## 2.3 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210/ASHRAE 51, "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating."

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install centrifugal fans level and plumb.
- B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.
- D. Support floor-mounting units using vibration-control devices as specified in Division 20 Section "Mechanical Vibration Controls."
  1. Secure vibration controls to concrete bases using anchor bolts cast in concrete base.

2. Exception: Fan arrays that meet the balancing specification do not require spring isolation.

- E. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- F. Support suspended units from structure using threaded steel rods and spring hangers with vertical-limit stops having a static deflection of 1 inch. Vibration-control devices are specified in Division 20 Section "Mechanical Vibration Controls."
- G. Install units with clearances for service and maintenance.
- H. Label fans according to requirements specified in Division 20 Section "Mechanical Identification."

### 3.2 CONNECTIONS

- A. Install line-sized piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding."
- C. Connect wiring according to Division 26 Section "Conductors and Cables."

### 3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following field tests and inspections and prepare test reports:
  1. Verify that shipping, blocking, and bracing are removed.
  2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
  3. Verify that cleaning and adjusting are complete.
  4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
  5. Adjust belt tension.
  6. Adjust damper linkages for proper damper operation.
  7. Verify lubrication for bearings and other moving parts.
  8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
  9. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.
  10. Remove and replace malfunctioning units and retest as specified above.

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- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans. Refer to Division 20 Section "Mechanical General Requirements."

**\*\*END OF SECTION\*\***

## DIFFUSERS, REGISTERS, AND GRILLES

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### 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.
- B. Related Sections include the following:
  1. Division 10 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
  2. Division 20 Section "Mechanical General Requirements."
  3. Division 23 Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

#### 1.2 SUBMITTALS

- A. Product Data: For each product indicated, include the following:
  1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
  2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Coordination Drawings: Reflected ceiling 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. Ceiling suspension assembly members.
  2. Method of attaching hangers to building structure.
  3. Size and location of initial access modules for acoustical tile.
  4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
  5. Duct access panels.

## PART 2 - PRODUCTS

### 2.1 AIR DIFFUSION DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - 1. Anemostat; a Mestek Company.
  - 2. Krueger; Tomkins PLC.
  - 3. Nailor Industries of Texas Inc.
  - 4. Price Industries.
  - 5. Titus; Tomkins PLC.
  - 6. Tuttle & Bailey; Tomkins PLC.
- B. Terminal air diffusion devices have been chosen in terms of specific air distribution requirements, spacing, and sound characteristics.
- C. Provide plaster frames for units installed in plaster ceilings.
- D. Provide gaskets for supply terminal air devices mounted in finished surfaces.
- E. Air diffusion devices shall be standard off white baked enamel finish unless noted otherwise. Provide air diffusion device interior surfaces, including blank-offs, with black matte finish.
- F. Air pattern adjustments shall be made from the face of the device.
- G. Refer to drawings and schedules for quantities, types, and finishes.
- H. Coordinate frame types with Architectural Reflected Ceiling Plan.

### 2.2 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."
- B. Acoustical Applications and Sound Evaluation: Based on ARI Standard 885-98, "Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets."

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.

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GRILLES

- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Wall-Mounted Supply Registers: Install 6 inches below finished ceiling unless otherwise indicated.
- D. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

**\*\*END OF SECTION\*\***



## CONDENSING BOILERS

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, fire-tube modular aluminum stainless steel vertical fire-tube condensing boilers, trim, and accessories for generating hot water.

#### 1.3 SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.

##### 1. Design calculations and vibration isolation base details.

- a. Design Calculations: Calculate requirements for selecting vibration isolators for designing vibration isolation bases.
- b. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.

##### 2. Wiring Diagrams: Power, signal, and control wiring.

- C. Source quality-control test reports.
- D. Full function factory fire test must be performed and documented on fire test label on boiler. A factory authorized start-up must be completed prior to final acceptance by Owner.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For boilers to include in operation and maintenance manuals.
- G. Other Informational Submittals:
  - 1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

#### 1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."
- E. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a NRTL acceptable to authorities having jurisdiction.
- F. ASME CSD-1 Certification, in the form of completed data sheet.

#### 1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

#### 1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Condensing Boilers:
    - a. Leakage and Materials: 10 years from date of Substantial Completion.
    - b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Nonprorated for five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MODULAR CAST-ALUMINUM CONDENSING BOILERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Patterson-Kelley Co./a Harsco Co.; MACH Series.
- B. Description: Factory-fabricated, -assembled, and -tested, modular aluminum condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.
- C. Individual Heat Exchangers: Corrosion-resistant cast-aluminum alloy sections mounted in parallel. Water enters and exits through external headers. Water flow surrounds burner cavity.
- D. Burner: Cylindrical metal fiber mesh, natural gas, forced draft.
- E. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
  - 1. Motors: Comply with requirements specified in Division 20 Section "Motors."
    - a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- F. Gas Train: Shall include a minimum of one manual shut-off valve, two safety solenoid valves, venturi style gas valve, one low gas pressure switch, one high gas pressure switch and two test ports.
- G. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
- H. Casing:
  - 1. Jacket: Sheet metal, with snap-in or interlocking closures.
  - 2. Control Compartment Enclosures: NEMA 250, Type 1A.
  - 3. Finish: Baked-enamel or powder-coated protective finish.
  - 4. Insulation: Minimum 2-inch- thick, mineral-fiber or polyurethane-foam insulation surrounding the heat exchanger.
  - 5. Combustion-Air Connections: Inlet and vent duct collars.
  - 6. Mounting base to secure boiler.
- I. Characteristics and Capacities: Refer to Schedule on Drawings.

2.2 HOT-WATER BOILER TRIM

- A. Aquastat Controllers: Operating, firing rate, and high limit.

- B. Safety Relief Valve: ASME rated.
- C. Pressure and Temperature Gage: Minimum 3-1/2-inch- diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
- D. Boiler Air Vent: Automatic.
- E. Drain Valve: Minimum NPS 3/4 hose-end gate valve.
- F. Low water/flow cut off.
- G. High and low gas pressure switch.
- H. Flame rectification rod.

## 2.3 CONTROLS

- A. Boiler Control System:
  - 1. Each boiler shall be provided with all necessary controls, all necessary programming sequences, and all safety interlocks. Each boiler control system shall be properly interlocked with all safeties.
  - 2. Each boiler shall be provided with a "Full Modulating" firing control system whereby the firing rate is infinitely proportional at any firing rate between 20% and 100% as determined by the pulse width modulation input control signal. Both fuel input and air input must be sequenced in unison to the appropriate firing rate without the use of mechanical linkage.
  - 3. Control system shall provide the minimum capabilities:
    - a. Maintain single set point.
    - b. Reset the set point based on outdoor air temperature.
    - c. Boiler shutdown based on outdoor air temperature.
    - d. Internal dual set point program with an external point of closure.
    - e. Alarm relay for any manual reset alarm function.
    - f. Programmable Low Fire Delay to prevent short cycling based on a time and temperature factor for release to modulation.
    - g. LCD text display showing current supply and return temperatures, current set points as well as differential set points. It must also display any fault codes whether automatically reset or manually reset.
    - h. Local Manual Operation.
    - i. Cascade control for up to 8 boilers without the need for external control source.

- j. Remote Control System (Building Management/Sequencer Control) - The boiler control shall be capable of accepting a 0 to 10vdc remote external analog signal or 4-20 Ma input to control the firing rate and temperature setpoint.
- k. On board Domestic Hot Water Priority capable of changing from the heating pump to the DHW pump as well as changing the boiler set point from a heating temperature to a higher set point temperature to satisfy the DHW system and then return to the heating mode.
- l. Domestic Hot Water may run concurrent with Comfort Heat mode.
- m. All equipment shall be provided with necessary communication capabilities and hardware to allow integration with Mod-Bus Communications with building Automation System (provided by others.)
- n. Optional converter for LONWORKS® and BacNet® must be available.

## 2.4 ELECTRICAL POWER

- A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.
- B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
  - 1. House in NEMA 250, Type 1 enclosure.
  - 2. Wiring shall be numbered and color-coded to match wiring diagram.
  - 3. Install factory wiring outside of an enclosure in a metal raceway.
  - 4. Field power interface shall be lockable, nonfused disconnect switch.
  - 5. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.
  - 6. Provide each motor with overcurrent protection.

## 2.5 VENTING KITS

- A. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.
- B. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

## 2.6 ACCESSORIES

- A. Flue Side Condensate Neutralizer:
  - 1. Description: Designed to raise the PH level of flue side condensate to near neutral prior to condensate entering the sanitary drainage system.

2. Materials: Neutralizer constructed of PVC pipe and fittings mounted on channel strut base with galvanized or stainless steel clamps and hardware; and charged with calcium carbonate.
3. Manufacturers:
  - a. BKI Industries, Inc.; Acid Neutralizer Kits.
  - b. J.J.M. Boiler Works; JM Neutralizing Tubes.
  - c. Any of the approved boiler manufacturers.

## 2.7 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
- C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
  1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 BOILER INSTALLATION

- A. Install boilers level on concrete base. Concrete base is specified in Division 20 Section "Basic Mechanical Materials and Methods," and concrete materials and installation requirements are specified in Division 03.
- B. Vibration Isolation: Elastomeric isolation pads with a minimum static deflection of 0.25 inch (6.35 mm). Vibration isolation devices and installation requirements are specified in Division 20 Section "Mechanical Vibration Controls."
- C. Install natural gas-fired boilers according to NFPA 54.
- D. Install propane-fired boilers according to NFPA 58.
- E. Assemble and install boiler trim.
- F. Install electrical devices furnished with boiler but not specified to be factory mounted.
- G. Install control wiring to field-mounted electrical devices.

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Division 20 Section "Pipe Flexible Connectors, Expansion Fittings and Loops."
- E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.
- G. Connect steam and condensate piping to supply-, return-, and blowdown-boiler tappings with shutoff valve and union or flange at each connection.
- H. Install piping from safety relief valves to nearest floor drain.
- I. Install piping from safety valves to drip-pan elbow and to nearest floor drain.
- J. Boiler Venting:
  - 1. Install flue venting kit and combustion-air intake.
  - 2. Connect full size to boiler connections.
- K. Ground equipment according to Division 26 Section "Grounding and Bonding."
- L. Connect wiring according to Division 26 Section "Conductors and Cables."

### 3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
  - 1. Perform installation and startup checks according to manufacturer's written instructions.
  - 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
  - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.
- E. Performance Tests:
  - 1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
  - 2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
  - 3. Perform field performance tests to determine capacity and efficiency of boilers.
    - a. Test for full capacity.
    - b. Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20 percent of full capacity. Determine efficiency at each test point.
  - 4. Repeat tests until results comply with requirements indicated.
  - 5. Provide analysis equipment required to determine performance.
  - 6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
  - 7. Notify Architect in advance of test dates.
  - 8. Document test results in a report and submit to Architect.

### 3.5 DEMONSTRATION

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

**\*\*END OF SECTION\*\***



# PACKAGED CONDENSING UNITS

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## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  1. Division 20 Section "Mechanical General Requirements."
  2. Division 20 Section "Basic Mechanical Materials and Methods."
  3. Division 20 Section "Hangers and Supports."
  4. Division 23 Section "Refrigerant Piping."
  5. Division 23 Section "Temperature Controls."

### 1.2 SUBMITTALS

- A. Product Data: For each packaged condensing unit. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.
- B. Shop Drawings: For packaged condensing units. Include plans, elevations, sections, details, and attachments to other work.
  1. Wiring Diagrams: For power, signal, and control wiring.
- C. Delegated-Design Submittal: For packaged condensing units indicated to comply with performance requirements and design criteria, including analysis data.

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PACKAGED  
CONDENSING UNITS

1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
  2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
  - D. Coordination Drawings: 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 to which packaged condensing units will be attached.
    2. Liquid and vapor pipe sizes.
    3. Refrigerant specialties.
    4. Piping including connections, oil traps, and double risers.
    5. Compressors.
    6. Evaporators.
  - E. Field quality-control reports.
  - F. Operation and Maintenance Data: For packaged condensing units to include in operation and maintenance manuals.
- 1.3 QUALITY ASSURANCE
- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
  - B. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Standard for Refrigeration Systems."
- 1.4 COORDINATION
- A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-In-Place Concrete" and Division 03 Section "Miscellaneous Cast-In-Place Concrete."
  - B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. Installation of curbs and penetrations is specified in Division 07 Section "Roof Accessories."
  - C. Coordinate location of piping and electrical rough-ins.

PART 2 - PRODUCTS

2.1 PACKAGED CONDENSING UNITS, AIR COOLED, 1 TO 5 TONS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Carrier Corporation; a United Technologies Company; Commercial HVAC Systems.
  2. Johnson Controls Incorporated/YORK Engineered Systems Group.

3. Daikin Applied (McQuay) International/Lennox Industries Inc.
4. Trane; a Division of Ingersoll Rand.
- B. Description: Factory assembled and tested; consisting of compressor, condenser coil, fan, motors, refrigerant reservoir, and operating controls.
- C. Compressor: Scroll, hermetically sealed, with rubber vibration isolators.
  1. Motor: Two speed, and includes thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
  2. Two-Speed Compressor: Include manual-reset, high-pressure switch and automatic-reset, low-pressure switch.
- D. Refrigerant: R-407C or R-410A.
- E. Condenser Coil: Seamless copper-tube, aluminum-fin coil; circuited for integral liquid subcooler, with removable drain pan and brass service valves with service ports.
- F. Condenser Fan: Direct-drive, aluminum propeller fan; with permanently lubricated, totally enclosed fan motor with thermal-overload protection.
- G. Accessories:
  1. Coastal Filter: Mesh screen to protect condenser coil from salt damage.
  2. Crankcase heater.
  3. Cycle Protector: Automatic-reset timer to prevent rapid compressor cycling.
  4. Evaporator Freeze Thermostat: Temperature-actuated switch that stops unit when evaporator reaches freezing temperature.
  5. Filter-dryer.
  6. High-Pressure Switch: Automatic-reset switch cycles compressor off on high refrigerant pressure.
  7. Liquid-line solenoid.
  8. Low-Ambient Controller: Controls condenser fan speed to permit operation down to 0 deg F.
  9. Low-Pressure Switch: Automatic-reset switch cycles compressor off on low refrigerant pressure.
  10. Sound Hood: Wrap-around sound attenuation cover for compressor.
  11. Thermostatic expansion valve.
  12. Time-Delay Relay: Continues operation of evaporator fan after compressor shuts off.
  13. Reversing valve.

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- H. Unit Casing: Galvanized steel, finished with baked enamel; with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Mount service valves, fittings, and gage ports on exterior of casing.
- I. Capacities and Characteristics: As scheduled on the Drawings.

2.2 PACKAGED CONDENSING UNITS, AIR COOLED, 6 TO 120 TONS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Carrier Corporation; a United Technologies Company; Commercial HVAC Systems.
  - 2. Johnson Controls Incorporated/YORK Engineered Systems Group.
  - 3. Daikin Applied (McQuay) International.
  - 4. Trane; a Division of Ingersoll Rand.
- B. Description: Factory assembled and tested, air cooled; consisting of casing, compressors, condenser coils, condenser fans and motors, and unit controls.
- C. Compressor: Hermetic scroll compressor designed for service with crankcase sight glass, crankcase heater, and backseating service access valves on suction and discharge ports.
- D. Refrigerant: R-407C, R-410A.
- E. Condenser Coil: Seamless copper-tube, aluminum-fin coil, including subcooling circuit and backseating liquid-line service access valve. Factory pressure test coils, then dehydrate by drawing a vacuum and fill with a holding charge of nitrogen or refrigerant.
- F. Condenser Fans: Propeller-type vertical discharge; either directly or belt driven. Include the following:
  - 1. Permanently lubricated, ball-bearing motors.
  - 2. Separate motor for each fan.
  - 3. Dynamically and statically balanced fan assemblies.
- G. Operating and safety controls include the following:
  - 1. Manual-reset, high-pressure cutout switches.
  - 2. Automatic-reset, low-pressure cutout switches.
  - 3. Low-oil-pressure cutout switch.
  - 4. Compressor-winding thermostat cutout switch.
  - 5. Three-leg, compressor-overload protection.
  - 6. Control transformer.
  - 7. Magnetic contactors for compressor and condenser fan motors.

8. Timer to prevent excessive compressor cycling.

H. Accessories:

1. Low-Ambient Controller: Controls condenser fan speed to permit operation down to 0 deg F.
2. Gage Panel: Package with refrigerant circuit suction and discharge gages.
3. Hot-gas bypass kit.
4. Part-winding-start timing relay, circuit breakers, and contactors.
5. Reversing valve.

I. Unit Casings: Designed for outdoor installation with weather protection for components and controls and with removable panels for required access to compressors, controls, condenser fans, motors, and drives. Additional features include the following:

1. Steel, galvanized or zinc coated, for exposed casing surfaces; treated and finished with manufacturer's standard paint coating.
2. Perimeter base rail with forklift slots and lifting holes to facilitate rigging.
3. Gasketed control panel door.
4. Nonfused disconnect switch, factory mounted and wired, for single external electrical power connection.
5. Condenser coil hail guard/security grille.

J. Capacities and Characteristics: As scheduled on the Drawings.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 20 Section "Motors."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.4 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate packaged condensing units according to AHRI 210/240.
- B. Testing Requirements: Factory test sound-power-level ratings according to AHRI 270.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of packaged condensing units.
- B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.

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- C. Examine walls, floors, and roofs for suitable conditions where packaged condensing units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.
- B. Install packaged condensing units on concrete base. Concrete materials and installation requirements are specified in Division 03 Section "Cast-In-Place Concrete" and Division 03 Section "Miscellaneous Cast-In-Place Concrete."
- C. Install roof-mounting units on roof mounted equipment supports specified in Division 20 Section "Hangers and Supports."
- D. Vibration Isolation: Mount packaged condensing units on rubber pads with a minimum deflection of 1/4 inch. Vibration isolation devices and installation requirements are specified in Division 20 Section "Mechanical Vibration Controls."
- E. Vibration Isolation: Mount packaged condensing units on restrained spring isolators. Vibration isolation devices and installation requirements are specified in Division 20 Section "Mechanical Vibration Controls."
- F. Maintain manufacturer's recommended clearances for service and maintenance.
- G. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 CONNECTIONS

- A. Comply with requirements for piping in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- C. Connect refrigerant piping to air-cooled packaged condensing units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Division 23 Section "Refrigerant Piping."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
  - 2. Leak Test: After installation, charge system with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor operation and unit operation, product capability, and compliance with requirements.
  4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  5. Verify proper airflow over coils.
  - C. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
  - D. Packaged condensing units will be considered defective if they do not pass tests and inspections.
  - E. Prepare test and inspection reports.
- 3.5 STARTUP SERVICE
- A. Perform startup service.
    1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
      - a. Inspect for physical damage to unit casing.
      - b. Verify that access doors move freely and are weathertight.
      - c. Clean units and inspect for construction debris.
      - d. Verify that all bolts and screws are tight.
      - e. Adjust vibration isolation and flexible connections.
      - f. Verify that controls are connected and operational.
  - B. Lubricate bearings on fan motors.
  - C. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
  - D. Adjust fan belts to proper alignment and tension.
  - E. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.
  - F. Measure and record airflow and air temperature rise over coils.
  - G. Verify proper operation of condenser capacity control device.
  - H. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
  - I. After startup and performance test, lubricate bearings.
- 3.6 DEMONSTRATION
- A. Train Owner's maintenance personnel to adjust, operate, and maintain packaged condensing units.

**\*\*END OF SECTION\*\***

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 specification sections, apply to work of this section.
- B. Related Sections include the following:
  - 1. Division 20 Section "Mechanical General Requirements."
  - 2. Division 23 Section "Common Work Results for HVAC" for common mechanical drive requirements for fans and air moving equipment.
  - 3. Division 23 Section "Heating and Cooling Coils."

#### 1.2 REFERENCES

- A. Standards referenced in this Section:
  - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
  - 2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
  - 3. AMCA 99 - Standards Handbook.
  - 4. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.



5. AMCA 300 - Test Code for Sound Rating Air Moving Devices.
6. AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices.
7. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
8. AHRI 410 – Forced-Circulation Air-Cooling and Air-Heating Coils.
9. ANSI/AHRI 430 – Central Station Air Handling Units.
10. ANSI/AHRI 440 – Performance Rating of Room Fan-Coils.
11. NEMA MG1 - Motors and Generators.
12. NFPA 70 - National Electrical Code.
13. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
14. ANSI/UL 586 - Test Performance of High Efficiency Particulate Air Filter Units.
15. ANSI/UL 900 - Test Performance of Air Filter Units.
16. ASHRAE 52 - Method of Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
17. MIL-STD-282 - Filter Units, Protective Clothing, Gas-Mask Components and Related Products: Performance-Test Methods.
18. UL Standard 1995 – Standard for Heating and Cooling Equipment.

### 1.3 SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Filters: Filter performance data, filter assembly, and filter frames.
- C. 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. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
  2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
  3. Wiring Diagrams: Power, signal, and control wiring.
- D. Field quality-control test reports.
- E. Start-up reports.
- F. Operation and Maintenance Data: For environmental equipment to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Air handling units shall be ETL listed to UL Standard 1995.
- B. Filters:
  - 1. Filter media shall be ANSI/UL 900 listed, Class 1 or Class 2, as approved by local authorities.
  - 2. Provide all filters as product of one manufacturer.
  - 3. Assemble filter components to form filter banks from products of one manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
- B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.
- C. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors.
- D. Protect coils from entry of dirt and debris with pipe caps or plugs.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate equipment for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.7 EXTRA MATERIALS

- A. Provide one set of fan belts for each fan.
- B. Provide one additional set of each filter type for each unit, to be installed at project closeout.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL DOUBLE AND SINGLE WIDTH FANS

- A. Centrifugal double and single width fans shall include housing, wheel, fan shaft, fan shaft seals, bearings and side support structure in arrangement as indicated on drawings. Fans shall be air foil, backward inclined or forward curved as indicated on drawings. Air foil and backward inclined fans shall be non-overloading type. Select fans to avoid instability in service and compute outlet areas to outlet velocities per AMCA Standards. Maintain fan duty point to the right of the peak static pressure point farthest from shut-off and at approximately 60 percent overall efficiency. After mounting in cabinet, balance fan wheels on shafts supported pillow blocks mounted on the cabinet.
- B. Fan scrolls shall have bolted or continuously welded construction and shall be rigidly braced to prevent vibration. Metal thickness of the wheels, scroll, and side sheets shall not be less than that specified by the AMCA for the class of service.
- C. Fan inlet cones shall be streamline design, bolted to fan housing to allow for wheel removal. Bearing pedestals shall be carried to the main structural framework. Fans shall carry the AMCA rating seal.

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- D. Where there are duct connections to fan inlets and outlets, provide frames or flanges for duct attachment. Fans shall be prime and finish painted on all interior and exterior surfaces with approved corrosion inhibiting enamel.
- E. Hinged access doors shall be provided for fans larger than 18 inches in diameter and shall be located in the lower section of the fan scroll.
- F. Vibration isolation provisions shall be as specified in Division 20 Section "Mechanical Vibration Controls."
- G. Manufacturers:
  - 1. Buffalo Forge Co.
  - 2. Trane.
  - 3. Acme.
  - 4. Aerovent; a Twin City Fan Company.
  - 5. Twin City.
  - 6. Chicago Blower.
  - 7. Greenheck.
  - 8. Loren Cook.
  - 9. PennBarry.

2.2 PLENUM/PLUG FANS

- A. General: Select fans to avoid instability in service and compute outlet areas to outlet velocities in accordance with AMCA Standards. Maintain fan duty point to the right of the peak static pressure point farthest from shut-off and at approximately 60 percent overall efficiency.
- B. Description: AMCA certified, factory-fabricated, -assembled, -tested, and -finished, belt-driven, unhooded centrifugal plenum/plug fans consisting of wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure.
- C. Motors: Comply with requirements in Division 20 Section "Motors."
- D. Manufacturers:
  - 1. Acme Engineering & Mfg. Corp.
  - 2. Aerovent; a Twin City Fan Company.
  - 3. PennBarry.
  - 4. Chicago Blower Corporation.
  - 5. Loren Cook Company.
  - 6. Trane.

7. Twin City Fan & Blower; a Twin City Fan Company.
8. Howden Buffalo; Buffalo Forge.

## 2.3 CENTRAL STATION AIR HANDLING UNITS

### A. General:

1. Furnish central station type air handling units, factory fabricated and sectionally or fully assembled, including components and auxiliaries as indicated and specified elsewhere herein, and classified and defined, as applicable, under ANSI/ARI Standard 430-2009.
2. Performance test and rate air handling unit and components, where applicable, per AMCA Bulletin 203 except as otherwise specified. Provide air handling ratings in accordance with ANSI/AHRI 430 and classify total static pressure in accordance with AMCA Standard 1401.
3. Furnish DWDI centrifugal scroll type fan as specified. Confirm unit components to be included and edit appropriately.
4. Provide components including but not limited to: Piping, hot water heating coils, cooling coils, dampers, fan, motors, drives, filters, blank/access sections, thermal insulation and dampers, as specified.
5. Fans:
  - a. Fans, located within cabinets of packaged central station air handling equipment shall be backward curved, air foil or forward curved centrifugal scroll type as indicated on the drawings. Determine catalogued capacity with fan installed within fan-section cabinet. Backward inclined and air foil type shall be non-overloading type. Select fans to avoid instability in service and compute outlet areas to outlet velocities per AMCA Standards. Maintain fan duty point to the right of the peak static pressure point farthest from shut-off and at approximately 60 percent overall efficiency. After mounting in cabinet, balance fan wheels on shafts supported by pillow blocks mounted on the cabinet. Fit draw-through fan scroll with drainage provisions from lowest point for moisture disposal.
  - b. Fan scrolls shall have bolted or continuously welded construction and shall be rigidly braced to prevent vibration. Metal thickness of the wheels, scroll, and side sheets shall not be less than that specified by the AMCA for the class of service. Fan inlet cones shall be streamline design, bolted to fan housing to allow for wheel removal. Bearing pedestals shall be carried to the main structural framework. Fans shall carry the AMCA rating seal.
  - c. Where there are duct connections to fan inlets and outlets, provide frames or flanges for duct attachment.

### B. Materials and Construction:

1. Fabricate enclosure from mill galvanized carbon steel or aluminum sheet, and finish with manufacturer's standard painting system.
2. Construct unit cabinet suitable for AMCA Class A pressure with leaktight joints, closures, penetrations and access provisions. Seal joints between cabinet sections and between exterior panels and structural frames with closed-cell foam gasketing for leak seal and for thermal/acoustical break.
3. Construct cabinet so as not to expand or contract perceptibly during starting and stopping of fan and not to pulsate during operation. Stiffen pulsating panels which produce low frequency

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noise due to diaphragming of unstable panel walls to raise natural frequency to an easily attenuated level.

4. All sections of the central station air handling unit cabinet including coil segments shall be 2-inch double-wall construction with solid inner and outer panels. Insulation between panels shall be 2 inches thick with characteristics specified below.
5. Where man access is possible, strengthen floor to permit entry without damage to any part. Provide access doors and size as large as unit will permit. Reinforce access doors and panels with mill rolled structural steel if necessary and hinge and latch doors at a spacing sufficiently close to preclude leaks caused by distortion. Effectively gasket the door and furnish latches operable from either side of man access plenums. Door swing shall be such that the door is held shut by normal system operating pressure.
6. Extend integral IAQ compliant drain pan under all areas where condensate collects. Fabricate of AISI Type 304 stainless steel watertight with welded or brazed joints piped to drain, and insulated against sweating. Enclose and factory insulate cooling coil ends against sweating or drain to drain pan.
7. Furnish intermediate IAQ compliant coil drip pans for each tiered coil bank where needed to restrict downstream carryover of condensate. Fabricate pan of minimum 22 gauge AISI Type 304 stainless steel with brazed joints and pipe bottom of pan to drain.
8. Provide all necessary piping internal to cabinet and including penetration of cabinet walls and terminal connection for piping external to cabinet. Seal cabinet penetrations air tight and protect against condensation within cabinet walls.
9. Where space within a cabinet does not allow including water seals of sufficient depth, provide seals external to the cabinet.
10. Coordinate, in sufficient time during construction, placement of drain piping external to the cabinet to safe disposal point. Do not place drain piping on floor surface unless so indicated.
11. Furnish unit, factory insulated with internally fitted sound attenuating-thermal insulating fibrous glass material with a surface deeply impregnated with chloroprene. Insulation shall be 1-1/2 lb./cu.ft. matt faced type, with thickness as specified above. Furnish insulation which precludes condensation on any exterior cabinet surface under ambient conditions of 90 deg F and 75 percent relative humidity, normal to the unit installed location. Efficiency of acoustic treatment shall be such as to effectively attenuate fan noise. Apply material to the cabinet with adhesive on a 100 percent coverage basis, welded pins and speed clips or channels. Furnish adhesive and insulating materials conforming to requirements of NFPA 90A.
12. Should any condensation occur on exterior surfaces or enclosure once system is in operation, remove any installed materials and effectively apply new materials to the affected surfaces to preclude condensation at no increase in the Contract Sum and to the satisfaction of the Architect.
13. Provide motors, fans, fan drives, unit coils, filters, power transmission, guards, air blenders and the like in conformance with requirements specified under appropriate headings in this section.
14. Provide dampers in conformance with requirements specified in Division 23 Section "Temperature Controls."

15. Units shall be factory balanced as a complete assembly to 0.2 in./sec. measured in the horizontal, vertical and axial direction at the bearings of the unit (not the motor).
16. All cabinet sections shall be installed on a six inch high (minimum) galvanized steel base rail.
- C. Coils: As specified in Division 23 Section "Heating and Cooling Coils."
- D. Vibration Isolation:
  1. Fans, motors and drives shall be internally vibration isolated from cabinet. Provide internal vibration isolation in accordance with Division 20 Section "Mechanical Vibration Controls" requirements for centrifugal fans. Where units are not internally vibration isolated, provide external vibration isolation in accordance with Division 20 Section "Mechanical Vibration Controls" requirements for central station air handling units.
- E. Manufacturers:
  1. Trane.
  2. JCI/York.
  3. Buffalo.
  4. Daikin Applied.
  5. Carrier.

#### 2.4 AIR COOLED CONDENSING UNIT

- A. Outdoor unit shall be factory assembled, charged, and tested air cooled scroll compressor condensing unit with capacities as scheduled. Unit shall be provided with two independent refrigeration circuits with service valves.
- B. Condenser coils shall be internally enhanced seamless copper tubes with aluminum fins. Design working pressure shall be 450 PSIG.
- C. Fans shall be statically and dynamically balanced, direct drive, with low noise, full airfoil section blades and fan guard.
- D. Microprocessor control center shall manufacturers standard with liquid crystal display, and programmable setpoints, and shall automatically start, stop, cycle fans, modulate unit output, and prevent short cycling of the compressors when enabled through the building automation system.
- E. Provide unit with standard outdoor ambient control, single point terminal block and non-fused disconnect, pressure and temperature transducers and sensors, control power transformer, hot gas by-pass, building automation system reset interface, and sound reduction package including low speed reduced noise fans and compressor acoustic blankets.
- F. Manufacturers
  1. Carrier.
  2. JCI/York.
  3. Daikin Applied.

4. Trane.

## 2.5 ROOF CURBS

- A. Isolation Curb: Refer to Division 20 Section "Mechanical Vibration [**and Seismic**] Controls."
- B. Provide prefabricated roof curbs where indicated. Coordinate installation and type with Architectural Trades. Top of curb shall be level and extend a minimum of 10 inches above top of roof insulation.
  1. Manufacturers:
    - a. Pate.
    - b. Thycurb.
    - c. Roof Products and Systems.
    - d. Greenheck.
    - e. Creative Metals.
    - f. Any of the approved rooftop equipment manufacturers.

## 2.6 DISPOSABLE, EXTENDED AREA PANEL FILTERS (PRE-FILTER)

- A. Media: Pleated, non-woven cotton/polyester blend, bonded to galvanized expanded metal or welded wire grid. Media pack shall be enclosed in a heavy duty, moisture resistant beverage board frame with support members on both upstream and downstream sides. Filters shall contain not less than 5.5 square feet of media per square foot of filter face area. Filters shall be UL Listed, Class II as to flammability.
- B. Rating (unless otherwise indicated on drawings) MERV 7 in accordance with ASHRAE 52.2 (30 percent dust spot in accordance with ASHRAE 52.1), 592 fpm face velocity, 0.30 inch W.G. maximum initial resistance, 1.0 inch W.G. maximum recommended final resistance.
- C. Manufacturers:
  1. Eco Air; C35II.
  2. Filtration Group; Series 400.
  3. Flanders.
  4. Camfil Farr; 30/30.
  5. American Air Filter; Amair300X.

## 2.7 HIGH CAPACITY EXTENDED SURFACE (V-STYLE) FILTERS

- A. Media: Ultra fine synthetic media, (fiberglass media is not acceptable) pleated, totally rigid and totally disposable type. Each filter shall consist of wet-laid, high efficiency media bonded to V-bank design high-strength, impact-resistant plastic enclosing frame. Each filter shall have foam gasketing on the vertical sides of the header. Capacity, efficiency and nominal size shall be indicated on the drawings. Filters shall be UL Listed, Class II as to flammability.
- B. Rating: AHU's-MERV 14 in accordance with ASHRAE 52.2 (90-95 percent dust spot in accordance with ASHRAE 52.1), ERU's-MERV 11 in accordance with ASHRAE 52.2 (60-65 percent dust spot in accordance with ASHRAE 52.1), 500 fpm face velocity, maximum initial resistance: 0.55 inch W.G.

for MERV 14, 0.25 inch W.G. for MERV 11. Maximum recommended final resistance is 1.5 inches W.G. for both.

C. Manufacturers:

1. Eco Air.
2. Filtration Group.
3. Flanders.
4. Camfil Farr; Durafil 2V.
5. American Air Filter.

2.8 FILTER GAUGES

- A. Direct Reading Dial: 3-1/2 inch diameter diaphragm actuated dial in metal case, vent valves, black figures on white background, front recalibration adjustment, range 0-2.0 inch WG, 2 percent of full scale accuracy.
- B. Manufacturer:
1. Dwyer Magnehelic.
- C. Provide filter gauges across each filter bank.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Furnish, install and apply equipment and materials in accordance with the manufacturer's published instructions, and approved shop Drawings.
- B. Install central station air handling units in accordance with manufacturer's recommended procedures.
- C. Hoist, transport, and rig air handling units or their shipping sections into position following procedures recommended by the manufacturer.
- D. Replace filters in each unit at time of project final acceptance. Refer to Division 20 Section "Mechanical General Requirements" for additional information.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 20 and 23 Sections.
- B. Install piping adjacent to machine to allow service and maintenance.
1. Gas Piping: Comply with applicable requirements in Division 23 Section "Fuel Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.
  2. Hot-Water Heating Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Connect to supply and return coil tapings with shutoff or balancing valve and union or flange at each connection.



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3. Steam and Condensate Piping: Comply with applicable requirements in Division 23 Section "Steam and Condensate Piping." Connect to supply and return coil tapings with shutoff valve and union or flange at each connection.
  - C. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts.
  - D. Electrical System Connections: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.
  - E. Ground equipment according to Division 26 Section "Grounding and Bonding."
  - F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- 3.3 LUBRICATION
- A. Lubricate equipment and fill lubrication systems per manufacturer's published instructions.
- 3.4 FIELD QUALITY CONTROL
- A. Perform tests in accordance with manufacturer's published data.
- 3.5 START-UP SERVICE
- A. Provide a field Engineer for start-up of factory fabricated, built-up air handling and exhaust units. Field Engineer shall provide start-up service for temporary construction use, final inspection and adjustment of the units. Include labor, materials, travel, per diem and any other costs as part of the "Field Engineer" work.
- 3.6 DEMONSTRATION
- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain equipment. Refer to Division 20 Section "Mechanical General Requirements." Provide copies of operation and maintenance manuals as specified.

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## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  1. Division 20 Section "Mechanical General Requirements."
  2. Division 20 Section "Basic Mechanical Materials and Methods."
  3. Division 20 Section "Mechanical Vibration Controls."
  4. Division 23 Section "Common Work Results for HVAC" for common mechanical drive requirements for fans and air handling equipment.

### 1.2 SUMMARY

- A. This Section includes outdoor-mounted unitary air conditioning units smaller than 20 tons.
- B. Products supplied but not installed under this Section:
  1. Roof curbs and equipment rails.

### 1.3 DEFINITIONS

- A. DDC: Direct-digital controls.

- B. BAS: Building Automation System.

#### 1.4 SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- 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. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
  - 2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
  - 3. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For rooftop air conditioners to include in operation and maintenance manuals.

#### 1.5 QUALITY ASSURANCE

- A. AHRI Compliance:
  - 1. Comply with AHRI 210/240 and AHRI 340/360 for testing and rating energy efficiencies for RTUs.
  - 2. Comply with AHRI 270 for testing and rating sound performance for RTUs.
- B. ASHRAE Compliance:
  - 1. Comply with ASHRAE 15 for refrigeration system safety.
  - 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
- C. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
- D. UL Compliance: Comply with UL 1995.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

#### 1.6 COORDINATION

- A. Coordinate size and locations of roof curbs, equipment supports, and roof penetrations. Framing, flashing, and attachment to roof structure are specified under Division 07.

1.7 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. Fan Belts: One set for each belt-drive fan.
  - 2. Filters: One set of filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 UNITARY ROOFTOP AIR CONDITIONERS 6 TONS AND SMALLER

- A. Manufacturers:
  - 1. Carrier Corp.; United Technologies Corporation.
  - 2. Johnson Controls Incorporated/YORK; Engineered Systems Group; Series 5.
  - 3. Daikin Applied.
  - 4. Trane Company; a Division of Ingersoll Rand; Precedent.
- B. Description: Factory assembled and tested; designed for exterior installation; consisting of compressor, condenser coil, direct expansion cooling coil, supply-air fan, condenser coil fan, refrigeration controls, filters, dampers, and temperature controls or unit interface specified for unit controls.
- C. Maximum Temperature Distribution Across Supply Air Outlet:
  - 1. 10 deg F Heating.
  - 2. 5 deg F Cooling.
- D. Casing: Galvanized-steel single-wall construction with enamel paint finish, hinged access doors with neoprene gaskets for inspection and access to internal parts, minimum 3/4-inch- thick thermal insulation, knockouts for electrical and piping connections, exterior condensate drain connection, and lifting lugs.
- E. Condensate Drain Pans: Formed sections of galvanized-steel sheet, a minimum of 2 inches deep.
  - 1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
  - 2. Drain Connections: Threaded nipple.

3. Pan-Top Surface Coating: Corrosion-resistant compound.
- F. Supply-Air Fan: Forward curved, centrifugal, belt driven by single-speed motor.
- G. Condenser Coil Fan: Propeller type, directly driven by motor.
- H. Direct Expansion Cooling Coils: Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
- I. Compressor: Hermetic reciprocating or scroll compressor with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief, and crankcase heater.
- J. Refrigeration System:
  1. Compressor.
  2. Condenser coil and fan.
  3. Direct expansion cooling coil and supply-air fan.
  4. Check valves.
  5. Expansion valve with replaceable thermostatic element.
  6. Refrigerant dryer.
  7. High-pressure switch.
  8. Low-pressure switch.
  9. Thermostat for coil freeze-up protection during low-ambient temperature operation or loss of air.
  10. Low-ambient switch.
  11. Brass service valves installed in discharge and liquid lines.
  12. Refrigerant: R-407C or R-410A.
  13. Compressor Motor Overload Protection: Manual reset.
  14. Anti-recycling Timing Device: Prevents compressor restart for five minutes after shutdown.
  15. Oil-Pressure Switch: Designed to shut down compressors on low oil pressure.
- K. Filters: 2-inch- thick, fiberglass, pleated, throwaway filters in filter rack.
- L. Heat Exchanger: Aluminized-steel or stainless-steel construction for natural-gas-fired burners. Units utilizing 50 percent or greater outside air must be stainless steel construction. Include the following controls:
  1. Redundant single or dual gas valve with manual shutoff.

2. Direct-spark pilot ignition.
  3. Electronic flame sensor.
  4. Induced-draft blower.
  5. Flame rollout switch.
- M. Economizer: Return- and outside-air dampers with neoprene seals, bird screen, and hood.
1. Damper Motor: Fully modulating spring return with adjustable minimum position.
  2. Relief Damper: Gravity actuated with bird screen and hood.
- N. Power Connection: Provide for single connection of power to unit with factory mounted and wired unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in circuit breaker.
- O. Unit Controls: Solid-state control board and components contain at least the following features:
1. Provide typical R-G, Y1, Y2, W1, W2 –style termination strip.
  2. Default control to ensure proper operation after power interruption.
  3. Gas valve delay between first- and second-stage firing. Provide terminals if providing modulating gas control.
  4. Low-refrigerant pressure and condenser fan control.
- P. Conventional Thermostat Interface (BAS control or thermostat provided by others): For heating control, cooling control, occupied/unoccupied mode scheduling, and miscellaneous available status and alarm monitoring. Control interface details in accordance with temperature control system details indicated on the Drawings and specified in Division 23 Section “Temperature Controls.”
- Q. Accessories:
1. Service Outlets: 115-V, ground-fault, circuit-interrupter type.
  2. Power Exhaust Fan (where scheduled).
- R. Roof Curb: Steel with corrosion-protection coating, gasketing, and factory-installed wood nailer; complying with NRCA standards. Top of curb shall be level and extend a minimum of 10 inches above top of roof insulation.
- 2.3 UNITARY ROOFTOP AIR CONDITIONERS 7-1/2 TO 20 TONS
- A. Manufacturers:
1. Carrier Corp.; United Technologies Corporation.
  2. Johnson Controls Incorporated/YORK; Engineered Systems Group; Series 10 and Series 20.

3. Daikin Applied.
  4. Trane Company; a Division of Ingersoll Rand; Precedent and Voyager Light Commercial.
- B. Description: Factory assembled and tested; designed for exterior installation; consisting of compressor, condenser coil, direct expansion cooling coil, supply-air fan, condenser coil fan, refrigeration controls, filters, dampers, and temperature controls or interface specified for unit controls.
- C. Maximum Temperature Distribution Across Supply Air Outlet:
1. 10 deg F Heating.
  2. 5 deg F Cooling.
- D. Casing: Galvanized-steel single-wall construction with enamel paint finish, hinged access doors with neoprene gaskets for inspection and access to internal parts, minimum 3/4-inch- thick thermal insulation, knockouts for electrical and piping connections, exterior condensate drain connection, and lifting lugs.
- E. Condensate Drain Pans: Formed sections of galvanized-steel sheet, a minimum of 2 inches deep.
1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
  2. Drain Connections: Threaded nipple.
  3. Pan-Top Surface Coating: Corrosion-resistant compound.
- F. Supply-Air Fan: Forward curved, centrifugal, belt driven with adjustable motor sheaves, grease-lubricated ball bearings, and motor.
- G. Condenser Coil Fan: Propeller type, directly driven by permanently lubricated motor.
- H. Direct Expansion Cooling Coils: Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
- I. Compressor(s): Number as scheduled. Hermetic reciprocating or scroll compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief, and crankcase heater(s).
- J. Refrigeration System:
1. Compressor(s).
  2. Condenser coil and fan.
  3. Direct expansion cooling coil and supply-air fan.
  4. Expansion valves with replaceable thermostatic elements.
  5. Check valves.
  6. Refrigerant dryers.

7. High-pressure switches.
  8. Low-pressure switches.
  9. Thermostats for coil freeze-up protection during low-ambient temperature operation or loss of air.
  10. Low ambient switch.
  11. Brass service valves installed in discharge and liquid lines.
  12. Independent refrigerant circuits.
  13. Refrigerant: R-407C or R-410A.
  14. Compressor Motor Overload Protection: Manual reset.
  15. Anti-recycling Timing Device: Prevents compressor restart for five minutes after shutdown.
  16. Oil-Pressure Switch: Designed to shut down compressors on low oil pressure.
- K. Filters: 2-inch- thick, fiberglass, pleated, throwaway filters in filter rack.
- L. Heat Exchanger: Aluminized-steel or stainless-steel construction for natural-gas-fired burners. Units utilizing 50 percent or greater outside air must be stainless steel construction. Include the following controls:
1. Redundant dual gas valve with manual shutoff.
  2. Direct-spark pilot ignition.
  3. Electronic flame sensor.
  4. Induced-draft blower.
  5. Flame rollout switch.
- M. Economizer: Return- and outside-air dampers with neoprene seals, bird screen, and hood.
1. Damper Motor: Fully modulating spring return with adjustable minimum position.
  2. Relief Damper: Gravity actuated with bird screen and hood.
- N. Power Connection: Provide for single connection of power to unit with unit-mounted and wired disconnect switch accessible from outside unit and control-circuit transformer with built-in circuit breaker.
- O. Unit Controls: Solid-state control board and components contain at least the following features:
1. Provide typical R-G, Y1, Y2, W1,W2 –style termination strip.
  2. Default control to ensure proper operation after power interruption.



- 3. Gas valve delay between first- and second-stage firing. Provide terminals if providing modulating gas control.
  - 4. Low-refrigerant pressure control.
  - P. Conventional Thermostat Interface (BAS control or thermostat provided by others): For heating control, cooling control, occupied/unoccupied mode scheduling, and miscellaneous available status and alarm monitoring. Control interface details in accordance with temperature control system details indicated on the Drawings and specified in Division 23 Section "Temperature Controls."
  - Q. Accessories:
    - 1. Service Outlets: 115-V, ground-fault, circuit-interrupter type.
    - 2. Power Exhaust Fan (where scheduled).
  - R. Roof Curb: Steel with corrosion-protection coating, gasketing, and factory-installed wood nailer; complying with NRCA standards. Top of curb shall be level and height shall be as scheduled.
  - S. Isolation Curb: Refer to Division 20 Section "Mechanical Vibration Controls."
- 2.4 MOTORS
- A. Comply with requirements in Division 20 Section "Motors."

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Hoist, transport, and rig air conditioning units or their shipping sections into position following procedures recommended by the manufacturer.
- B. Install units level and plumb, maintaining manufacturer's recommended clearances. Install according to AHRI Guideline B.
- C. Deliver roof curbs and equipment supports to site for installation under Division 07. Install rooftop air conditioners on equipment curbs and supports specified and as scheduled. Secure units to curb support with anchor bolts.
- D. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure units to structural support with anchor bolts.
- E. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for base requirements. Coordinate wall penetrations and flashing with wall construction.

#### 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 20 and 23 Sections.
- B. Install piping adjacent to machine to allow service and maintenance.
  - 1. Gas Piping: Comply with applicable requirements in Division 23 Section "Fuel Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

- C. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
  - 1. Install ducts to termination in roof curb.
  - 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
  - 3. Connect supply ducts to rooftop unit with flexible duct connectors specified in Division 23 Section "Duct Accessories."
  - 4. Terminate return-air duct through roof structure and insulate space between roof and bottom of unit with 2-inch- thick, acoustic duct liner.
- D. Electrical System Connections: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.
- E. Ground equipment according to Division 26 Section "Grounding and Bonding."
- F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

### 3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.
- B. Perform the following field quality-control tests and inspections and prepare test reports:
  - 1. After installing rooftop air conditioners and after electrical circuitry has been energized, test units for compliance with requirements.
  - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Repair malfunctioning units and retest as specified above; or remove malfunctioning units, replace with new units and retest as specified.

### 3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
  - 1. Inspect for visible damage to unit casing.
  - 2. Inspect for visible damage to furnace combustion chamber.

3. Inspect for visible damage to compressor, air-cooled outside coil, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean outside coil and inspect for construction debris.
10. Clean furnace flue and inspect for construction debris.
11. Connect and purge gas line.
12. Adjust vibration isolators.
13. Inspect operation of barometric dampers.
14. Lubricate bearings on fan.
15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
16. Adjust fan belts to proper alignment and tension.
17. Start unit according to manufacturer's written instructions.
  - a. Start refrigeration system in summer only.
  - b. Complete startup sheets and attach copy with Contractor's startup report.
18. Inspect and record performance of interlocks and protective devices; verify sequences.
19. Operate unit for an initial period as recommended or required by manufacturer.
20. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency. Adjust pilot to stable flame.
  - a. Measure gas pressure on manifold.
  - b. Measure combustion-air temperature at inlet to combustion chamber.
  - c. Measure flue-gas temperature at furnace discharge.
  - d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
  - e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
21. Check control interface wiring.
22. Adjust and inspect high-temperature limits.
23. Inspect outside-air dampers for proper stroke and interlock with return-air dampers.

24. Start refrigeration system and measure and record the following:
  - a. Coil leaving-air, dry- and wet-bulb temperatures.
  - b. Coil entering-air, dry- and wet-bulb temperatures.
  - c. Outside-air, dry-bulb temperature.
  - d. Outside-air-coil, discharge-air, dry-bulb temperature.
25. Inspect and verify operation of controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
26. Measure and record the following minimum and maximum airflows.
  - a. Supply-air volume.
  - b. Return-air volume.
  - c. Relief-air volume.
  - d. Outside-air intake volume.
27. Simulate maximum cooling demand and inspect the following:
  - a. Compressor refrigerant suction and hot-gas pressures.
  - b. Short circuiting of air through outside coil or from outside coil to outside-air intake.
28. Record all final adjustment and control settings.
29. After startup and performance testing, change filters, vacuum heat exchanger and cooling and outside coils, lubricate bearings, adjust belt tension, and inspect operation of power vents.

### 3.5 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.

### 3.6 DEMONSTRATION

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

**\*\*END OF SECTION\*\***

## COMMERCIAL ROOFTOP AIR CONDITIONERS

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 20 Section "Mechanical General Requirements."
  - 2. Division 20 Section "Basic Mechanical Materials and Methods."
  - 3. Division 20 Section "Mechanical Vibration Controls."
  - 4. Division 23 Section "Temperature Controls."

#### 1.2 SUMMARY

- A. This Section includes outdoor-mounted air conditioning units.
- B. Products supplied but not installed under this Section:
  - 1. Roof curbs and equipment rails.

#### 1.3 DEFINITIONS

- A. DDC: Direct-digital controls.
- B. BAS: Building Automation System.

- C. Modulating: As applied to gas-fired heat exchangers, infinite or finely stepped regulation of burner output within a specified range.

#### 1.4 SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- 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. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
  - 2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
  - 3. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For rooftop air conditioners to include in operation and maintenance manuals.

#### 1.5 QUALITY ASSURANCE

- A. AHRI Compliance:
  - 1. Comply with AHRI 210/240 and AHRI 340/360 for testing and rating energy efficiencies for RTUs.
  - 2. Comply with AHRI 270 for testing and rating sound performance for RTUs.
- B. ASHRAE Compliance:
  - 1. Comply with ASHRAE 15 for refrigeration system safety.
  - 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
- C. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
- D. UL Compliance: Comply with UL 1995.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

#### 1.6 COORDINATION

- A. Coordinate size and locations of roof curbs, equipment supports, and roof penetrations. Framing, flashing, and attachment to roof structure are specified under Division 07.

1.7 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. Fan Belts: One set for each belt-drive fan.
  2. Filters: One set of filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 COMMERCIAL ROOFTOP AIR CONDITIONERS MANUFACTURERS:

1. Carrier; a United Technologies Company; WeatherMaster P Series.
  2. Daikin Applied; a member of Daikin Industries, Ltd.; MPS II.
  3. Trane Company (The); IntelliPak.
  4. Johnson Controls Incorporated/YORK; Engineered Systems Group; Series 40 and Eco 2.
- B. Description: Factory assembled and tested; designed for exterior installation; consisting of compressor, condenser coils, direct expansion refrigerant coils, heat exchanger, supply-air fan, relief or exhaust fan, condenser coil fan, refrigeration controls, filters, dampers, and temperature controls or interface specified for unit controls.
- C. Maximum Temperature Distribution Across Supply Air Outlet:
1. 10 deg F Heating.
  2. 5 deg F Cooling.
- D. Casing: Double-wall galvanized sheet metal construction with exterior enamel paint finish. Units having single-wall casing construction are not acceptable.
1. Finish able to withstand minimum 500-hour salt spray test in accordance with ASTM B117.
  2. Hinged access doors with neoprene gaskets for inspection and access to internal parts.
  3. Minimum 1-inch-thick thermal insulation.
  4. Knockouts for electrical and piping connections.
  5. Exterior condensate drain connection.

6. Lifting lugs.
- E. Supply-Air Fan: Airfoil, or backward inclined as scheduled, centrifugal, direct-driven or V-belt driven with fixed motor sheaves, grease-lubricated ball bearings, and motor. Mount fan and motor assembly on base with spring isolators having 1-inch deflection.
- F. Condenser Coil Fans: Propeller type, directly driven by permanently lubricated motor.
- G. Condenser Coils: Heavy duty aluminum fins mechanically bonded to seamless copper tubes, tested to 450 psig and leak tested to 300 psig with air under water. Provide subcooling circuit(s) integral with condenser coils to maximize efficiency and prevent premature flashing of liquid refrigerant, to a gaseous state, ahead of the expansion valve. Condenser coils shall not exceed 14 fins per inch density in order to permit routine cleaning, and prevent excessive air pressure drop across the condenser coil.
- H. Direct Expansion Cooling Coils: Aluminum-plate fin and seamless copper tube in stainless-steel casing inter-circuited to assure complete coil face activity, with equalizing-type vertical distributor and thermal expansion valve; tested to 450 psig and leak tested to 300 psig with air under water.
- I. Drain Pan: Under cooling coils. Formed of stainless-steel sheet and complying with requirements in ASHRAE 62.1. Fabricate pans with slopes in two planes to collect condensate from cooling coils (including coil piping connections and return bends) and when units are operating at maximum design face velocity across the coils.
  1. Drain Connections: Both ends of pan.
  2. Units with stacked coils shall have an intermediate stainless steel drain pan or drain trough to collect condensate from top coil.
- J. Compressor(s): Number as scheduled. Hermetic scroll compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief, and crankcase heater(s).
- K. Refrigeration System:
  1. Compressor(s).
  2. Condenser coils and fans.
  3. Direct expansion cooling coil and supply-air fan.
  4. Check valves.
  5. Expansion valves with replaceable thermostatic elements.
  6. Refrigerant dryers.
  7. High-pressure switches.
  8. Low-pressure switches.
  9. Thermostats for coil freeze-up protection during low-ambient temperature operation or loss of air.



10. Independent refrigerant circuits.
  11. Brass service valves installed in discharge and liquid lines.
  12. Refrigerant: R-407C or R-410A.
  13. Refrigerant Circuits: Interlaced refrigerant-coil circuiting with circuit for each compressor.
  14. Capacity Control: Number of stages as scheduled on the Drawings, and hot-gas bypass valve and piping.
  15. Compressor Motor Overload Protection: Manual reset.
  16. Anti-recycling Timing Device: Prevents compressor restart for five minutes after shutdown.
  17. Oil-Pressure Switch: Designed to shut down compressors on low oil pressure.
- L. Filters: Size, type, and rating as scheduled on the Drawings, in filter racks or galvanized-steel frames as required by filter type.
1. Air Filter and Filter-Holding System Manufacturers:
    - a. AAF International.
    - b. ECO Air.
    - c. Farr Co.
    - d. Flanders Filters, Inc.
- M. Heat Exchanger: Stainless-steel construction, including secondary tubes, for natural-gas-fired burners with the following controls:
1. Redundant dual gas valve with manual shutoff.
  2. Modulating control with turn-down ratio as scheduled on the Drawings.
  3. Direct-spark pilot ignition.
  4. Electronic flame sensor.
  5. Induced-draft blower.
  6. Flame rollout switch.
- N. Outside-Air Damper: Linked damper blades with fully modulating, spring-return damper motor and hood. Refer to Division 23 Section "Temperature Controls" for additional requirements.
- O. Economizer: Return- and outside-air dampers with neoprene seals, bird screen, and hood.
1. Damper Motor: Fully modulating spring return with adjustable minimum position.
  2. Control: Electronic-control system uses outside-air and return-air enthalpy to adjust mixing dampers.
  3. Relief Damper: Gravity actuated with bird screen and hood.

4. Leakage: Maximum leakage 2.5 percent at nominal airflow of 400 cfm per ton with 1-inch wg pressure differential.
5. Refer to Division 23 Section "Temperature Controls" for additional damper and operator requirements.

P. Electrical:

1. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection.
2. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.
3. Wiring shall be numbered and color-coded to match wiring diagram.
4. Field power interface shall be to NEMA KS 1, heavy-duty, nonfused disconnect switch.
5. Each motor shall have branch power circuit and controls with one of the following disconnecting means having SCCR to match main disconnecting means (10,000 amps):
  - a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
  - b. NEMA KS 1, heavy-duty, nonfusible switch.
  - c. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
6. Each motor shall have overcurrent protection.

Q. Unit Controls: Solid-state control board and components contain at least the following features:

1. Supply-air fan control relay.
2. Default control to ensure proper operation after power interruption.
3. Service relay output.
4. Unit diagnostics and diagnostic code storage.
5. Field-adjustable control parameters.
6. Economizer control.
7. Gas valve modulation control.
8. Indoor-air quality control with carbon dioxide sensor.
9. Night setback mode (outside air damper lockout relay).
10. Return-air temperature limit.
11. Low-refrigerant pressure control.

- R. Programmable DDC (with field mounted sensors): Wall-mounted, with integral thermostat function, heating setback and cooling setup with seven-day programming; and the following:
1. Touch sensitive keypad.
  2. Digital display of outside temperature, supply-air temperature, return-air temperature, economizer damper position, and control parameters.
  3. Deg Fspace temperature readout.
  4. LED indicators.
  5. Time and operational mode readout.
  6. Status indicator.
  7. Battery backup.
  8. Dirty-filter indication.
- S. BAS Hardwired Interface (in addition to Programmable DDC): Include the following:
1. Occupied (continuous) mode signal.
  2. Warm-up mode control signal.
  3. Unoccupied cycle mode control signal.
  4. Supply-air fan status.
  5. Common alarm (other than dirty filter alarm).
  6. Dirty filter alarm
  7. Occupied space heating and cooling setpoints.
  8. Unoccupied space heating and cooling setpoints.
  9. Supply-air discharge temperature setpoint (for reset control).
  10. Supply-air static pressure setpoint (for reset control).
- T. BAS Communication Link (with or without unit manufacturer provided Programmable DDC): Stand-alone control module providing link between unit controls and DDC temperature-control system. Control module shall be compatible with temperature-control system specified in Division 23 Section "Temperature Controls." Interface shall communicate the following:
1. Occupied (continuous) mode signal.
  2. Warm-up mode control signal.
  3. Unoccupied cycle mode control signal.

4. Supply-air fan status.
5. Dirty filter alarm.
6. Specific unit alarms system diagnostics.
7. Occupied space heating and cooling setpoints.
8. Unoccupied space heating and cooling setpoints.
9. Supply-air discharge temperature setpoint (for reset control).
10. Supply-air static pressure setpoint (for reset control).
11. Unit monitored temperatures and static pressures.
12. Control signal feedback (on/off or modulating signals).

U. Accessories:

1. Service Outlets: 115-V, ground-fault, circuit-interrupter type, factory wired such that outlet shall remain energized even if the unit main disconnect is open.

V. Roof Curb: By unit manufacturer, steel with corrosion-protection coating, gasketing, and factory-installed wood nailer; complying with NRCA standards; minimum height as scheduled on the Drawings.

W. Isolation Curb: Refer to Division 20 Section "Mechanical Vibration Controls."

## 2.3 MOTORS

- A. Comply with requirements in Division 20 Section "Motors."

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Hoist, transport, and rig air conditioning units or their shipping sections into position following procedures recommended by the manufacturer.
- B. Install units level and plumb, maintaining manufacturer's recommended clearances. Install according to AHRI Guideline B.
- C. Deliver roof curbs and equipment supports to site for installation under Division 07. Install rooftop air conditioners on equipment curbs and supports specified. Secure units to curb support with anchor bolts.
- D. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure units to structural support with anchor bolts.
- E. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for base requirements. Coordinate wall penetrations and flashing with wall construction.

### 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 20 and 23 Sections.
- B. Install piping adjacent to machine to allow service and maintenance.
  - 1. Gas Piping: Comply with applicable requirements in Division 23 Section "Fuel Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.
- C. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
  - 1. Install ducts to termination in roof curb.
  - 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
  - 3. Connect supply ducts to rooftop unit with flexible duct connectors specified in Division 23 Section "Duct Accessories."
  - 4. Terminate return-air duct through roof structure and insulate space between roof and bottom of unit with 2-inch- thick, acoustic duct liner.
- D. Electrical System Connections: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.
- E. Ground equipment according to Division 26 Section "Grounding and Bonding."
- F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

### 3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.
- B. Perform the following field quality-control tests and inspections and prepare test reports:
  - 1. After installing rooftop air conditioners and after electrical circuitry has been energized, test units for compliance with requirements.
  - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Repair malfunctioning units and retest as specified above; or remove malfunctioning units, replace with new units and retest as specified.

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
  - 1. Inspect for visible damage to unit casing.
  - 2. Inspect for visible damage to furnace combustion chamber.
  - 3. Inspect for visible damage to compressor, air-cooled outside coil, and fans.
  - 4. Inspect internal insulation.
  - 5. Verify that labels are clearly visible.
  - 6. Verify that clearances have been provided for servicing.
  - 7. Verify that controls are connected and operable.
  - 8. Verify that filters are installed.
  - 9. Clean outside coil and inspect for construction debris.
  - 10. Clean furnace flue and inspect for construction debris.
  - 11. Connect and purge gas line.
  - 12. Adjust vibration isolators.
  - 13. Inspect operation of barometric dampers.
  - 14. Lubricate bearings on fan.
  - 15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
  - 16. Adjust fan belts to proper alignment and tension.
  - 17. Start unit according to manufacturer's written instructions.
    - a. Start refrigeration system in summer only.
    - b. Complete startup sheets and attach copy with Contractor's startup report.
  - 18. Inspect and record performance of interlocks and protective devices; verify sequences.
  - 19. Operate unit for an initial period as recommended or required by manufacturer.
  - 20. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency. Adjust pilot to stable flame.
    - a. Measure gas pressure on manifold.
    - b. Measure combustion-air temperature at inlet to combustion chamber.

- c. Measure flue-gas temperature at furnace discharge.
  - d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
  - e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
- 21. Check control interface wiring.
  - 22. Adjust and inspect high-temperature limits.
  - 23. Inspect outside-air dampers for proper stroke and interlock with return-air dampers.
  - 24. Start refrigeration system and measure and record the following:
    - a. Coil leaving-air, dry- and wet-bulb temperatures.
    - b. Coil entering-air, dry- and wet-bulb temperatures.
    - c. Outside-air, dry-bulb temperature.
    - d. Outside-air-coil, discharge-air, dry-bulb temperature.
  - 25. Inspect and verify operation of controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
  - 26. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
    - a. Supply-air volume.
    - b. Return-air volume.
    - c. Relief-air volume.
    - d. Outside-air intake volume.
  - 27. Simulate maximum cooling demand and inspect the following:
    - a. Compressor refrigerant suction and hot-gas pressures.
    - b. Short circuiting of air through outside coil or from outside coil to outside-air intake.
  - 28. Record all final adjustments and control settings.
  - 29. After startup and performance testing, change filters, vacuum heat exchanger and cooling and outside coils, lubricate bearings, adjust belt tension, and inspect operation of power vents.

### 3.5 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain rooftop air conditioners. Refer to Division 20 Section "Mechanical General Requirements."

**\*\*END OF SECTION\*\***



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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  1. Division 20 Section "Mechanical General Requirements."
  2. Division 20 Section "Basic Mechanical Materials and Methods."

#### 1.2 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
- 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. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For computer-room air-conditioning units to include in operation and maintenance manuals.

#### 1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

D. ASME Compliance: Fabricate and label water-cooled condenser shell to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

1.4 COORDINATION

- A. Coordinate layout and installation of computer-room air-conditioning units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
- B. Coordinate installation of computer-room air-conditioning units with computer-room access flooring Installer.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

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. Fan Belts: One set for each belt-drive fan.
  2. Filters: One set of filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 CEILING-MOUNTING UNITS (SPLIT-SYSTEM DX)

- A. Manufacturers:
  1. APC Network Air.
  2. Data Aire Inc.
  3. Liebert Corporation.

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- B. Description: Factory assembled split-system units with compressor located in remote condensing unit, and including cabinet, fan, filters, and controls, suitable for horizontal ceiling mounting with air distribution through integral grilles or ducted connections.
- C. Cabinet: Galvanized steel with baked-enamel finish, insulated with 1/2-inch thick duct liner.
- D. Evaporator Fan: Forward curved, centrifugal, and directly driven by two-speed motor.
  - 1. Motor: Comply with requirements in Division 20 Section "Motors."
- E. Evaporator Coil: Direct-expansion cooling coil of seamless copper tubes expanded into aluminum fins.
  - 1. Mount coil assembly over stainless-steel drain pan having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir.
- F. Condensing Unit Cabinet: Steel with baked-enamel finish and containing compressor and condenser.
- G. Remote Air-Cooled Condensing Unit: Copper-tube aluminum-fin coil with propeller fan, direct driven.
  - 1. System shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.
- H. Compressor: Scroll, with resilient suspension system, oil strainer, and internal motor overload protection.
  - 1. Refrigeration Circuit: Low-pressure switch, manual-reset high-pressure switch, thermal-expansion valve with external equalizer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.
  - 2. Refrigerant: R-407C.
  - 3. Capacity Control: Hot gas bypass.
- I. Filter: 1-inch thick, disposable, glass-fiber media.
- J. Atomizing Humidifier: Centrifugal atomizer with stainless-steel pan, demister pad, and solenoid valve.
- K. Control System: Microprocessor based, unit-mounted panel with main fan contactor, compressor contactor, compressor start capacitor, control transformer with circuit breaker, solid-state temperature control modules time-delay relay, reheat contactor, and high-temperature thermostat. Provide solid-state, wall-mounting control panel with start-stop switch and adjustable temperature set point.

2.3 ACCESSORIES

- A. Unit support curbs:
  - 1. Manufacturers:

- a. Pate.
  - b. ThyCurb.
  - c. Roof Products & Systems.
2. Coordinate type and installation with Architectural trades. Top of support shall be level and extend a minimum of 8 inches above the top of the roof insulation.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install computer-room air-conditioning units level and plumb, maintaining manufacturer's recommended clearances.
- B. Curb Support: Install and secure roof-mounting units on curbs and coordinate roof penetrations and flashing with roof construction. Secure units to curb support with anchor bolts.
- C. Install suspended components level. Coordinate wall penetrations and flashing with wall construction.
- D. Install air-cooled condenser on rubber-in-shear vibration isolators.

#### 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 20, 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Water and Drainage Connections: Comply with applicable requirements in Division 22 Section "Domestic Water Piping." Provide adequate connections for water-cooled units, condensate drain, and humidifier flushing system.
- D. Refrigerant Piping: Comply with applicable requirements in Division 23 Section "Refrigerant Piping." Provide shutoff valves and piping.
- E. Electrical System Connections: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.
- F. Ground equipment according to Division 26 Section "Grounding and Bonding."
- G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

#### 3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
  - 1. Inspect for and remove shipping bolts, blocks, and tie-down straps.

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2. After installing computer-room air-conditioning units and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Verify that computer-room air-conditioning units are installed and connected according to manufacturer's written instructions and the Contract Documents.
- C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.
- D. Complete installation and startup checks according to manufacturer's written instructions.
- E. After startup service and performance test, change filters.

3.5 ADJUSTING

- A. Adjust initial temperature set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain computer-room air-conditioning units. Refer to Division 20 Section "Mechanical General Requirements."

**\*\*END OF SECTION\*\***

## SPLIT-SYSTEM AIR-CONDITIONING UNITS

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 20 Section "Mechanical General Requirements."
  - 2. Division 20 Section "Basic Mechanical Materials and Methods."

#### 1.2 SUMMARY

- A. This Section includes ductless split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components.
- B. Products supplied but not installed under this Section:
  - 1. Roof curbs and equipment rails.

#### 1.3 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For split-system air-conditioning units to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
- C. ASHRAE Compliance:
  - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
- E. Seasonal Energy-Efficiency Ratio (SEER): Minimum 13.

1.5 COORDINATION

- A. Coordinate size and location of concrete or plastic pads for units.
- B. Coordinate delivery and placement of roof curbs, and equipment supports. Installation of roof curbs, equipment supports, and roof penetrations is specified in Division 07 Section "Roof Accessories." Pipe Roof Penetration Enclosures are specified in Division 20 Section "Basic Mechanical Materials and Methods."

1.6 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. Filters: One set of filters for each unit.
  - 2. Infrared remotes where applicable.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Single-Zone Split-System Air-Conditioning Units:
    - a. Airedale North America, Inc.
    - b. Daikin Applied; a member of Daikin Industries, Ltd.; Daikin AC.
    - c. EMI (EnviroMaster International LLC); a subsidiary of ECR International.
    - d. LG Electronics, HVAC Division.
    - e. Mitsubishi Electric & Electronics America, Inc.; HVAC Advanced Products Division.
    - f. Sanyo North America Corporation; a member of the Panasonic Group.
  - 2. Roof Curbs and Equipment Rails:
    - a. Pate Company (The).
    - b. Roof Products and Systems Corp.

c. ThyCurb; a division of THYBAR Corporation.

## 2.2 SINGLE-ZONE DUCTLESS SPLIT SYSTEM AIR CONDITIONER

- A. Complete packaged air conditioning unit factory fabricated and tested.
- B. Indoor Evaporator Section: Complete with fan section, motor, washable filter, condensate drain pan, condensate pump, and direct expansion evaporator section.
- C. Air Cooled Condensing Section: Completely factory piped for single point connection of refrigerant lines. Condensing unit with propeller fan shall be matched to evaporator section to provide cooling capacity as scheduled on drawings.
- D. Controls: Unit furnished with factory installed microprocessor controls. Provide wireless remote or unit mounted control or wall thermostat, which shall provide selection of all functions and control of room temperature set points. Furnish and install one mounting bracket for each wireless remote control.
- E. Units Serving Areas that Contain Additional Heating and Cooling Equipment: Provide with electro-mechanical controls to allow a common DDC space sensor to control the unit.
- F. Provide complete refrigerant piping circuit (including all piping specialties) sized in accordance with manufacturer's requirements to interconnect evaporator and condenser sections.
- G. Wall-Mounting, Evaporator-Fan Components:
  - 1. Cabinet: With removable panels for servicing, and discharge drain pans with drain connection.
  - 2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with thermal-expansion valve.
  - 3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.
  - 4. Fan: Direct drive, centrifugal fan.
  - 5. Fan Motors: Comply with requirements in Division 20 Section "Motors."
    - a. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
  - 6. Filters: Permanent, cleanable.
- H. Ceiling-Mounting, Evaporator-Fan Components:
  - 1. Cabinet: Enameled steel chassis with removable panels on front and ends, and discharge drain pans with drain connection.
  - 2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with thermal-expansion valve.



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3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.
4. Fan: Direct drive, centrifugal fan, with outside air intake, and integral factory or field installed condensate pump.
5. Fan Motors: Comply with requirements in Division 20 Section "Motors."
  - a. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
6. Filters: Permanent, cleanable.
- I. Air-Cooled, Compressor-Condenser Components:
  1. Casing: Steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
  2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
    - a. Compressor Type: Reciprocating or Scroll.
    - b. Include refrigerant charge.
    - c. Refrigerant: R-410A.
  3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with liquid subcooler.
  4. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.
  5. Fan: Aluminum-propeller type, directly connected to motor.
  6. Motor: Permanently lubricated, with integral thermal-overload protection.
  7. Low Ambient Kit: Permits operation down to 0 deg F. Include wind manufacturer's wind baffle accessory.
- J. Control equipment is specified in Division 23 Section "Temperature Controls," and sequence of operation is indicated on the Drawings.
- K. Thermostat: Wall-mounted low voltage type to control compressor and evaporator fan.
- L. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:
  1. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
  2. Fan-speed selection, including auto setting.

- M. Automatic-reset timer to prevent rapid/short cycling of compressor.

## 2.3 ACCESSORIES

- A. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized with nitrogen, and sealed; factory-insulated suction line with flared fittings at both ends.
- B. Roof Curbs and Equipment Rails:
  - 1. Minimum 18 gage welded galvanized steel construction.
  - 2. Integral base flange or plate.
  - 3. Built-in fully mitered raised cant with step matching insulation thickness.
  - 4. Factory installed insect and decay resistant wood nailer.
  - 5. Top of curb or equipment support shall be level and extend a minimum of 8 inches above the top of the roof insulation.
- C. Automatic Condensate Pump Units (Field Installed)
  - 1. Manufacturers:
    - a. Little Giant Pump Co.; Subsidiary of Tecumseh Products Co.
    - b. Beckett Corporation.
    - c. Hartell Pumps Div.; Milton Roy Co.
    - d. Hydromatic Pump Company; Division of Pentair Pump Group.
  - 2. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls.
- D. Automatic Condensate Pump Units (Field Installed Above Ceiling Applications)
  - 1. Manufacturers:
    - a. Hartell Pumps Div.; Milton Roy Co.; Model A2-X-1965.
  - 2. Description: Packaged units with corrosion-resistant pump, dual-voltage thermally protected motor, cast aluminum tank with cover, and automatic controls. Include auxiliary safety switch; junction box wire connections, with 3/4-inch knock out for conduit; and factory- or field-installed check valve.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install grade-mounting, compressor-condenser components on 2-inch thick reinforced precast concrete, or plastic pad; extending 2 inches beyond unit perimeter.

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- D. Deliver roof curbs and equipment support to site for installation under Division 07. Install roof-mounting compressor-condenser components on equipment supports specified. Anchor units to supports with removable, cadmium-plated fasteners. Install wind baffle according to manufacturer's installation instructions.
- E. Install and connect refrigerant tubing to components. Install tubing to allow access to unit. Evacuate and charge with refrigerant in accordance with manufacturers instructions.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to unit to allow service and maintenance.
- C. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

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

**\*\*END OF SECTION\*\***

## HEATING AND COOLING COILS

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 20 Section "Mechanical General Requirements."
  - 2. Division 23 Sections for coils that are integral to air-handling units.

#### 1.2 SUMMARY

- A. This Section includes duct-mounted heating and cooling coils, and heating and cooling coils that are an integral part of air-handling units.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each coil. Include rated capacity and pressure drop for each coil.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which coil location and ceiling-mounted access panels are shown and coordinated with each other.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

#### 1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.

PART 2 - PRODUCTS

2.1 WATER COILS

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

1. Aerofin Corporation.
2. Carrier; a United Technologies Company.
3. Daikin Applied; a member of Daikin Industries, Ltd.
4. JCI/York International.
5. Luvata/Heatcraft Commercial/Industrial Products.
6. Precision Coils; a business of Unison Comfort Technologies.
7. Trane Inc.; a Division of Ingersoll Rand.

B. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.

C. Minimum Working-Pressure/Temperature Ratings: 200 psig, 325 deg F.

D. Source Quality Control: Factory tested to 300 psig.

E. Tubes: ASTM B 743 copper, minimum 0.024 inch wall thickness, and minimum 0.50 inch diameter.

F. Fins: Aluminum, minimum 0.010 inch thick.

G. Headers: Cast iron with cleaning plugs, and drain and air vent tappings or seamless copper tube with brazed joints, prime coated.

H. Frames, Hot Water Coils: Galvanized-steel channel frame, minimum 0.0625 inch thick for flanged mounting.

I. Frames, Chilled Water Coils: ASTM A 666, Type 304 stainless steel, minimum 0.0625 inch thick for flanged mounting.

J. Coating: Heresite P-403 baked phenolic for coils installed in stainless steel ductwork.

2.2 REFRIGERANT COILS

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

1. Aerofin Corporation.
2. Carrier; a United Technologies Company.
3. Daikin Applied; a member of Daikin Industries, Ltd.

4. JCI/York International.
5. Luvata/Heatcraft Commercial/Industrial Products.
6. Precision Coils; a business of Unison Comfort Technologies.
7. Trane Inc.; a Division of Ingersoll Rand.

- B. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.
- C. Minimum Working-Pressure Rating: 300 psig.
- D. Source Quality Control: Factory tested to 450 psig.
- E. Tubes: ASTM B 743 copper, minimum 0.020 inch wall thickness, and minimum 0.50 inch diameter.
- F. Fins: Aluminum, minimum 0.010 inch thick.
- G. Suction and Distributor Piping: ASTM B 88, Type L copper tube with brazed joints.
- H. Frames: ASTM A 666, Type 304 stainless steel, minimum 0.0625 inch thick for flanged mounting.

## 2.3 DRAIN PANS

- A. Description: For cooling coils, IAQ compliant formed to slope from all directions to the drain connection as required by ASHRAE 62.
- B. Construction: Minimum 22 gage, Type 304 stainless steel with welded joints, positively sloped a minimum of 1/8 inch per foot, with threaded drain connection at lowest point of pan. Intermediate pans piped to the primary drain pan are required for all stacked cooling coils.
- C. Provide intermediate coils with 3 inch deep pans for each tiered coil bank. Top pan shall extend 6 inches beyond face of coil and bottom pan shall extend not less than 12 inches beyond face of coil. Where more than two panes are used, pan extension shall be proportional.
- D. Supports: Same material as pans.
- E. Pipe pan drain to floor drain. A deep seal trap shall be installed on the drain pipe from the pans.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install coils level and plumb.
- B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

- C. Laboratory Terminal Unit Hot Water Coils: Caulk and seal frame and all housing tube openings in the field with a non-hardening sealant. Sealant type shall be approved by the coil manufacturer.
- D. Install minimum 22 gage, Type 304 stainless-steel drain pan under each cooling coil.
  - 1. Construct drain pans with connection for drain; insulated.
  - 2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
  - 3. Extend drain pan upstream and downstream from coil face.
  - 4. Extend drain pan under coil headers and exposed supply piping.
- E. Install moisture eliminators for cooling coils. Extend drain pan under moisture eliminator.
- F. Straighten bent fins on air coils.
- G. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to coils to allow service and maintenance.
- C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Division 23 Section "Temperature Controls," and other piping specialties are specified in Division 23 Section "Hydronic Piping."
- D. Connect steam piping with gate valve and union and steam condensate piping with union, strainer, trap, and gate valve to allow coils to be disconnected without draining piping. Control valves are specified in Division 23 Section "Temperature Controls," and other piping specialties are specified in Division 23 Section "Steam and Condensate Piping."
- E. Connect refrigerant piping according to Division 23 Section "Refrigerant Piping."
- F. Ground equipment according to Division 26 Section "Grounding and Bonding."
- G. Connect wiring according to Division 26 Section "Conductors and Cables."

### 3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
  - 1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

**\*\*END OF SECTION\*\***

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## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 specification sections, apply to work of this section.
- B. Related Sections include the following:
  1. Division 15 Section "Mechanical General Requirements."
  2. Division 15 Section "Basic Mechanical Materials and Methods."
  3. Division 15 Section "Common Work Results for HVAC" for common mechanical drive requirements for fans and air moving equipment.

### 1.2 REFERENCES

- A. Standards referenced in this Section:
  1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
  2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
  3. AMCA 99 - Standards Handbook.
  4. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.
  5. AMCA 300 - Test Code for Sound Rating Air Moving Devices.
  6. AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices.



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7. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
8. AHRI 410 – Forced-Circulation Air-Cooling and Air-Heating Coils.
9. ANSI/AHRI 430 – Central Station Air Handling Units.
10. ANSI/AHRI 440 – Performance Rating of Room Fan-Coils.
11. NEMA MG1 - Motors and Generators.
12. NFPA 70 - National Electrical Code.
13. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
14. ANSI/UL 586 - Test Performance of High Efficiency Particulate Air Filter Units.
15. ANSI/UL 900 - Test Performance of Air Filter Units.
16. ASHRAE 52 - Method of Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
17. MIL-STD-282 - Filter Units, Protective Clothing, Gas-Mask Components and Related Products: Performance-Test Methods.
18. UL Standard 1995 – Standard for Heating and Cooling Equipment.

1.3 SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Filters: Filter performance data, filter assembly, and filter frames.
- C. 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. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
  2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
  3. Wiring Diagrams: Power, signal, and control wiring.
- D. Field quality-control test reports.
- E. Start-up reports.
- F. Operation and Maintenance Data: For environmental equipment to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Air handling units shall be ETL listed to UL Standard 1995.

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B. Filters:

1. Filter media shall be ANSI/UL 900 listed, Class 1 or Class 2, as approved by local authorities.
2. Provide all filters as product of one manufacturer.
3. Assemble filter components to form filter banks from products of one manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
- B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.
- C. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors.
- D. Protect coils from entry of dirt and debris with pipe caps or plugs.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate equipment for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.7 EXTRA MATERIALS

- A. Provide one set of fan belts for each fan.
- B. Provide one additional set of each filter type for each unit, to be installed at project closeout.

PART 2 - PRODUCTS

2.1 UNIT VENTILATORS

A. General:

1. Manufacturers must participate in the AHRI Certification program. Unit performance data must be rated in accordance with latest ANSI Standard for safe and efficient performance and AHRI Standard, and must display the AHRI Symbol on all standard units. Units shall be UL listed.

B. Materials and Construction:

1. Floor mounted units shall be 30 inches high. Electrical wiring shall be in accordance with local and National Electric Codes (NEC). The front surface shall consist of a removable panel. Control compartment must be accessible. Unit discharge grille shall be welded continuous bar type with round edged steel bars with multiple direction discharge. A 1/4-inch painted galvanized mesh shall be furnished and located beneath discharge grille for blow-through units. Unit top surface shall be supplied with a textured paint surface.
2. Cabinet Insulation: Cabinet insulation shall be 1/2-inch thick dual density bonded glass fiber. The exposed side shall be high density erosion proof material for use in airstreams up to 4500 FPM. Open fiber insulation shall not be accepted.

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3. Hot Water Heating: Evenly spaced aluminum fins mechanically bonded to copper tubes, designed for 200 psi and 220 degrees F.
4. DX Cooling Coil: All DX coils shall be supplied with factory installed thermal expansion device. This device must be sized for the manufacturer's matching integral (Higgins)/remote (Middle School Central) condensing unit.
5. Drain Pan: Provide insulated stainless steel or non-corroding drain pan under cooling coil, easily removable for cleaning, sloped for positive drainage and supplied with a drain connection. Drain pans are not required for heating only units.
6. Cabinet: 16-gauge steel with exposed corners and edges rounded, easily removed panels, and integral air inlet and outlet grille. All sheet metal panels shall be cleaned, phosphatized, polished, rinsed and dried before application of oven-baked enamel finish. Provide color selection chart to Architect and Owner for selection. Provide pipe tunnel for cross over pipes.
7. Fans and Motor: The motor and fan assembly shall be low speed design to assure maximum quietness and efficiency. Fans shall be double inlet, forward curved centrifugal type and shall be modular design. Assembly shall be statically and dynamically balanced. Fan housings shall be steel construction. Fan and motor assembly shall be direct drive type. Motor speed shall be controlled by factory-mounted multi-tap transformer through high-low-off switch. Motors shall be permanent split-capacitor (PSC), plug in type designed specifically for unit ventilator operation. Motors shall have sleeve type bearings and shall require oiling no more than once annually. Fan, motor, and bearings shall be on a common fan board assembly that can be easily removed for servicing. Motor shall have thermal overload protection and shall be fed from a manual motor starter toggle switch. Manual motor starter shall be mounted integral to the unit ventilator.
8. Outdoor and Return Air Dampers: Each unit shall be provided with return air and outdoor air dampers. Dampers shall be fitted with seals along all the sealing edges. Damper bearings shall be made of nylon or other material which does not require lubrication.
9. Falsebacks: Provide falsebacks for all floor mounted units. Falsebacks shall be a minimum of 6" in depth and allow for field installed pipe crossover and outside air intake flexibility via plenum inlet. Provide insulated vertical and horizontal baffles to prevent pipe freezing.
10. End Cabinets: Provide a minimum of 12 inch end pockets for field installed piping specialties.
11. Filter: Easily removable, one inch thick glass fiber throw-away type, located to filter both the outside and return air.
12. Condensing Unit: The unit ventilator manufacturer shall provide integral air cooled condensing units where indicated.
13. Temperature Control: Microprocessor based control shall be furnished and fully prewired for each unit ventilator at the factory. Controls shall include controller, discharge air sensor (low limit), mixed air sensor, electronic damper and valve actuator with spring return, exhaust fan interlock relay, two speed switch, day/night relay, outside air temperature sensor, wall mounted room temperature sensor with thumb wheel (field installed), etc. The following control features shall be provided:
  - a. ASHRAE Cycle II Control

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- b. Night Cycle
  - c. Low Ambient Temperature Lockout (55 deg. F.)
  - d. Minimum Outside Air Setting
  - e. Morning Warm-Up Cycle
  - f. 100 Percent Outside Air Economizer
  - g. Dead Band
  - h. Night Setback
  - i. Timed Override Initiation
14. The controller shall be configured such that in the unoccupied mode, the heating valve shall open and provide full flow to the coil when the outside air temperature drops below 25 deg. F.
15. The control system shall be pre-engineered and programmed for each unit to perform the control sequence indicated on the drawings.
16. All temperature control wiring shall be on the load side of the manual motor starter.
- C. Manufacturers:
- 1. Daikin Applied.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Furnish, install and apply equipment and materials in accordance with the manufacturer's published instructions, and approved shop Drawings.
- B. Install central station air handling units in accordance with manufacturer's recommended procedures.
- C. Hoist, transport, and rig air handling units or their shipping sections into position following procedures recommended by the manufacturer.
- D. Replace filters in each unit at time of project final acceptance. Refer to Division 15 Section "Mechanical General Requirements" for additional information.

#### 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections.
- B. Install piping adjacent to machine to allow service and maintenance.
  - 1. Hot-Water Heating Piping: Comply with applicable requirements in Division 15 Section "Hydronic Piping." Connect to supply and return coil tapings with shutoff or balancing valve and union or flange at each connection.
- C. Duct installation requirements are specified in other Division 15 Sections. Drawings indicate the general arrangement of ducts.
- D. Electrical System Connections: Comply with applicable requirements in Division 16 Sections for power wiring, switches, and motor controls.
- E. Ground equipment according to Division 16 Section "Grounding and Bonding."

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- F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 LUBRICATION

- A. Lubricate equipment and fill lubrication systems per manufacturer's published instructions.

3.4 FIELD QUALITY CONTROL

- A. Perform tests in accordance with manufacturer's published data.

3.5 START-UP SERVICE

- A. Provide a field Engineer for start-up of factory fabricated, built-up air handling and exhaust units. Field Engineer shall provide start-up service for temporary construction use, final inspection and adjustment of the units. Include labor, materials, travel, per diem and any other costs as part of the "Field Engineer" work.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain equipment. Refer to Division 15 Section "Mechanical General Requirements." Provide copies of operation and maintenance manuals as specified.

**\*\*END OF SECTION\*\***

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### 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 work of this section.

#### 1.2 SUMMARY

- A. This Section includes electrical general administrative and procedural requirements. The following requirements are included in this Section to supplement the requirements specified in Division 1 Specification Sections.

#### 1.3 REFERENCES

- A. All materials shall be new. The electrical and physical properties of all materials, and the design, performance characteristics, and methods of construction of all items of equipment, shall be in accordance with the latest issue of the various, applicable Standard Specifications of the following recognized authorities:

1. A.N.S.I. American National Standards Institute
2. A.S.T.M. American Society for Testing Materials
3. I.C.E.A. Insulated Cable Engineers Association
4. I.E.E.E. Institute of Electrical and Electronics Engineers
5. N.E.C. National Electrical Code
6. N.E.C.A National Electrical Contractors Association
7. N.E.M.A.National Electrical Manufacturer's Association
8. U.L.Underwriters Laboratories, Inc.
9. N.E.C.A. 1-2000, "Practices for Good Workmanship in Electrical Contracting (ANSI)."

#### 1.4 QUALITY ASSURANCE

- A. Scope of Work: Furnish all labor, material, equipment, technical supervision, and incidental services required to complete, test and leave ready for operation the electrical systems as specified in the Division 26 Sections and as indicated on Drawings.
- B. Ordinances and Codes: Perform all Work in accordance with applicable Federal, State and local ordinances and regulations, the Rules and Regulations of NFPA, NECA, and UL, unless otherwise indicated.
  1. Notify the Architect/Engineer before submitting a proposal should any changes in Drawings or Specifications be required to conform to the above codes, rules or regulations. After entering into Contract, make all changes required to conform to above ordinances, rules and regulations without additional expense to the Owner.
- C. Source Limitations: All equipment of the same or similar systems shall be by the same manufacturer.
- D. Tests and Inspections: Perform all tests required by state, city, county and/or other agencies having jurisdiction. Provide all materials, equipment, etc., and labor required for tests.
- E. Performance Requirements: Perform all work in a first class and workmanlike manner, in accordance with the latest accepted standards and practices for the trades involved.
- F. Sequence and Schedule: Work so as to avoid interference with the work of other trades. Be responsible for removing and relocating any work which in the opinion of the Owner's Representatives causes interference.

#### 1.5 CODES, PERMITS AND FEES

- A. Unless otherwise indicated, all required permits, licenses, inspections, approvals and fees for electrical work shall be secured and paid for by the Contractor. All work shall conform to all applicable codes, rules and regulations.
- B. Rules of local utility companies shall be complied with. Coordinate with the utility company supplying service to the installation and determine all devices including, but not limited to, all

current and potential transformers, meter boxes, C.T. cabinets and meters which will be required and include the cost of all such items and all utilities costs in proposal.

- C. All work shall be executed in accordance with the rules and regulations set forth in local and state codes. Prepare any detailed Drawings or diagrams which may be required by the governing authorities. Where the Drawings and/or Specifications indicate materials or construction in excess of code requirements, the Drawings and/or Specifications shall govern.

#### 1.6 DRAWINGS

- A. The Drawings show the location and general arrangement of equipment, electrical systems and related items. They shall be followed as closely as elements of the construction will permit.
- B. Examine the Drawings of other trades and verify the conditions governing the work on the job site. Arrange work accordingly, providing such fittings, conduit, junction boxes and accessories as may be required to meet such conditions.
- C. Deviations from the Drawings, with the exception of minor changes in routing and other such incidental changes that do not affect the functioning or serviceability of the systems, shall not be made without the written approval of the Architect/Engineer.
- D. The architectural and structural Drawings take precedence in all matters pertaining to the building structure, mechanical Drawings in all matters pertaining to mechanical trades and electrical Drawings in all matters pertaining to electrical trades. Where there are conflicts or differences between the Drawings for the various trades, report such conflicts or differences to the Architect/Engineer for resolution.
- E. Drawings are not intended to be scaled for rough-in or to serve as shop drawings. Take all field measurements required to complete the Work.

#### 1.7 MATERIAL AND EQUIPMENT MANUFACTURERS

- A. All items of equipment shall be furnished complete with all accessories normally supplied with the catalog items listed and all other accessories necessary for a complete and satisfactory operating system. All equipment and materials shall be new and shall be standard products of manufacturers regularly engaged in the production of electrical equipment and shall be of the manufacturer's latest design.
- B. If an approved manufacturer is other than the manufacturer used as the basis for design, the equipment or product provided shall be equal in size, quality, durability, appearance, capacity, and efficiency through all ranges of operation, shall conform with arrangements and space limitations of the equipment shown on the plans and/or specified, shall be compatible with the other components of the system and shall comply with the requirements for Items Requiring Prior Approval specified in this section of the Specifications. All costs to make these items of equipment comply with these requirements including, but not limited to, electrical work, and building alterations shall be included in the original Bid. Similar equipment shall be by one manufacturer.

#### 1.8 INSPECTION OF SITE

- A. Visit the site, examine and verify the conditions under which the Work must be conducted before submitting Proposal. The submitting of a Proposal implies that the Contractor has visited the site and understands the conditions under which the Work must be conducted. No additional charges will be allowed because of failure to make this examination or to include all materials and labor to complete the Work.



1.9 ITEMS REQUIRING PRIOR APPROVAL

- A. Bids shall be based upon manufactured equipment specified. All items that the Contractor proposes to use in the Work that are not specifically named in the Contract Documents must be submitted for review prior to bids. Such items must be submitted in compliance with Division 1 specifications. Requests for prior approval must be accompanied by complete catalog information, including but not limited to, model, size, accessories, complete electrical information and performance data in the form given in the equipment schedule on the drawings at stated design conditions. Where items are referred to by symbolic designations on the drawings, all requests for prior approval shall bear the same designations.
  - 1. Equipment to be considered for prior approval shall be equal in quality, durability, appearance, capacity and efficiency through all ranges of operation, shall fulfill the requirements of equipment arrangement and space limitations of the equipment shown on the plans and/or specified and shall be compatible with the other components of the system.
  - 2. All costs incurred to make equipment comply with other requirements, including providing maintenance, clearance, electrical, replacement of other components, and building alterations shall be included in the original bid.
- B. Voluntary alternates may be submitted for consideration, with listed addition or deduction to the bid.

1.10 SHOP DRAWINGS/SUBMITTALS

- A. Submit project-specific submittals for review in compliance with Division 1.
- B. All shop Drawings shall be submitted in groupings of similar and/or related items (lighting fixtures, switchgear, etc.). Incomplete submittal groupings will be returned unchecked.
- C. Provide detailed layout shop Drawings (on transparent media) of all lighting and power distribution systems, routing of conduits, combining of circuits, circuiting, details and related information necessary of installation and maintenance. After review by the Architect/Engineer, a copy of Drawings will be stamped and returned to the Contractor.
- D. If deviations (not substitutions) from Contract Documents are deemed necessary by the Contractor, details of such deviations, including changes in related portions of the project and the reasons therefore, shall be submitted with the submittal for approval.
- E. Submit for approval shop drawings for all electrical systems or equipment but not limited to the items listed below. Where items are referred to by symbolic designation on the Drawings and Specifications, all submittals shall bear the same designation (light fixtures). Refer to other sections of the electrical Specifications for additional requirements.
  - 1. Panelboards
  - 2. Dry-Type Transformers
  - 3. Enclosed Controllers
  - 4. Disconnect Switches
  - 5. Contactors
  - 6. Time Controllers

7. Wiring Devices
  8. Lighting Fixtures
  9. Occupancy Sensors (material and lay-out drawings)
  10. Fire Alarm Systems
  11. Sound Systems
- 1.11 COORDINATION DRAWINGS
- A. Submit project specified coordination drawings for review in compliance with Division 1 Specification Sections.
- 1.12 OPERATION AND MAINTENANCE INSTRUCTIONAL MANUALS
- A. Submit project specific Operation and Maintenance Instructional Manuals for review in compliance with Division 1 Specification Sections.
  - B. Provide complete operation and maintenance instructional manuals covering all electrical equipment herein specified, together with parts lists. Maintenance and operating instructional manuals shall be job specific to this project. Generic manuals are not acceptable. Four (4) copies of all literature shall be furnished for Owner and shall be bound in ring binder form. Maintenance and operating instructional manuals shall be provided when construction is approximately 75% complete.
  - C. The operating and maintenance instructions shall include a brief, general description for all mechanical systems including, but not limited to:
    1. Routine maintenance procedures.
    2. Lubrication chart listing all types of lubricants to be used for each piece of equipment and the recommended frequency of lubrication.
    3. Trouble-shooting procedures.
    4. Contractor's telephone numbers for warranty repair service.
    5. Submittals.
    6. Recommended spare parts lists.
    7. Names and telephone numbers of major material suppliers and subcontractors.
    8. System schematic drawings on 8-1/2" x 11" sheets.
- 1.13 RECORD DRAWINGS
- A. Submit record drawings in compliance with Division 1.
  - B. Contractor shall submit to the Architect/Engineer, record drawings on electronic media or mylar which have been neatly marked to represent as-built conditions for all new electrical work.

- C. The Contractor shall keep accurate note of all deviations from the construction documents and discrepancies in the underground concealed conditions and other items of construction on field drawings as they occur. The marked up field documents shall be available for review by the Architect, Engineer and Owner at their request.

#### 1.14 INSTRUCTION OF OWNER PERSONNEL

- A. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of electrical equipment and systems at agreed upon times. A minimum of 8 hours of formal instruction to Owner's personnel shall be provided for each building. Additional hours are specified in individual specification sections.
- B. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
- C. In addition to individual equipment training provide overview of each electrical system. Utilize the as-built documents for this overview.
- D. Prepare and insert additional data in operation and maintenance manual when need for such data becomes apparent during instruction, or as requested by Owner.

#### 1.15 WARRANTY

- A. Warranty: Comply with the requirements in Division 1 Specification Sections. Contractor shall warrant that the electrical installation is free from defects and agrees to replace or repair, to the Owner's satisfaction, any part of this electrical installation which becomes defective within a period of one year (unless specified otherwise in other Division 26 sections) from the date of substantial completion following final acceptance, provided that such failure is due to defects in the equipment, material, workmanship or failure to follow the contract documents.
- B. File with the Owner any and all warranties from the equipment manufacturers including the operating conditions and performance capacities they are based on.

#### 1.16 USE OF EQUIPMENT

- A. The use of any equipment, or any part thereof for purposes other than testing even with the Owner's consent, shall not be construed to be an acceptance of the work on the part of the Owner, nor be construed to obligate the Owner in any way to accept improper work or defective materials.
- B. Do not use Owner's lamps for temporary lighting except as allowed and directed by the Owner. Equip lighting fixtures with new lamps when the project is turned over to the Owner.

### PART 2 - PRODUCTS

Not applicable.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION OF EQUIPMENT

- A. Install all equipment in strict accordance with all directions and recommendations furnished by the manufacturer. Where such directions are in conflict with the Drawings and Specifications, report such conflicts to the Architect/Engineer for resolution.
- B. Device Location:

1. Allow for relocation prior to installation of wiring devices and other control devices, for example, receptacles, switches, fire alarm devices, and access control devices, within a 10-foot radius of indicated location without additional cost.

### 3.2 DEMOLITION WORK

- A. All demolition of existing electrical equipment and materials will be done by this Contractor unless otherwise indicated. Include all items such as, but not limited to, electrical equipment, devices, lighting fixtures, conduit, and wiring called out on the Drawings and as necessary whether such items are actually indicated on the Drawings or not in order to accomplish the installation of the specified new work.
- B. In general, demolition work is indicated on the Drawings. However, the Contractor shall visit the job site to determine the full extent and character of this work.
- C. Unless specifically noted to the contrary, removed materials shall not be reused in the work. Salvaged materials that are to be reused shall be stored safe against damage and turned over to the appropriate trade for reuse. Salvaged materials of value that are not to be reused shall remain the property of the Owner unless such ownership is waived. Items on which the Owner waives ownership shall become the property of the Contractor, who shall remove and legally dispose of same, away from the premises.
- D. Where equipment or fixtures are removed, outlets shall be properly blanked off, and conduits capped. After alterations are done, the entire installation shall present a "finished" look, as approved by the Architect/Engineer. The original function of the present electrical work to be modified shall not be changed unless required by the specific revisions to the system as specified or as indicated.
- E. Reroute signal wires, lighting and power wiring as required to maintain service. Where walls and ceilings are to be removed as shown on the Drawings, the conduit is to be cut off by the Electrical Trades so that the abandoned conduit in these walls and ceilings may be removed with the walls and ceilings by the Architectural Trades. All dead-end conduit runs shall be plugged at the remaining line outlet boxes or at the panels.
- F. Where new walls and/or floors are installed which interfere with existing outlets, devices, etc., the Electrical Trades shall adjust, extend and reconnect such items as required to maintain continuity of same.
- G. All electrical work in altered and unaltered areas shall be run concealed wherever possible. Use of surface raceway or exposed conduits will be permitted only where approved by the Architect/Engineer.
- H. Existing lighting shall be reused where indicated on plans. Reused fixtures shall be detergent cleaned, relamped and reconditioned suitable for satisfactory operation and appearance.

### 3.3 TEMPORARY SERVICES

- A. Provide and remove upon completion of the project, in accordance with the general conditions and as described in Division 1, a complete temporary electrical and telephone service during construction.

3.4 CHASES AND RECESSES

- A. Provided by the architectural trades, but the Contractor shall be responsible for their accurate location and size.

3.5 CUTTING, PATCHING AND DAMAGE TO OTHER WORK

- A. Refer to General Conditions for requirements.
- B. All cutting, patching and repair work shall be performed by the Contractor through approved, qualified subcontractors. Contractor shall include full cost of same in bid.

3.6 EXCAVATION AND BACKFILLING

- A. Provide all excavation, trenching, tunneling, dewatering and backfilling required for the electrical work. Coordinate the work with other excavating and backfilling in the same area.
- B. Where conduit is installed less than 2'6" below the surface of pavement, provide concrete encasement, 4" minimum coverage, all around or as shown on the electrical Drawings.
- C. Backfill all excavations with well-tamped granular material. Backfill all excavations under wall footings with lean mix concrete up to underside of footings and extend concrete within excavation a minimum of four (4) feet each side of footing. Granular backfill shall be placed in layers not more than 8 inches in thickness, 95 percent compaction throughout with approved compaction equipment. Tamp, roll as required. Excavated material shall not be used.
- D. Backfill outside building with granular material to a height 12 inches over top of pipe compacted to 95 percent compaction as specified above. Backfill remainder of excavation with unfrozen, excavated material in such a way to prevent settling.

3.7 EQUIPMENT CONNECTIONS

- A. Make connections to equipment, motors, lighting fixtures, and other items included in the work in accordance with the approved shop Drawings and rough-in measurements furnished by the manufacturers of the particular equipment furnished. All additional connections not shown on the Drawings, but called out by the equipment manufacturer's shop Drawings shall be provided.

3.8 CLEANING

- A. All debris shall be removed daily as required to maintain the work area in a neat, orderly condition.
- B. Final cleanup shall include, but not be limited to, washing of fixture lenses or louvers, switchboards, substations, motor control centers, panels, etc. Fixture reflectors and lenses or louvers shall be left with no water marks or cleaning streaks.

3.9 PROTECTION AND HANDLING OF EQUIPMENT AND MATERIALS

- A. Equipment and materials shall be protected from theft, injury or damage.
- B. Protect conduit openings with temporary plugs or caps.
- C. Provide adequate storage for all equipment and materials delivered to the job site. Location of the space will be designated by the Owner's representative or Architect/Engineer. Equipment set in place in unprotected areas must be provided with temporary protection.

3.10 EXTRA WORK

- A. For any extra electrical work which may be proposed, this Contractor shall furnish to the General Contractor, an itemized breakdown of the estimated cost of the materials and labor required to complete this work. The Contractor shall proceed only after receiving a written order from the General Contractor establishing the agreed price and describing the work to be done.

Prior to any extra work which may be proposed, the Electrical Contractor shall submit unit prices (same prices for increase/decrease of work) for the following items: 1/2", 3/4", 1", 1-1/2" conduit; #12, #10, #8, #6, #2 wire; receptacle, I.G. receptacle, data box, fire alarm horn/strobe, fire alarm strobe, P.A. speaker, clock, or other devices which may be required for any proposed extra work.

3.11 DRAWINGS AND MEASUREMENTS

- A. These Specifications and accompanying Drawings are intended to describe and provide for finished work. They are intended to be cooperative, and what is called for by either shall be as binding as if call for by both. The Contractor understands that the work herein described shall be complete in every detail.
- B. The Drawings are not intended to be scaled for rough-in measurements nor to serve as Shop Drawings. Field measurements necessary for ordering materials and fitting the installation to the building construction and arrangement are the Contractor's responsibility. The Contractor shall check latest Architectural Drawings and locate light switches from same where door swings are different from Electrical Drawings.

**\*\*END OF SECTION\*\***

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## 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. Electrical equipment coordination and installation.
  - 2. Sleeves for raceways and cables.
  - 3. Sleeve seals.
  - 4. Common electrical and communications installation requirements.
  - 5. Grout.

### 1.3 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.
- C. NBR: Acrylonitrile-butadiene rubber.

### 1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

1.6 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 and provide 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 electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

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 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 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."

2.3 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.



1. Manufacturers:
  - 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: Stainless steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## 2.4 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 AND COMMUNICATIONS 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 raceways and piping systems installed at a required slope.

### 3.2 SLEEVE INSTALLATION FOR ELECTRICAL AND COMMUNICATIONS 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. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."
- C. 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.
- 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.

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- G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require a different clearance.
  - H. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
    - 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. Refer to Division 7 Section "Joint Sealants" for materials and installation.
  - 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 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 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 "wall pipes" for 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 underground, 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.
- 3.4 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."
- 3.5 FIELD QUALITY CONTROL
- A. Inspect installed sleeve and sleeve-seal installations and associated firestopping for damage and faulty work.

**\*\*END OF SECTION\*\***

## CONDUCTORS AND CABLES

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### 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 building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.
- B. Related Sections include the following:
  - 1. Division 26 Section "Control/Signal Transmission Media" for transmission media used for control and signal circuits.
  - 2. Division 26 Section "Electrical Identification" for conductor and cable color-coding.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For testing agency.
- C. Field Quality-Control Test Reports: From a qualified testing and inspecting agency engaged by Contractor.

#### 1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association 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.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

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

### 2.2 CONDUCTORS AND CABLES

- A. Manufacturers, Copper:
  - 1. Triangle.
  - 2. Royal.
  - 3. Rome.
  - 4. General Cable Corporation.
  - 5. Southwire Company.
  - 6. Draka USA.
- B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.
- C. Conductor Material: Copper.
- D. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.
- E. Conductor Insulation Types: Type THHN-THWN and XHHW complying with NEMA WC 70.
- F. Multiconductor Cable: Metal-clad cable, Type MC with ground wire.
- G. Power Cable for Variable Frequency Controlled Motors: 600V and 2000V, three conductor, XLPE cable with three symmetrical positioned ground conductors and a continuous impervious corrugated aluminum armor and overall PVC jacket. Cable shield transfer impedance shall be less than 10 ohms per meter up to 30 MHZ when tested in accordance with NEMA WC 61.
  - 1. Approved manufacturers for VFC power cables:
    - a. Southwire Armor-x
    - b. Draka USA

## 2.3 CONNECTORS AND SPLICES

- A. Manufacturers:
  - 1. AFC Cable Systems, Inc.
  - 2. AMP Incorporated/Tyco International.
  - 3. Hubbell/Anderson.
  - 4. O-Z/Gedney; EGS Electrical Group LLC.
  - 5. 3M Company; Electrical Products Division.
  - 6. T & B.
  - 7. Burndy.
  - 8. ILSCO.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

## PART 3 - EXECUTION

### 3.1 CONDUCTOR AND INSULATION APPLICATIONS

- A. Service Entrance: Type XHHW, single conductors in raceway.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- C. Exposed Feeders #4/0 and larger: Type XHHW, single conductor in raceway.
- D. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- E. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspace: 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 and metal-clad cable, Type MC, for branch circuit drops to devices and within partition walls. MC cable shall not be run in ceiling space in lengths greater than 6'-0".
- H. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.
- I. Underground Feeders and Branch Circuits: XHHW single conductors in conduit.
- J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord.
- K. Fire Alarm Circuits: Type THHN-THWN, in raceway or Power-limited, fire-protective, signaling circuit cable.
- L. Class 1 Control Circuits: Type THHN-THWN, in raceway.

- M. Class 2 Control Circuits: Type THHN-THWN, in raceway.
- N. Critical Fire Control Circuits: Type RHH, single conductor in raceway. UL classified with two hour fire rating when installed in EMT conduit per the NEC and UL electrical circuit protective system (FHIT) #25 of the UL fire resistance directory. Support every 5' on center.
- O. Variable Speed Drives to Motors: Use VFD power cable manufactured by Southwire or Draka. Support every 5' on center.

### 3.2 INSTALLATION

- 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 26 Section "Basic Electrical Materials and Methods."
- F. Seal around cables penetrating fire-rated elements according to Division 7 Section "Through-Penetration Firestop Systems."
- G. Each feeder shall be of the same conductor and insulation material (phase, neutral, and parallel).
- H. Identify and color-code conductors and cables according to Division 26 Section "Electrical Identification."
- I. All wiring shall be installed in conduit or approved raceway. All raceways shall be provided with a ground conductor unless noted otherwise on the Contract Documents.
- J. Use conductor not smaller than 12 AWG for power and lighting circuits. Unless indicated otherwise, all circuits shall be 2#12, 1#12G, ¾"C. Do not share neutrals.
- K. Use conductor not smaller than 14 AWG for control circuits, provided by Electrical Contractor.
- L. Support communication cables above accessible ceiling, using spring metal clips or plastic cable ties to support cables from structure. Do not rest cable on ceiling panels.
- M. Use suitable cable fittings and connectors.
- N. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- O. Clean conductor surfaces before installing lugs and connectors.
- P. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- Q. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and larger.
- R. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

- S. Branch circuits may be combined up to 6 circuits in a homerun conduit. Electrical Contractor shall be responsible for derating of conductors as required by N.E.C. Do not share neutrals.
- T. Use piercing connector with insulating covers for conductor splices and taps, 8 AWG and larger.
- U. Where the armor of type AC cable terminates, a fitting shall be provided to protect the wiring from abrasion. An approved bushing shall be provided between the conductors and the armor.
- V. Type MC cable shall be supported and secured at intervals not exceeding 4'-0".
- W. Fittings used for MC cable shall be identified for such use.
- X. AC/MC cable shall not be used for home runs to receptacle or distribution panels.
- Y. Between support, hangers and termination no more than 3" deflection from the bottom of the cable to a horizontal line between the support/hanger or termination.

### 3.3 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.

### 3.4 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing"
  - 1. Description: Test all feeders rated 100 A and above.
  - 2. Visual and Mechanical Inspection
    - a. Inspect cables for physical damage and proper connection in accordance with the one line diagram.
    - b. Test cable mechanical connections with an infrared survey.
    - c. Check cable color-coding against project Specifications and N.E.C. requirements.
  - 3. Electrical Tests
    - a. Perform insulation resistance test on each conductor with respect to ground and adjacent conductors. Applied potential to be 1000 volts dc for 1 minute.
    - b. Perform continuity test to insure proper cable connection.
  - 4. Test Values
    - a. Minimum insulation resistance values shall be not less than fifty mega-ohms.
- B. Test Reports: Prepare a written report to record the following:
  - 1. Test procedures used.

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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.

**\*\*END OF SECTION\*\***



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### 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 grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.
- B. Related Sections include the following:
  - 1. Division 26 Section "Electrical General Requirements".
  - 2. Division 26 Section "Conductors and Cables".

#### 1.3 REFERENCES

- A. ASTM B 3: Specification for Soft or Annealed Copper Wire.
- B. ASTM B 8: Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
- C. ASTM B 33: Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.
- D. ASTM B 187: Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes.
- E. IEEE 81: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

- F. IEEE 142: Grounding of Industrial and Commercial Power Systems.
- G. IEEE 1100 – 1992: Recommended Practice for Powering and Grounding Sensitive Electronic Equipment.
- H. IEEE C2: National Electrical Safety Code.
- I. NETA MTS – 2001: Maintenance Testing Specifications.
- J. NFPA 70: National Electrical Code.
- K. NFPA 70B: Recommended Practice for Electrical Equipment Maintenance.
- L. NFPA 780: Lightning Protection Code.
- M. TIA/EIA 607: Commercial Building Grounding and Bonding Requirements Standard.
- N. UL 96: Lightning Protection Components.
- O. UL 467: Grounding and Bonding Equipment.
- P. UL 486 A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.
- Q. UL 486B: Wire Connectors for Use with Aluminum Conductors.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Data: For the following:
  - 1. Ground rods.
- C. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- D. Field Test Reports: Submit written test reports to include the following:
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.
  - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
  - 4. Indicate overall system resistance to ground.
  - 5. Indicate overall Telecommunications system resistance to ground.

#### 1.5 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 26 "Electrical General Requirements".
- B. Accurately record actual locations of grounding electrodes and connections to building steel.

#### 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Refer to specification section "Electrical Testing."

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
  - 1. Comply with UL 467.
- C. Comply with NFPA 70; for overhead-line construction and medium-voltage underground construction, comply with IEEE C2.
- D. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.
- E. Comply with ANSI/TIA/EIA-607 "Standard for Commercial Building Grounding and Bonding Requirements for Telecommunications".
- F. Comply with ANSI/IEEE 1100 -1992 "Powering and Grounding Sensitive Electronic Equipment".

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Grounding Conductors and Cables:
    - a. Refer to Division 26 Section "Conductors and Cables".
  - 2. Grounding Rods:
    - a. American Electric-Blackburn.
    - b. Apache Grounding/Erco Inc.
    - c. Chance/Hubbell.
  - 3. Mechanical Connectors:
    - a. American Electric-Blackburn.
    - b. Burndy.
    - c. Chance/Hubbell.
  - 4. Exothermic Connections:
    - a. Cadweld.

### 2.2 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 Section "Conductors and Cables."
- B. Material: Aluminum, copper-clad aluminum, and copper.
- C. Equipment Grounding Conductors: Insulated with green-colored insulation.
- D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
- E. Grounding Electrode Conductors: Stranded cable.

- F. Underground Conductors: Bare, tinned, stranded, copper unless otherwise indicated.
- G. Bare Copper Conductors: Comply with the following:
  - 1. Solid Conductors: ASTM B 3.
  - 2. Assembly of Stranded Conductors: ASTM B 8.
  - 3. Tinned Conductors: ASTM B 33.
- H. Copper Bonding Conductors: As follows:
  - 1. Bonding Conductor: Stranded copper conductor; size per the NEC.
  - 2. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; size per the NEC.
  - 3. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; size per the NEC.
- I. Aluminum Bonding Conductors: As follows:
  - 1. Bonding Conductor: Stranded aluminum conductor; size per the NEC.
  - 2. Bonding Jumper: Aluminum tape, braided bare aluminum conductors, terminated with aluminum ferrules; size per the NEC.
- J. Ground Conductor and Conductor Protector for Wood Poles: As follows:
  - 1. No. 4 AWG minimum, soft-drawn copper conductor.
  - 2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir, or cypress or cedar.
- K. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.
- L. Telecommunications Main Grounding Busbar (TMGB)
  - 1. 48" (min) x 4" x 1/4" tin plated, copper busbar with three rows of 1/4 x 20 tapped holes 3" on center.
- M. Telecommunications Grounding Busbar (TGB)
  - 1. 12" (min) x 2" x 1/4" tin plated, copper busbar with two rows of 1/4 x 20 tapped holes 3" on center.
- N. Telecommunications Bonding Backbone (TBB)
  - 1. Minimum No. 2 AWG insulated stranded copper.
- O. Telecommunications Bonding Conductors
  - 1. Minimum No. 6 AWG insulated stranded copper.

## 2.3 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.
- C. Welded Connectors: Exothermic-welded type, in kit form, and selected for the specific application per manufacturer's written instructions.
- D. Compression-Type Connectors: Pure, wrought copper, per ASTM B187.

## 2.4 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel.
  - 1. Size: 5/8 (16 mm) in diameter.
  - 2. Length: 120 inches (3000 mm).
- B. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Provide handholes as specified in Division 2 Section "Underground Ducts and Utility Structures."

## PART 3 - EXECUTION

### 3.1 EQUIPMENT GROUNDING

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- C. Underground Grounding Conductors: No. 2/0 AWG minimum. Bury at least 24 inches (600 mm) below grade or bury 12 inches (300 mm) above duct bank when installed as part of the duct bank.
- D. In raceways, use insulated equipment grounding conductors.
- E. Install equipment grounding conductors in all feeders and circuits. Terminate each end on suitable lugs, bus or bushing.
- F. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
- G. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.
- H. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at the isolated equipment ground bus of the source panelboard unless otherwise indicated.
- I. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment grounding conductor. Isolate equipment grounding conductor from raceway and from panelboard

grounding terminals. Terminate at the isolated ground bus in the circuit's overcurrent device enclosure unless otherwise indicated.

- J. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
- K. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.
- L. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.
- M. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.
- N. Verify specific equipment grounding requirements with the manufacturer's recommendations.

### 3.2 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
  - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
  - 2. Make connections with clean, bare metal at points of contact.
  - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
  - 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
  - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Equipment Grounding Conductor Terminations.
- D. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and larger.
- E. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
- F. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

- G. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and ground rods.
- H. Tighten screws and bolts for grounding and bonding 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.
- I. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- J. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

### 3.3 INSTALLATION

- A. Equipotential Ground: Interconnect grounding electrodes to form one, electrically continuous, equipotential grounding electrode system. Grounding electrodes to be interconnected include:
  - 1. Ground rods.
  - 2. Counterpoise ground.
  - 3. Ufer ground.
  - 4. Lightning protection system.
  - 5. Metal water service pipe.
  - 6. Plate electrode.
- B. Ground Rods: 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.
  - 1. Verify that final backfill and compaction has been complete before driving ground rods.
  - 2. Drive ground rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
  - 3. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.
- C. Counterpoise Ground:
  - 1. Ground the steel framework of the building with a driven ground rod at the base of every corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.
  - 2. Provide a grounding conductor (counterpoise), electrically connected to each ground rod and to each steel column, extending around the perimeter of the building. Use conductors not less than No. 2/0 AWG for counterpoise and for tap to building steel. Bury counterpoise not less than 18 inches (450 mm) below grade and 24 inches (600 mm) from building foundation.

- D. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, Paragraph 250-81(c):
1. Provide a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 4 AWG. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within the base of the foundation.
  2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts.
  3. Extend grounding conductor below grade and connect to building grounding grid or to a grounding electrode external to concrete.
- E. Common Ground Bonding 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. Install in conduit where routed above grade.
- F. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Install in conduit where routed above grade.
- G. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.
- H. Metal Water Service Pipe: Provide 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 by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
- I. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.
- J. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.
- K. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.
- L. Separately Derived AC Power Systems: Ground separately-derived ac power system neutrals including distribution transformers to grounding electrodes per NFPA 70.
- M. Packaged Engine Generator: Solidly ground the packaged engine generator neutral to the normal power source neutral. Do not ground the generator neutral to a separate grounding electrode.
- N. Install one test well for each service at the ground rod electrically closest to the service entrance. Set top of well flush with finished grade or floor.
- O. Grounding Bus:
1. Install grounding bus in the locations listed below and elsewhere as indicated:
    - a. Electrical equipment rooms.



- b. Telephone equipment rooms.
  - c. Rooms housing service equipment.
- 2. Use insulated spacer; space 1 inch (25.4 mm) from wall and support from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
- P. Equipment Grounding: Provide a permanent and continuous bonding of conductor enclosures, equipment frames, power distribution equipment ground busses, cable trays, metallic raceways, and other non-current carrying metallic parts of the electrical system.
- Q. Access Floor Pedestal Ground: Ground access floor pedestals where indicated.
  - 1. Provide access floor pedestal ground plate where indicated.
    - a. Provide ½ inch (12 mm) thick x 4 inches (102 mm) wide x 12 inches (305 mm) long, soft copper bar, bolted construction with minimum six 3/8 inch (10 mm) diameter drilled holes 1 ½ inches (38 mm) on center.
    - b. Provide cadmium plated bolts, nuts and screws.
    - c. Mount plate on ¾ inch (19 mm) plywood with 2 inch (50 mm) wood spacers.
  - 2. Provide No. 2 AWG insulated ground conductor from pedestal to pedestal ground plate or building steel.
  - 3. Provide No. 2 AWG insulated ground conductor from pedestal ground plate to building steel.
  - 4. Tie wrap ground conductor as close to concrete floor as possible at every other pedestal.
  - 5. Clean all pedestals prior to welding.
- R. Access Floor Ground Grid: Install ground grid under access floors where indicated.
  - 1. Construct grid of No. 2 AWG bare copper wire installed on 24 inch centers both ways.
  - 2. Bond each access floor pedestal to grid.
- S. Bond together each metallic raceway, pipe, duct and other metal object entering space under access floors. Bond to underfloor ground grid. Bond to pedestal ground plate or Bond to building steel. Use No. 2 AWG bare copper conductor.
- T. Provide grounding and bonding in patient care areas to meet requirements of NFPA 99 and ANSI/NFPA 70.
- U. Bond together metal siding not attached to grounded structure; bond to ground.
- V. Pool Structures: Provide a common bonding grid with a solid copper conductor not smaller than No. 8 AWG. Bond together the following:
  - 1. All metallic parts of the pool or fountain structure, including reinforcing steel of the pool or fountain shell, coping stones, and deck.
  - 2. All forming shells and mounting brackets of no-niche luminaries.
  - 3. All metal fittings within or attached to the pool or fountain structure that are greater than 4 inches (100 mm) in any dimension and penetrate the pool or fountain structure more than one inch (25 mm).

4. Metal parts of electrical equipment associated with the pool or fountain water circulating system, including pump motors and metal parts of equipment associated with pool covers, including electric motors.
5. Metal sheathed cables and raceways, metal piping, and all fixed metal parts including fences, awnings, door and window frames, except those separated from the pool or fountain by a permanent barrier shall be bonded that are within the following distances of the pool:
  - a. Within 5 feet (1.5 m) horizontally of the inside walls of the pool.
  - b. Within 12 feet (3.7 m) measured vertically above the maximum water level of the pool, or any observation stands, towers, or platforms, or any diving structure.

W. Provide a flexible braid bonding jumper at each set of columns at expansion joints.

### 3.4 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

- A. Manholes and Handholes: Install a driven ground rod close to wall, inside manhole, 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 a No. 1/0 AWG 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 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.
- B. Connections to Manhole Components: Connect all 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 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.
- C. Pad-Mounted Transformers and Switches: Install two ground rods and counterpoise circling pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with transformers/substations by connecting them to underground cable and grounding electrodes. Use not less than a No. 2 AWG conductor for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches (450 mm) below grade and 6 inches (150 mm) from the foundation.

### 3.5 TELECOMMUNICATIONS GROUNDING

- A. Telecommunications Grounding System: The telecommunications grounding system shall consist of:
  1. Telecommunications Main Grounding Busbar (TMGB) located in the main telecommunications room near the telecommunications service entrance. Bond to the main building electrical grounding electrode system via a No. 3/0 AWG copper ground conductor.
  2. A Telecommunications Grounding Busbar (TGB) in each telecommunications room, cabinets, etc.
  3. A Telecommunications Bonding Backbone (TBB) tying together the TMGB and each TGB.
  4. Bonding of all equipment racks, raceways, non-current carrying metallic equipment and surge protection devices within the telecommunications room to the TGB's or TMGB using approved bonding conductors. Each piece of equipment shall be bonded individually directly to the ground bus.
- B. All bonding connections shall be installed at an accessible location for inspection and maintenance.

- C. All telecommunications bonding connections shall be of an approved mechanical type connection. Do not use exothermic welds unless specifically indicated on the Drawings.
- D. The physical routing shall, in general, follow the same path as the backbone cable system.
- E. Bond each TGB directly to the building steel with a No. 6 AWG conductor.
- F. Do not use TGB's as a power system ground connection unless specifically noted on the Drawings.
- G. All bonding connectors and conductors shall be UL listed for the purpose intended.
- H. Mount TMGB and TGB bus to backboard or wall using 2" standoff insulators.
- I. Individually bond each piece of non-current carrying metallic equipment in the Telecommunications Room to the TGB.
- J. Install continuous cable from the TMGB to the furthest TGB. Bond all TGB's to TBB with bare No. 6 AWG copper ground conductor and T-tap grounding hardware.

### 3.6 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing"
  - 1. Inspect grounding and bonding system conductors and connections for tightness and proper installation and for compliance with the Drawings and Specifications.
  - 2. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
    - a. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal.
    - b. Measure ground resistance not less than two full days after the last trace of precipitation, and without the 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.
    - c. Perform tests, by the fall-of-potential method according to IEEE 81. Instrumentation utilized shall be as defined in Section 12 of IEEE 81 and shall be specifically designed for ground impedance testing. Provide sufficient spacing so that curves flatten in the 62% area of the distance between the item under test and the current electrode.
    - d. Perform ground-impedance measurements utilizing either the intersecting curves method of the slope method. (Ref. Nos. 40 and 41 in IEEE Std. 81).
    - e. Equipment Grounds: Utilize two-point method of IEEE 81. Measure between equipment ground being testing and known low-impedance grounding electrode or system.
  - 3. Provide drawings locating each 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.
    - a. Equipment Rated 500 kVA and Less: 10 ohms.
    - b. Equipment Rated 500 to 1000 kVA: 5 ohms.
    - c. Equipment Rated More Than 1000 kVA: 3 ohms.
    - d. Substations and Pad-Mounted Switching Equipment: 5 ohms.

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- e. Manhole Grounds: 10 ohms.
  - f. The telecommunications grounding system shall have a maximum resistance of 1 ohm as measured from the TMGB ground to earth ground.
4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

**\*\*END OF SECTION\*\***

## HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

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### 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. Hangers and supports for electrical equipment and systems.
  - 2. Construction requirements for concrete bases.

#### 1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

#### 1.5 SUBMITTALS

- A. Product Data: For the following:
  - 1. Steel slotted support systems.
  - 2. Nonmetallic slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
  - 1. Trapeze hangers. Include Product Data for components.
  - 2. Steel slotted channel systems. Include Product Data for components.
  - 3. Nonmetallic slotted channel systems. Include Product Data for components.
  - 4. Equipment supports.
- C. Welding certificates.

#### 1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

#### 1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

### PART 2 - PRODUCTS

#### 2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
  - 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:
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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SYSTEMS

- a. Allied Tube & Conduit.
  - b. Cooper B-Line, Inc.; a division of Cooper Industries.
  - c. ERICO International Corporation.
  - d. GS Metals Corp.
  - e. Thomas & Betts Corporation.
  - f. Unistrut; Tyco International, Ltd.
  - g. Wesanco, Inc.
3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
  5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
  6. Channel Dimensions: Selected for applicable load criteria.
- B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.
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:
  2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit.
    - b. Cooper B-Line, Inc.; a division of Cooper Industries.
    - c. Fabco Plastics Wholesale Limited.
    - d. Seasafe, Inc.
  3. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
  4. Fitting and Accessory Materials: Same as channels and angles.
  5. Rated Strength: Selected to suit applicable load criteria.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    - 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) Hilti Inc.
      - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      - 3) MKT Fastening, LLC.
      - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
  2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
    - 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) Cooper B-Line, Inc.; a division of Cooper Industries.
      - 2) Empire Tool and Manufacturing Co., Inc.
      - 3) Hilti Inc.
      - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      - 5) MKT Fastening, LLC.
  3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
  4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
  5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
  6. Toggle Bolts: All-steel springhead type.
  7. Hanger Rods: Threaded steel.

## 2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 5 Section "Metal Fabrications" for steel shapes and plates.



### PART 3 - EXECUTION

#### 3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  - 1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.
- E. Support all electrical items independently of supports provided by the other trades.
- F. Support conduits and boxes using steel conduit straps or 1/4-inch minimum diameter threaded rod hangers. Suspended ceiling hangers or hanger wire shall not be used (except to support flexible metallic conduit and manufactured wiring systems).
- G. Support cable trays with support brackets or 3/8" diameter minimum threaded rod hangers at intervals not exceeding 8'-0" for straight runs. Additional supports shall be provided at tray fittings.
- H. Hangers shall be of sufficient strength that their deflection at mid span does not exceed 1/240 of the hanger span length after the cables are installed.

#### 3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To Wood: Fasten with lag screws or through bolts.
  - 2. To New Concrete: Bolt to concrete inserts.
  - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 4. To Existing Concrete: Expansion anchor fasteners.

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5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
  6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
  7. To Light Steel: Sheet metal screws.
  8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.
  - E. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.
  - F. Obtain permission from Architect/Engineer before using powder-actuated anchors.
  - G. Obtain permission from Architect/Engineer before drilling or cutting structural members.
  - H. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
  - I. Install surface-mounted cabinets and panelboards with minimum of four anchors.
  - J. In wet and damp locations use steel channel supports to stand cabinets and panelboards one inch (25 mm) off wall.
  - K. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
  - L. The Contractor shall replace all supports and channels that sag, twist, and/or show signs of not providing proper structural support, to the equipment, it is intended for, as determined by the Owner and Architect/Engineer. All costs associated with replacing supports and steel channels shall be incurred by the Contractor.
- 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS
- A. Comply with installation requirements in Division 5 Section "Metal Fabrications" for site-fabricated metal supports.
  - B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
  - C. Field Welding: Comply with AWS D1.1/D1.1M.
- 3.4 CONCRETE BASES
- A. Provide concrete bases for all floor mounted electrical equipment.
  - B. Provide concrete bases for all exterior, grade level electrical equipment, and where indicated.

C. Base/Pad Construction:

1. Construct per manufacturer's recommendations for particular equipment, including suggested piers and dowel rods.
2. Construct concrete bases for primary and secondary power distribution equipment per requirements of the electrical utility, where submitted for its review.

D. Anchor equipment to base per both supports and equipment manufacturer's instructions.

E. Coordinate conduit openings and sleeve locations in base with requirements of equipment to be supported.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of the base.
2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (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\*\***

## RACEWAYS AND BOXES

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### 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 26 Section, "Basic Electrical Materials and Methods" for exterior ductbanks, manholes, and underground utility construction.
  - 2. Division 7 Section, "Through-Penetration Firestop Systems"
  - 3. Division 26 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings, and for access floor boxes and service poles.

#### 1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. FMC: Flexible metal conduit.
- D. IMC: Intermediate metal conduit.

- E. LFMC: Liquidtight flexible metal conduit.
- F. LFNC: Liquidtight flexible nonmetallic conduit.
- G. RNC: Rigid nonmetallic conduit.
- H. PVC: Polyvinyl Chloride.
- I. HDPE: High Density Polyethylene.

#### 1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Manufacturer Seismic Qualification Certification: Submit certification that enclosures, cabinets, accessories, and components will withstand seismic forces defined in Division 26 Section "Electrical Supports and Seismic Restraints." Include the following:
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
    - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

#### 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.
- C. All work in natatorium/pool area shall be in accordance with N.E.C. article 680, "Swimming Pools, Fountains, and Similar Installations."

#### 1.6 COORDINATION

- A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

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

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

## 2.2 METAL CONDUIT AND TUBING

### A. Manufacturers:

1. AFC Cable Systems, Inc.
2. Alflec Inc.
3. Allied Tube Triangle Century.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. International Metal Hose.
6. Electri-Flex Co
7. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
8. LTV Steel Tubular Products Company – Manhattan/CDT/Cole-Flex.
9. Maverick.
10. O-Z Gedney; unit of General Signal.
11. Wheatland.

### B. Rigid Steel Conduit: ANSI C80.1.

### C. IMC: ANSI C80.6.

### D. EMT and Fittings: ANSI C80.3.

1. Fittings: Steel set-screw type.

### E. LFMC: Flexible steel conduit with PVC jacket.

### F. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

## 2.3 FIRE ALARM EMT

### A. Manufacturers:

1. Allied Tube Triangle Century.
- B. EMT conduit with bright red topcoat; Fire Alarm EMT.
- C. EMT and Fittings: ANSI C80.3.

## 2.4 NONMETALLIC CONDUIT AND TUBING

### A. Manufacturers:

1. American International.

2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corp.
4. Cantex Inc.
5. Certainteed Corp.; Pipe and Plastics Group.
6. Condux International.
7. ElecSys, Inc.
8. Electri-Flex Co.
9. Integral.
10. Kor-Kap.
11. Lamson and Sessions: Carlon Electrical Products.
12. Manhattan/CDT/Cole-Flex.
13. RACO; Division of Hubbell, Inc.
14. Scepter.
15. Spiralduct, Inc./AFC Cable Systems, Inc.
16. Thomas & Betts Corporation.

- B. ENT: NEMA TC 13.
- C. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.
- D. ENT and RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.
- E. LFNC: UL 1660.
- F. HDPE: UL 651, ASTM D 3350, ASTM D 1248 Schedule 40.

## 2.5 METAL WIREWAYS

- A. Manufacturers:
  1. Hoffman.
  2. Square D.
- B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1.
- 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. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

- E. Wireway Covers: Hinged type.
- F. Finish: Manufacturer's standard enamel finish.

## 2.6 NONMETALLIC WIREWAYS

- A. Manufacturers:
  - 1. Hoffman.
  - 2. Lamson & Sessions; Carlon Electrical Products.
- B. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.
- C. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
- D. 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.
- E. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

## 2.7 SURFACE RACEWAYS

- A. Surface raceway (Wiremold – ivory color) shall be used in finished areas. Do not use EMT conduit in finished areas unless directed by the Architect.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating and ivory finish.
  - 1. Manufacturers:
    - a. Airey-Thompson Sentinel Lighting; Wiremold Company (The).
    - b. Walker Systems, Inc.; Wiremold Company (The).
    - c. Wiremold Company (The); Electrical Sales Division.
- C. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

## 2.8 BOXES, ENCLOSURES, AND CABINETS

- A. Sheet Metal Outlet and Device Boxes: NEMA OS 1. Shall be used within walls or ceiling.
- B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover. Shall be used in all exposed, non-recessed, locations.
- C. Nonmetallic Outlet and Device Boxes: NEMA OS 2. Shall be used in corrosive areas.
- D. Floor Boxes: Cast metal, fully adjustable, rectangular.
- E. Floor Boxes: Nonmetallic, nonadjustable, round.



- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover. Shall be used in areas exposed to water.
- H. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
  - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- I. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

## 2.9 FACTORY FINISHES

- A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

## PART 3 - EXECUTION

### 3.1 RACEWAY APPLICATION

- A. Outdoors Applications:
  - 1. Exposed: Rigid steel or IMC.
  - 2. Concealed: Rigid steel or IMC.
  - 3. Underground, Single Run: RNC.
  - 4. Underground, Grouped: RNC.
  - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
  - 6. Boxes and Enclosures: NEMA 250, Type 3R.
- B. Indoor Applications:
  - 1. Exposed, Not Subject to Physical Damage in non-finished areas: EMT.
  - 2. Exposed, Not Subject to Severe Physical Damage in non-finished areas: EMT.
  - 3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit up to 10'-0" above finished floor. 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: IMC.
  7. Raceways Embedded in Concrete Above Grade: EMT or Rigid Steel.
  8. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.
  9. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: EMT.
  10. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: EMT.
  11. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
  2. Rigid Steel Conduits: Use only fittings approved for use with that material.
  3. EMT Conduits: Use steel set-screw fittings.
- E. Do not install aluminum conduits embedded in or in contact with concrete.
- 3.2 INSTALLATION
- A. Install conduit in accordance with NECA "National Electrical Installation Standards".
  - 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 26 Section "Hangers and Supports for Electrical Systems."
  - E. Install temporary closures to prevent foreign matter from entering raceways.
  - F. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
  - G. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
  - H. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

- I. Raceways Embedded in Slabs:
  - 1. Raceways embedded in slabs shall be limited to above grade concrete decks. Embedded conduit shall be limited to servicing floor boxes and equipment located in open spaces away from accessible walls.
  - 2. Install in middle 1/3 of slab thickness where practical and leave at least 2 inches (50 mm) of concrete cover.
  - 3. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
  - 4. Space raceways laterally to prevent voids in concrete.
  - 5. Run conduit larger than 1-inch trade size (DN 27) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
  - 6. Conduits shall run flat. Do not allow conduits to cross.
- J. Raceways installed under slab on grade: Use Schedule 40 nonmetallic conduit with rigid steel conduit sweeps, route conduits a minimum of 6" below bottom of slab.
- K. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
  - 1. Run parallel or banked raceways together on common supports.
  - 2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- L. Join raceways with fittings designed and approved for that purpose and make joints tight.
  - 1. Use insulating bushings to protect conductors.
- M. Tighten set screws of threadless fittings with suitable tools.
- N. Terminations:
  - 1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
  - 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
- O. 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.
- P. Provide pull string and 25% spare capacity in every branch circuit conduit.
- Q. Telephone and Signal System Raceways, 2-Inch Trade Size (DN 53) and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet (45 m) and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

1. Electrical conduit (LB's) are not permitted.
  2. Conduits shall have no more than two 90 degree bends between pull points or pull boxes.
  3. Conduits shall contain no continuous sections longer than 100 ft. without a pull point/box.
  4. The bend radius of conduit must be at least 6 times the internal diameter for a conduit 2 inches or less and a radius of 10 times the diameter for a conduit greater than two inches.
  5. All conduit ends shall have an insulated bushing.
- R. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  2. Where otherwise required by NFPA 70.
- S. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches (150 mm) above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
- T. Flexible Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.
- U. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.
- V. Set floor boxes level and flush with finished floor surface.
- W. Set floor boxes level. Trim after installation to fit flush with finished floor surface.
- X. Install hinged-cover enclosures and cabinets plumb. Support at each corner.
- Y. Do not route feeders across roof.
- Z. Provide a pull box (a handhole for outdoor applications) for each conduit run that exceeds 250 feet. Provide two pull boxes (handholes for outdoor applications) for runs that exceed 500 feet.
- AA. Conduit run in natatorium/pool area shall be EMT with compression fittings, and painted by the painting contractor (corrosion treatment paint per Architect's requirements).
- BB. Provide bonding of the pool structure/equipment per N.E.C. article 680-22. Coordinate with the pool contractor.
- CC. Route conduits in finished areas with exposed ceilings at underside of structural deck or as high as possible.
- DD. Conduits that route through, to, or from a hazardous classified space (Class I or II) shall have proper seal offs when exiting or entering the hazardous classified space.

- EE. Outlet boxes within hazardous locations shall be of the proper class and division as noted in the N.E.C.
- FF. Offset outlet boxes on opposite sides of common walls to prevent sound transmission between adjoining rooms.
- GG. Firestop raceways passing through rated walls and floors in accordance with Division 07 specifications. See architectural drawings for locations of rated assemblies.

### 3.3 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.

### 3.4 CLEANING

- A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

**\*\*END OF SECTION\*\***

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### 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. Identification for raceway and metal-clad cable.
  - 2. Identification for conductors and communication and control cable.
  - 3. Underground-line warning tape.
  - 4. Warning labels and signs.
  - 5. Instruction signs.
  - 6. Equipment identification labels.
  - 7. Miscellaneous identification products.

#### 1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

- C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

#### 1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.145.

#### 1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, 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 RACEWAY 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. Color for Printed Legend:
  - 1. Power Circuits: Black letters on an orange field.
  - 2. Legend: Indicate system or service and voltage, if applicable.
- C. 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.
- D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

#### 2.2 CONDUCTOR, COMMUNICATION AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

- B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- C. Aluminum Wraparound Marker Labels: Cut from 0.014-inch- thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.
- D. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking nylon tie fastener.
- E. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
  - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

### 2.3 UNDERGROUND-LINE WARNING TAPE

- A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
  - 1. Not less than 6 inches wide by 4 mils thick.
  - 2. Compounded for permanent direct-burial service.
  - 3. Embedded continuous metallic strip or core.
  - 4. Printed legend shall indicate type of underground line.

### 2.4 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: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches.
- D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.
- E. Warning label and sign shall include, but are not limited to, the following legends:
  - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
  - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

### 2.5 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch 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.

## 2.6 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. Black letters on a white background. Minimum letter height shall be 3/8 inch.
- B. Outdoor Equipment Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

## 2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
  1. Minimum Width: 3/16 inch.
  2. Tensile Strength: 50 lb, minimum.
  3. Temperature Range: Minus 40 to plus 185 deg F.
  4. Color: Black, except where used for color-coding.
- B. Paint: Paint materials and application requirements are specified in Division 9 painting Sections.
- C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

## 2.8 WIRING DEVICE IDENTIFICATION

- A. Description: Self adhesive label with black upper case letters on clear polyester label, font size 7.

## PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Raceways and Duct Banks More Than 600 V Concealed within Buildings: 4-inch- wide black stripes on 10-inch centers over orange background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- high black letters on 20-inch centers. Stop stripes at legends. Apply to the following finished surfaces:
  1. Floor surface directly above conduits running beneath and within 12 inches 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 More Than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches high, with self-adhesive vinyl labels. Repeat legend at 10-foot maximum intervals.

- C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 400 A: Identify with orange self-adhesive vinyl label.
- D. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:
  - 1. Fire Alarm System: Red.
  - 2. Fire-Suppression Supervisory and Control System: Red and yellow.
  - 3. Combined Fire Alarm and Security System: Red and blue.
  - 4. Security System: Blue and yellow.
  - 5. Mechanical and Electrical Supervisory System: Green and blue.
  - 6. Telecommunication System: Green and yellow.
  - 7. Control Wiring: Green and red.
- E. Power-Circuit Conductor Identification: For primary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use metal tags. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
- F. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape. Identify each ungrounded conductor according to source and circuit number as indicated on Drawings. Identify control circuits by control wire number as indicated on shop drawings.
- G. Branch-Circuit Conductor Identification: Mark junction box covers in indelible ink with the panel and breaker numbers of other circuits contained within.
- H. Conductor Identification: Locate at each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection or termination point.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data 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 Operation and Maintenance Manual.
- J. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- K. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply baked-enamel warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

1. 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.
  2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
- L. Provide a 3" by 5" yellow "Warning Arc Flash Hazard" label on the outside of panels in 'occupant areas' - Brady Type 99454 or equivalent from another manufacturer. Center the label horizontally and vertically on outside of door.
- M. Provide a 4" by 6" red "Danger Arc Flash and Shock Hazard" label on the outside of panels in areas open only to 'qualified personnel', and on the inside panel door of panels in 'occupant areas' - Brady Type 99459. Center label on gutter areas of distribution panels, centered above or below the directory of panels, and otherwise centered in other applications. In all cases, label will be no lower than 48" or above 84" AFF
- N. Instruction Signs:
1. Operating Instructions: 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.
  2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer or load shedding.
- O. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and 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: Mechanically secured, 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 2 lines of text are required, use labels 2 inches (50 mm) high. Labels shall be 2 1/2" high x 4 1/2" wide. Provide 3 lines of text. Line one shall have 1/2" letters spaced 1/2" down from top of label. Lines 2 and 3 shall have 1/4" letters. Each line shall be spaced 1/4" apart.
    - 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.
  2. Equipment to Be Labeled:
    - a. Panelboards, electrical cabinets, and enclosures.
    - b. Access doors and panels for concealed electrical items.
    - c. Electrical switchgear and switchboards.
    - d. Transformers.

- e. Emergency system boxes and enclosures.
  - f. Motor-control centers.
  - g. Disconnect switches.
  - h. Enclosed circuit breakers.
  - i. Motor starters.
  - j. Push-button stations.
  - k. Power transfer equipment.
  - l. Contactors.
  - m. Remote-controlled switches, dimmer modules, and control devices.
  - n. Intercommunication and call system master and staff stations.
  - o. Fire-alarm control panel and annunciators.
  - p. Breakers at distribution panels.
- P. Wiring Device Identification Labels: On each faceplate install circuit designation label that is consistent with panelboard directories, and as-built plan drawings. Apply labels to receptacle faceplates centered below bottom outlet. Apply labels to toggle switch faceplates on backside.

### 3.2 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location:
  - 1. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
  - 2. Conduit Markers: Provide identification for each power conduit two inches or larger.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- E. System Identification Color Banding for Raceways and Cables: Each color 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 maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- F. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
  - 1. Color shall be factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.
  - 2. Colors for 208/120-V Circuits:
    - a. Phase A: Black.
    - b. Phase B: Red.
    - c. Phase C: Blue.
    - d. Neutral: White.
    - e. Ground: Green.
  - 3. Colors for 480/277-V Circuits:
    - a. Phase A: Brown.
    - b. Phase B: Orange.

- c. Phase C: Yellow.
  - d. Neutral: Gray.
  - e. Ground: Green.
4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches 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.
- 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. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.
- I. Label information arrangement for 3 lines of text.
- 1. Line one shall describe the panel or equipment. Line one example: "DP-XX," RP-XX," "T-XX," "EF-XX," etc.
  - 2. Line two shall describe the first disconnecting means feeding this panel or equipment. Line two example: "Fed from DP-XX," "Fed from RP-XX," etc.
  - 3. Line three indicates that location of the disconnecting means as identified in line two. Line three example: "First Floor Elect. Rm #XXX."
  - 4. Line four shall include "Via T-XX" when panel or equipment is fed from a transformer.
- J. Examples:
- |  |   |   |
|--|---|---|
| RP-1A<br>FED FROM<br>PP-2<br>ELECTRICAL<br>ROOM A100<br>VIA T-1A | EF-1<br>FED FROM<br>PP-1<br>MECHANICAL<br>ROOM F101 | LP-1A<br>FED from<br>MDP<br>ELECTRICAL<br>ROOM A100 |
|--|---|---|
- K. Painted Identification: Prepare surface and apply paint according to Division 9 painting Sections.
- L. Degrease and clean surface to receive nameplates.
- M. Install nameplate and labels parallel to equipment lines.
- N. Secure nameplate to equipment front using screws.
- O. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.
- P. Identify conduit using field painting where required.
- Q. Paint red colored band on each fire alarm conduit and junction box.
- R. Paint bands 10 feet on center, and 4 inches minimum in width.
- S. Labels shall be neatly centered. Place labels in like positions on similar equipment.

**\*\*END OF SECTION\*\***

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## 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 work of this section.

### 1.2 SCOPE

- A. The contractor shall furnish short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in NFPA 70E -Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D prepared by the electrical equipment manufacturer.
- C. The scope of the studies shall include all new distribution equipment supplied by the equipment manufacturer under this contract as well as all directly affected existing distribution equipment at the customer facility.

### 1.3 REFERENCES

- A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

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1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
6. IEEE 1584 -Guide for Performing Arc-Flash Hazard Calculations

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

C. The National Fire Protection Association (NFPA)

1. NFPA 70 -National Electrical Code, latest edition
2. NFPA 70E – Standard for Electrical Safety in the Workplace

1.4 SUBMITTALS FOR REVIEW/APPROVAL

- A. The short-circuit and protective device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.5 SUBMITTALS FOR CONSTRUCTION

- A. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. Five (5) bound copies of the complete final report shall be

submitted. Additional copies of the short-circuit input and output data, where required, shall be provided on CD in PDF format.

- B. The report shall include the following sections:
  - 1. Executive Summary.
  - 2. Descriptions, purpose, basis and scope of the study.
  - 3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties.
  - 4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.
  - 5. Fault current calculations including a definition of terms and guide for interpretation of the computer printout.
  - 6. Details of the incident energy and flash protection boundary calculations.
  - 7. Recommendations for system improvements, where needed.
  - 8. One-line diagram.
- C. Arc flash labels shall be provided in hard copy and a copy of the computer analysis software viewer program is required to provide arc flash labels in electronic format.

#### 1.6 QUALIFICATIONS

- A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.
- B. The Registered Professional Electrical Engineer shall be a full-time employee of the equipment manufacturer.
- C. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.
- D. The equipment manufacturer shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analysis it has performed in the past year.

#### 1.7 COMPUTER SOFTWARE PROGRAMS

- A. Computer Software Programs: Subject to compliance with requirements, provide products by one of the following:
  - 1. EDSA Micro Corporation.



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2. SKM Systems Analysis, Inc.
3. ESA Inc.
4. CGI CYME.
5. Operation Technology, Inc.

PART 2 - PRODUCTS

2.1 STUDIES

- A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E -Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D prepared by the equipment manufacturer.

2.2 DATA COLLECTION

- A. Contractor shall furnish all data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.
- B. Source combination may include present and future motors and generators.
- C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner.
- D. If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data to satisfy the study requirements.

2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

- A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141-1993.
- B. Transformer design impedances shall be used when test impedances are not available.
- C. Provide the following:
  1. Calculation methods and assumptions

2. Selected base per unit quantities
  3. One-line diagram of the system being evaluated
  4. Source impedance data, including electric utility system and motor fault contribution characteristics
  5. Tabulations of calculated quantities
  6. Results, conclusions, and recommendations.
- D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
1. Electric utility's supply termination point
  2. Incoming switchgear
  3. Unit substation primary and secondary terminals
  4. Low voltage switchgear
  5. Motor control centers
  6. Standby generators and automatic transfer switches
  7. Branch circuit panelboards
  8. Other significant locations throughout the system.
- E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.
- F. Protective Device Evaluation:
1. Evaluate equipment and protective devices and compare to short circuit ratings
  2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
  3. Notify design engineer in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.

## 2.4 PROTECTIVE DEVICE COORDINATION STUDY

- A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.
- B. Include on each TCC graph, a complete title and one-line diagram with legend identifying the specific portion of the system covered.

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- C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
- D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
- E. Plot the following characteristics on the TCC graphs, where applicable:
  - 1. Electric utility's overcurrent protective device
  - 2. Medium voltage equipment overcurrent relays
  - 3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
  - 4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
  - 5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
  - 6. Conductor damage curves
  - 7. Ground fault protective devices, as applicable
  - 8. Pertinent motor starting characteristics and motor damage points, where applicable
  - 9. Pertinent generator short-circuit decrement curve and generator damage point
  - 10. The largest feeder circuit breaker in each motor control center and applicable panelboard.
- F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

## 2.5 ARC FLASH HAZARD ANALYSIS

- A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.
- B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
- C. The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA where work could be performed on energized parts.
- D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm<sup>2</sup>.

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- E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations
- F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.
- G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
  - 1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
  - 2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).
- H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.
- I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.
- J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
- K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

## 2.6 REPORT SECTIONS

- A. Input data shall include, but not be limited to the following:

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1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
  2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
  3. Generation contribution data, (synchronous generators and Utility), including short-circuit reactance ( $X''_d$ ), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
  4. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.
- B. Short-Circuit Output Data shall include, but not be limited to the following reports:
1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
    - a. Voltage
    - b. Calculated fault current magnitude and angle
    - c. Fault point X/R ratio
    - d. Equivalent impedance
  2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
    - a. Voltage
    - b. Calculated symmetrical fault current magnitude and angle
    - c. Fault point X/R ratio
    - d. Calculated asymmetrical fault currents
      - 1) Based on fault point X/R ratio
      - 2) Based on calculated symmetrical value multiplied by 1.6
      - 3) Based on calculated symmetrical value multiplied by 2.7
    - e. Equivalent impedance
  3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
    - a. Voltage
    - b. Calculated symmetrical fault current magnitude and angle
    - c. Fault point X/R ratio
    - d. No AC Decrement (NACD) Ratio
    - e. Equivalent impedance
    - f. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a symmetrical basis
    - g. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a total basis
- C. Recommended Protective Device Settings:

1. Phase and Ground Relays:
    - a. Current transformer ratio
    - b. Current setting
    - c. Time setting
    - d. Instantaneous setting
    - e. Recommendations on improved relaying systems, if applicable.
  2. Circuit Breakers:
    - a. Adjustable pickups and time delays (long time, short time, ground)
    - b. Adjustable time-current characteristic
    - c. Adjustable instantaneous pickup
    - d. Recommendations on improved trip systems, if applicable.
- D. Incident energy and flash protection boundary calculations
1. Arcing fault magnitude
  2. Protective device clearing time
  3. Duration of arc
  4. Arc flash boundary
  5. Working distance
  6. Incident energy
  7. Hazard Risk Category
  8. Recommendations for arc flash energy reduction

### PART 3 - EXECUTION

#### 3.1 FIELD ADJUSTMENT

- A. The contractor shall adjust relay and protective device settings according to the recommended settings table provided by the coordination study.
- B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
- C. Notify design engineer in writing of any required major equipment modifications.

### 3.2 ARC FLASH WARNING LABELS

- A. The contractor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
- B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.
- C. The label shall include the following information, at a minimum:
  - 1. Location designation
  - 2. Nominal voltage
  - 3. Flash protection boundary
  - 4. Hazard risk category
  - 5. Incident energy
  - 6. Working distance
  - 7. Engineering report number, revision number and issue date.
- D. Labels shall be machine printed, with no field markings.
- E. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
  - 1. For each 480 and applicable 208 volt panelboard, one arc flash label shall be provided.
  - 2. For each motor control center, one arc flash label shall be provided.
  - 3. For each low voltage switchboard, one arc flash label shall be provided.
  - 4. For each switchgear, one flash label shall be provided.
  - 5. For medium voltage switches one arc flash label shall be provided
- F. Labels shall be field installed by the contractor.

**\*\*END OF SECTION\*\***

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### 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 lighting control devices:
  - 1. Occupancy sensors.
  - 2. Lighting contactors.
- B. Related Sections include the following:
  - 1. Division 26 Section "Electrical General Requirements".
  - 2. Division 26 Section "Wiring Devices" for wall-box dimmers and manual light switches.



### 1.3 REFERENCES

- A. IEEE C62.41: Guide for Surge Voltages in Low-Voltage AC Power Circuits.
- B. IEEE C136.10: Standard for Roadway Lighting Equipment Locking-Type Photocontrol Devices and Mating Receptacle Physical and Electrical Interchangeability and Testing.
- C. NEMA ICS 2: Industrial Control and Systems Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC Part 8: Disconnect Devices for Use in Industrial Control Equipment.
- D. NFPA 70: National Electrical Code.
- E. UL 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.
- F. UL 486B: Wire Connectors for Use with Aluminum Conductors.
- G. UL 773: Plug-in, Locking Photocontrols for Use with Area Lighting.
- H. UL 773A: Nonindustrial Photoelectric Switches for Lighting Control.
- I. UL 917: Clock Operated Switches.
- J. UL 1449: Transient Voltage Surge Suppressors.
- K. UL 1598: Luminaires.
- L. NECA 130-2010: Installing and Maintaining Wiring Devices.

### 1.4 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.
- C. ULTRASONIC: Active emission of at least 35 kHz sound waves, using Doppler reflectance to detect motion.
- D. MICROPHONIC: Passive reception to listen for continued occupancy, with circuitry to filter out white noise.
- E. MULTI-Tech: Using PIR and ultrasonic or microphonic technologies in one sensor.

### 1.5 SUBMITTALS

- A. Product Data: For each type of product indicated including physical data and electrical performance.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
  - 1. Lighting plan showing location, orientation, and coverage area of each sensor.

2. Interconnection diagrams showing field-installed wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. Include the following:
  1. Description of operation and servicing procedures.
  2. List of major components.
  3. Recommended spare parts.
  4. Programming instructions and system operation procedures.

#### 1.6 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.

#### 1.7 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the site under provisions of Division 26 Section "Electrical General Requirements".
- B. Store and protect products under provisions of Division 26 Section "Electrical General Requirements".

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

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

## 2.2 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS

- A. Line-Voltage Surge Protection: An integral part of the devices for 120- and 277-V solid-state equipment. For devices without integral line-voltage surge protection, field-mounting surge protection shall comply with IEEE C62.41 and with UL 1449.

## 2.3 OCCUPANCY SENSORS

### A. General

1. Coordinate occupancy sensor locations, coverages and required quantities with manufacturer's recommendations. Coverage areas indicated on the Drawings are for minor motion (6 to 8 inches of hand movement). Provide additional occupancy sensors and control units as required to achieve complete minor motion coverage of the space indicated.
2. Adjust occupancy sensors and test that complete minor motion coverage is obtained in accordance with Part 3. Provide written confirmation of testing to owner, architect and engineer.
3. Provide occupancy sensors with a bypass switch to override the "ON" function in the event of sensor failure.
4. Provide occupancy sensors with an LED indicator indicating when motion is being detected during testing and normal operation of the sensor.
5. Provide occupancy sensors and occupancy sensor control units from single manufacturer.

### B. Wall Switch Passive Infrared Occupancy Sensor

- C. 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:

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

1. Leviton ODS15-IDW
2. Description: Wall mounted, 180° coverage, passive infrared sensing occupancy sensor.
  - a. Electrical Characteristics: Capable of switching up to 800W fluorescent or incandescent lighting loads at 120V and 1200 watts fluorescent loads at 277V.
  - b. Functions: Automatic ON/Automatic OFF, or Manual ON/Automatic OFF operation, field selectable. Integral manual override pushbutton switch.
  - c. Adjustments: User adjustable sensitivity and time delay. Time delay shall be adjustable from 30 seconds to 30 minutes.
  - d. Device Body: White, plastic with momentary on/off override pushbutton designed to mount in a standard switch box with "decora" style switch plate.
3. Dual Level Switching: Provide occupancy sensor capable of controlling two switch legs independently where dual level switching is indicated.

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- 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) Leviton ODS0D-IDW

E. 360° Ceiling Mounted Dual Technology Occupancy Sensor

- 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:
- 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Leviton OSC20-M0W
- 3. Description: Ceiling mounted, 360° coverage, multi-tech sensing occupancy sensor.
  - a. Housing: White, thermoplastic, tamper resistant ceiling mount.
  - b. Functions: Automatic ON must sense motion from both ultrasonic and infrared sensing elements. Either technology shall maintain ON, with adjustable time delays.
  - c. Adjustments: User adjustable sensitivity adjustment shall be provided for each sensing technology. Time delay shall be adjustable from 15 seconds to 30 minutes.
  - d. Sensor shall operate on 24V DC power through control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.
  - e. Manual override function.

F. 110° Wall Mounted Dual Technology Occupancy Sensor

- 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:
- 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Leviton OSW12-M0W
- 3. Description: Wall mounted, 110° coverage, multi-tech occupancy sensor.
  - a. Housing: White, thermoplastic, tamper resistant with swivel bracket for wall or ceiling mounting.
  - b. Functions: Automatic ON must sense motion from both sensing elements. Either technology shall maintain ON, with adjustable time delays.
  - c. Adjustments: User adjustable sensitivity adjustment shall be provided for each sensing technology. Time delay shall be adjustable from 15 seconds to 15 minutes.
  - d. Sensor Orientation: Orient sensor in room such that sensor will not detect motion through open door which could cause false activation.
  - e. Sensor shall operate on 24V DC power through control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.

- f. Manual override function.

G. 360° Ceiling Mounted Ultrasonic Occupancy Sensors

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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Leviton OSC20-U0W
3. Description: Ceiling mounted, 360° coverage, ultrasonic or microphonics sensing occupancy sensor.
  - a. Housing: White, thermoplastic, tamper resistant.
  - b. Adjustments: Adjustments: User adjustable sensitivity and time delay. Time delay shall be adjustable from 15 seconds to 15 minutes.
  - c. Sensor shall operate on 24V DC power through control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.
  - d. Manual override function.

H. 360° Ceiling Mounted Passive Infrared Occupancy Sensor.

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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Leviton OSC15-I0W
3. Description: Ceiling mounted, 360° coverage, infrared sensing occupancy sensor.
  - a. Housing: White, thermoplastic, tamper resistant ceiling mount.
  - b. Adjustments: User adjustable sensitivity adjustment shall be provided for each sensing technology. Time delay shall be adjustable from 30 seconds to 30 minutes.
  - c. Sensor shall operate on 24V DC power through control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.
  - d. Manual override function.

I. Occupancy Sensor Control Units: OPP20-OD1

1. Description: Transformer and relay combined in single unit to provide 24DC power to sensors and provide 20A contact(s) for control of lighting loads at 120 or 277V. Control unit input power shall be from unswitched leg of lighting circuit it is controlling.
  - a. Control units shall be provided as required to power ceiling mounted occupancy sensors, control lighting loads and provide a minimum of one auxiliary contact.
  - b. Occupancy sensor control units shall mount external to 4" sq junction box in the ceiling space. Wiring between control unit and occupancy sensor shall be plenum rated.

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- c. Locate control unit in accessible location in gyp-board ceilings, adjacent to return air grilles, or provide access panel.
- d. Additional auxiliary relay modules shall be provided as required to provide control of all lighting circuits and additional auxiliary contacts as required.
- e. It is acceptable to provide controls and auxiliary contacts as required integral to the ceiling sensor, provided all required contacts are provided.
- f. Maximum of 3 sensors per power pack. Verify exact quantities required with manufacturer.

2.4 LIGHTING CONTACTORS

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

- 1. Square D.

B. Contactor

- 1. Electrically-operated electrically-held unless otherwise indicated 600 volt, 30 ampere three pole with number of poles indicated.
- 2. Provide contacts to be 100 percent, continuously rated for all types of ballast and tungsten lighting and resistance loads without the need for in-rush current derating.
- 3. Provide NEMA type 1 enclosure unless otherwise indicated.
- 4. Provide NEMA type 1 hinged cover cabinet enclosure sized as required for contactors as indicated on drawings. Mount switches and indicating lights required on front of enclosure. Install terminal strips for connection of all external control wiring connections.
- 5. Provide solderless pressure wire terminals.
- 6. Provide corrosion-resistant primer treatment with light gray baked acrylic enamel finish.
- 7. Provide the following control and indicating devices:
  - a. Auxiliary contacts: One field convertible.
  - b. Auxiliary relay to convert maintained-contact type control circuit to momentary-contact type control circuit necessary for contactor control.
  - c. Green pilot light to indicate "power on" condition. Mount on front cover with legend plate.

PART 3 - EXECUTION

3.1 LIGHTING CONTACTOR INSTALLATION

- A. Install lighting contactors as indicated on plan. Install at accessible locations. Switch controls where provided shall be no higher than 54" or lower than 48".
- B. Demonstrate proper operation of all lighting control functions to the Owner and Engineer.

### 3.2 OUTDOOR PHOTOELECTRIC CONTROL INSTALLATION

- A. Mount photocell on roof or parapet to ½" GRS conduit, supported to building structure below. Coordinate roof penetration with roofing contractor.
- B. Install photoelectric control oriented in the northeast direction and not within any potential shadows.
- C. Adjust photocell sensitivity and delay to meet owner's requirements. Multiple adjustments may be required, as needed.

### 3.3 TIME CONTROLLER INSTALLATION

- A. Install time controller, near contactor control equipment or as indicated on plan. Install at accessible location.
- B. Program time controller as directed by the owner. Train owner in time clock programming.

### 3.4 OCCUPANCY SENSOR INSTALLATION

- A. Install wall mounted occupancy sensors as noted on plan. Arrange occupancy sensors with adjacent switch devices so that device plates line-up and are equally spaced.
- B. Install ceiling mounted sensors at approximate locations as indicated on plan. Sensor manufacturer shall provide quantity of sensors as required to provide complete coverage for rooms.
- C. Locate sensors such that motion through open doors will not falsely activate sensors.
- D. Do not locate ultrasonic sensors within six feet of supply air diffusers.
- E. Locate infrared sensors to avoid obstructions.
- F. Provide the services of a manufacturer's representative for commissioning of occupancy sensor installation. This shall include consultation on layout and location prior to installing sensors, testing of each sensor for compliance with Contract Documents and field adjustment and fine tuning after installation is complete. Provide written confirmation of testing to the Owner, Architect and Engineer.
- G. Field adjustments shall take place in the presence of the owner and the engineer. This shall include owner training on adjustment techniques for the occupancy sensors. The owner shall dictate the setting of the time delay in all sensors.

### 3.5 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Conductors and Cables".
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

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- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.6 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Electrical Identification."
- B. Label time switches and contactors with a unique designation.

3.7 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
  - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
  - 2. Operational Test: Verify actuation of each sensor and adjust time delays.
- B. Remove and replace lighting control devices where test results indicate that they do not comply with specified requirements.
- C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.8 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

**\*\*END OF SECTION\*\***



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### 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 work of this section.
- B. Related Sections include the following:
  - 1. Division 26 Section "Electrical General Requirements."
  - 2. Division 26 Section "Conductors and Cables."
  - 3. Division 26 Section "Grounding and Bonding."
  - 4. Division 26 Section "Enclosed Switches."
  - 5. Division 26 Section "Enclosed Controllers."
  - 6. Division 26 Section "Dry-Type Transformers"
  - 7. Division 26 Section "Panelboards."
  - 8. Division 26 Section "Switchboards."

#### 1.2 SECTION INCLUDES

- A. The Electrical Contractor shall engage the services of a recognized corporately independent N.E.T.A. certified testing firm for the purpose of performing inspections and tests as herein specified
- B. The testing firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.
- C. It is the intent of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design Specifications.
- D. The test and inspections shall determine suitability for energization.

- E. Equipment to be tested and inspected shall be the new equipment shown on the one line diagram and schedules as required by part three of each individual Specification Section. In addition, all equipment that is part of an emergency distribution system shall be tested.

### 1.3 REFERENCES

- A. All inspections and tests shall be in accordance with the latest version of the following codes and standards except as provided otherwise herein.

1. National Electrical Manufacturer's Association - NEMA
2. American Society for Testing and Materials - ASTM
3. Institute of Electrical and Electronic Engineers - IEEE
4. InterNational Electrical Testing Association - NETA Acceptance Testing Specifications - ATS-1996
5. InterNational Electrical Testing Association - NETA Maintenance Testing Specifications- MTS-1997
6. American National Standards Institute - ANSI C2: National Electrical Safety Code
7. State and Local Codes and Ordinances
8. Insulated Cable Engineers Association - ICEA
9. Association of Edison Illuminating Companies - AEIC
10. Occupational Safety and Health Administration
11. National Fire Protection Association - NFPA
  - a. ANSI/NFPA 70: National Electrical Code
  - b. ANSI/NFPA 70B: Electrical Equipment Maintenance
  - c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces
  - d. ANSI/NFPA 101: Life Safety Code

### 1.4 QUALIFICATIONS

- A. The testing firm shall be a corporately independent testing organization, which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.
- B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.
- C. The lead, on site, technical person and at least 50% of the on site crew shall be currently certified by the InterNational Electrical Testing Association (NETA).
- D. The testing firm shall only utilize technicians who are regularly employed by the firm on a full-time basis for testing services.
- E. The Contractor shall submit proof of the above qualifications with bid proposal.

F. The terms used herewithin such as Test Agency, Test Contractor, Testing Laboratory, or Contractor Test Company, shall be construed to mean the testing organization.

G. Acceptable Testing Firms:

1. Northern Electrical Testing; Phone (248) 689-8980.
2. Utilities Instrumentation Services; Phone (734) 482-1450.
3. Emerson/High Voltage Maintenance Corporation; Phone (734) 524-0409.
4. Power Plus Engineering; Phone (248) 344-0200.
5. Magna; Phone (248) 486-7370.

#### 1.5 PERFORMANCE REQUIREMENTS

- A. The Electrical Contractor shall supply a suitable and stable source of electrical power to each test site. The testing firm shall specify the power requirements.
- B. The Electrical Contractor shall notify the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.
- C. The testing firm shall notify the Owner's Representative prior to commencement of any testing.
- D. Any system, material or workmanship, which is found defective on the basis of acceptance tests, shall be reported to the Engineer. The Electrical Contractor shall correct all defects.
- E. The testing organization shall maintain a written record of all tests and shall assemble and certify a final test report.

F. Safety and Precautions

1. Safety practices shall include, but are not limited to, the following requirements:
  - a. Occupational Safety and Health Act.
  - b. Accident Prevention Manual for Industrial Operations, National Safety Council.
  - c. Applicable state and local safety operating procedures.
  - d. NETA Safety/Accident Prevention Program.
  - e. Owner's safety practices.
  - f. National Fire Protection Association - NFPA 70E.
  - g. American National Standards for Personnel Protection.
2. All tests shall be performed with apparatus de-energized except where otherwise specifically required.
3. The testing organization shall have a designated safety representative on the project to supervise operations with respect to safety.

#### 1.6 TEST INSTRUMENT CALIBRATION

A. Test Instrument Calibration

1. The testing firm shall have a calibration program, which assures that all applicable test instruments are maintained within rated accuracy.

2. The accuracy shall be directly traceable to the National Institute of Standards and Technology.
3. Instruments shall be calibrated in accordance with the following frequency schedule:
  - a. Field instruments: Analog - 6 months maximum Digital - 12 months maximum
  - b. Laboratory instruments: 12 months
  - c. Leased specialty equipment: 12 months  
(Where accuracy is guaranteed by Lessor)
4. Dated calibration labels shall be visible on all test equipment.
5. Records must be kept up-to-date which show date and results of instruments calibrated or tested.
6. An up-to-date instrument calibration instruction and procedures shall be maintained for each test instrument.
7. Calibrating standard shall be of higher accuracy than that of the instrument tested.

B. Field Test Instrument Standards

1. All equipment used for testing and calibration procedures shall exhibit the following characteristics:
  - a. Maintained in good visual and mechanical condition.
  - b. Maintained in safe, operating condition.

C. Suitability of Test Equipment

1. All test equipment shall be in good mechanical and electrical condition.
2. Selection of metering equipment should be based on knowledge of the waveform of the variable being measured. Digital multi-meters may be average of RMS sensing and may include or exclude the dc component. When the variable contains harmonics of dc offset and, in general, any deviation from a pure sine wave, average sensing, average measuring RMS scaled meters may be misleading. Use of RMS measuring meters is recommended.
3. Field test metering used to check power system meter calibration must have any accuracy higher than that of the instrument being checked.
4. Accuracy of metering in test equipment shall be appropriate for the test being performed.
5. Waveshape and frequency of test equipment output waveforms shall be appropriate for the test and tested equipment.

1.7 TEST REPORTS

- A. A test report shall be generated for each piece of major equipment or groups of equipment and shall include the following:
  1. A list of visual and mechanical inspections required by Division 26 Specification Sections in a checklist or similar format.
  2. Test reports, including test values where applicable, for all required electrical tests. Clearly indicate where test values fall outside of the limits of recommended values.

3. Summary and interpretation of test results detailing problems located and recommended corrective measures.
  4. Record of infrared scan and photos showing potential problem locations.
  5. Signed and dated by the testing firm field superintendent stating that all required tests have been completed.
- B. Test reports shall be furnished to the Architect/Engineer within 14 days of the completion each test on an ongoing basis. Original copies of the reports shall be furnished directly to the Architect/Engineer by the testing company prior to formal submittal via the Contractors.

## PART 2 - PRODUCTS

Not Applicable

## PART 3 - EXECUTION

### 3.1 THERMOGRAPHIC SURVEY

- A. Visual and Mechanical Inspection
1. Remove all necessary covers prior to scanning.
  2. Inspect for physical, electrical, and mechanical condition.
- B. Equipment to be Scanned
1. All components of the distribution system down to and including branch circuit panelboards and motor control centers. Return 3 months after equipment has been energized and loaded to do a final scan of all equipment.
- C. Provide report indicating the following:
1. Problem area (location of "hot spot").
  2. Temperature rise between "hot spot" and normal or reference area.
  3. Cause of heat rise.
  4. Phase unbalance, if present.
  5. Areas scanned.
- D. Test Parameters
1. Scanning distribution system with ability to detect 1°C between subject area and reference at 30°C.
  2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
  3. Infrared surveys should be performed during periods of maximum possible loading but not less than twenty percent (20%) of rated load of the electrical equipment being inspected.
- E. Test Results

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1. Interpretation of temperature gradients requires an experienced technician. Some general guidelines are:
  - a. Temperature gradients of 3°C to 7°C indicate possible deficiency and warrant investigation.
  - b. Temperature gradients of 7°C to 15°C indicate deficiency; repair as time permits.
  - c. Temperature gradients of 16°C and above indicate major deficiency; repair immediately.

**\*\*END OF SECTION\*\***

DRY-TYPE TRANSFORMERS (600 V AND LESS)

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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 types of dry-type transformers rated 600 V and less, with capacities up to 750 kVA:
  - 1. Distribution transformers.
  - 2. Buck-boost transformers.
  - 3. Isolation transformers.
  - 4. Control and signal transformers.
- B. Related Section includes the following:
  - 1. Division 26 Section "Electrical General Requirements."
  - 2. Division 26 Section "Grounding and Bonding."
  - 3. Division 26 Section "Conductors and Cables."
  - 4. Division 26 Section "Raceways and Boxes."

### 1.3 REFERENCES

- A. ANSI/IEEE C57.12.9: Test Code for Dry-Type Distribution and Power Transformers
- B. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum)
- C. NEMA ST 1: Specialty Transformers
- D. NEMA ST 20: Dry Type Transformers for General Applications
- E. NEMA TP 1: Guide for Determining Energy Efficiency for Distribution Transformers
- F. NEMA TP 2: Standard Test Method for Measuring the Energy Consumption of Distribution Transformers
- G. NETA ATS: Acceptable Testing Specifications for Electrical Power Distribution Equipment and Systems
- H. NFPA 70: National Electrical Code
- I. UL 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors
- J. UL 486B: Wire Connectors for Use with Aluminum Conductors
- K. UL 506: Specialty Transformers
- L. UL 1561: Dry-Type General Purpose and Power Transformers

### 1.4 SUBMITTALS

- A. Product Data Include rated nameplate data, capacities, weights, dimensions, utility or manufacturer's anchorage and base recommendations, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- B. Shop Drawings: Wiring and connection diagrams.
- C. Manufacturer Seismic Qualification Certification: Submit certification that transformer assembly and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Work." Include the following:
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Qualification Data: Testing agency.



- E. Source quality-control test reports. Include loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.
- F. Output Settings Reports: Record of tap adjustments specified in Part 3.

#### 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 in 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 onsite 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 IEEE C 57.12.91.
- D. Comply with NFPA 70.
- E. Energy-Efficient Transformers Rated 15 kVA and Larger: Certified as meeting NEMA TP 1, Class 1 efficiency levels when tested according to NEMA TP 2.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.
- B. Store, protect, and handle products to site under provisions of Division 26 section "Electrical General Requirements."
- C. Deliver transformers individually wrapped for protection and mounted on shipping skids.
- D. Accept transformers on site. Inspect for damage.
- E. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- F. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

#### 1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork shall meet load requirements. Requirements for concrete bases for electrical equipment are specified in Division 26 "Hangers and Supports for Electrical Systems."
- B. Coordinate installation of wall-mounting and structure-hanging supports.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Square D (base bid – bid price shall include Square D equipment).
  - 2. Siemens.
  - 3. Cutler-Hammer.

### 2.2 MATERIALS

- A. Cores: Grain-oriented, non-aging silicon steel.
- B. Coils: Continuous windings without splices, except for taps.
  - 1. Internal Coil Connections: Brazed or pressure type.
  - 2. Coil Material: Copper.
- C. Vibration Isolation: Isolate core and coil from enclosure using vibration-absorbing mounts.
- D. Grounding: Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

### 2.3 DISTRIBUTION TRANSFORMERS

- A. Description: Factory-assembled and tested, air cooled, dry-type transformer rated for 60 Hz operation. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Provide transformers with base KVA as indicated without the use of internal cooling fans.
- C. Provide transformers that are internally braced to withstand seismic forces specified in Division 26 Section "Seismic Controls for Electrical Work."
- D. Cores: One leg per phase.
- E. Indoor Enclosure: Ventilated, NEMA 250, Type 2. Provide lifting eyes or brackets.
- F. Indoor Transformer Enclosure Finish: Comply with NEMA 250 for "Indoor Corrosion Protection."
  - 1. Finish Color: Gray.
- G. Outdoor Enclosure: Ventilated, raintight, NEMA 250, Type 3R. Provide lifting eyes or brackets.
- H. Outdoor Transformer Enclosure Finish: Comply with NEMA 250 for "Outdoor Corrosion Protection."
  - 1. Finish Color: Gray.
- I. Insulation Class (15 kVA and larger): 220 deg C, UL-component-recognized insulation system with a maximum of 80 deg C rise above 40 deg C ambient temperature TP-1 compliant.

- J. Insulation Class (less than 15 kVA): 185 deg C, UL-component-recognized insulation system with a maximum of 80 deg C rise above 40 deg C ambient temperature.
- K. Basic Impulse Level: 10 kV.
- L. Taps for Transformers Smaller than 3 kVA: None.
- M. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- N. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- O. Case Temperature: Do not exceed 35 degrees C rise above ambient at warmest point.
- P. Mounting: Suitable for mounting as indicated.
- Q. Wall Brackets: Manufacturer's standard brackets.
- R. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.
- S. Sound Rating: Transformers shall have a sound rating 3dB below NEMA Standard (42dB for 10-50 kVA, 47 dB for 51-150 kVA, 52 db for 151-300 kVA, and 57 dB for 301-500 kVA rated transformers.

#### 2.4 ISOLATION TRANSFORMERS

- A. Description: Factory-assembled and –tested, air cooled, dry-type, shielded isolation transformer rated for 60 Hz operation. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. General: Comply with the requirements specified for Distribution Transformers.
- C. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
  - 1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
  - 2. Include special terminal for grounding the shield.
  - 3. Shield Effectiveness:
    - a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
    - b. Common-Mode Noise Attenuation: Minus 120 dBA minimum at 0.5 to 1.5 kHz; minus 65 dBA minimum at 1.5 to 100 kHz.
    - c. Normal-Mode Noise Attenuation: Minus 52 dBA minimum at 1.5 to 10 kHz.

#### 2.5 CONTROL AND SIGNAL TRANSFORMERS

- A. Description: Factory-assembled and tested, self-cooled, two-winding dry type, rated for continuous duty, and 60 Hz operation, complying with NEMA ST 1, and listed and labeled as complying with UL 506.

- B. Ratings: Continuous duty. If rating is not indicated, provide at least 50 percent spare capacity above connected peak load.

## 2.6 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91.
- B. Provide the following factory tests on each unit provided in accordance with NEMA ST 20:
  - 1. Voltage ratio.
  - 2. Polarity and phase relation.
  - 3. No load losses.
  - 4. Impedance (501 kVA and larger).
  - 5. Applied and induced potential.
- C. Provide the factory tests on the actual transformers provided or on similar units identical to those provided in accordance with NEMA ST 20:
  - 1. Impedance (less than 501 kVA).
  - 2. Temperature rise.
  - 3. Audible sound level.
  - 4. Full load losses.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls and floors for suitable mounting conditions where transformers will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install Products in accordance with manufacturer's instructions.
- B. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
  - 1. Brace wall-mounting transformers as specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

- C. Install floor mounted transformers on and anchor to concrete bases according to manufacturer's recommendations, seismic codes at Project, and requirements in Division 26 section "Vibration and Seismic Controls for Electrical Systems."
  - 1. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.
- D. Identification: Engraved metal or laminated-plastic nameplate mounted with corrosion resistant screws. Provide nameplate according to Division 26 Section "Electrical Identification" indicating the following:
  - 1. Transformer designation (e.g. "T-1").
  - 2. Primary power characteristics (e.g. "480V, 3PH, 3W").
  - 3. Secondary power characteristics (e.g. "208Y/120V, 3PH, 4W").
  - 4. Power rating (e.g. "75 kVA").
  - 5. Power source (e.g. "Fed from DP-1").

### 3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding."
- B. Connect wiring according to Division 26 Section "Conductors and Cables."
- C. Provide conduit according to Division 26 Section "Raceways and Boxes" for connections to transformer case. Make conduit connections to side panel of enclosure.
- D. 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.
- E. Check for damage and tighten connections prior to energizing transformer.

### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections and to assist in field testing. Report results in writing.
  - 1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing" for transformers 75KVA and above:
  - 1. Visual and Mechanical Inspection
    - a. Inspect for physical damage, cracked insulators, tightness of connections, defective wiring and general mechanical and electrical conditions.
    - b. Verify proper core grounding.
    - c. Verify proper equipment grounding.
    - d. Compare equipment nameplate with single line diagram and report discrepancies.

2. Electrical Tests

- a. Perform insulation resistance tests, winding-to-winding and windings-to-ground, utilizing a meg-ohmmeter with test voltage output in accordance with N.E.T.A. Acceptance Testing Specifications, Table 10.5. Test duration shall be for 10 minutes with resistance values tabulated at 30 seconds, 1 minute, and 10 minutes. Calculate Polarization index.
- b. Perform a turns ratio test between windings at every tap position. The final tap setting is to be set at the secondary system rated voltage at full load or as directed by the Architect/Engineer.
- c. Verify proper secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.
- d. Test mounting and anchorage devices according to requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

3. Test Values

- a. Perform insulation resistance tests in accordance with N.E.T.A. Acceptance Testing Specifications, Table 10.5. Results to be temperature corrected in accordance with Table 10.14.
- b. The polarization index should be above 1.2 unless an extremely high value is obtained initially, such that when doubled will not yield a meaningful value.
- c. Turns ratio test results shall not deviate more than one half percent (0.5%) from either the adjacent coils or the calculated ratio.

3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 5 percent. Submit recording and tap settings as test results.
- B. Adjust buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

\*\*END OF SECTION\*\*

## SWITCHBOARDS

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### 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 service and distribution switchboards rated 600 V and less.
- 1.3 DEFINITIONS
  - A. EMI: Electromagnetic interference.
  - B. GFCI: Ground-fault circuit interrupter.
  - C. RFI: Radio-frequency interference.
  - D. RMS: Root mean square.
  - E. SPDT: Single pole, double throw.
- 1.4 SUBMITTALS
  - A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include

dimensions, utility or manufacturer's anchorage and base recommendations, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

- B. Shop Drawings: For each switchboard and related equipment.
  - 1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
    - a. Enclosure types and details for types other than NEMA 250, Type 1.
    - b. Bus configuration, current, and voltage ratings.
    - c. Short-circuit current rating of switchboards and overcurrent protective devices.
    - d. Descriptive documentation of optional barriers specified for electrical insulation and isolation if specified.
    - e. Utility company's metering provisions with indication of approval by utility company if called out.
    - f. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Manufacturer Seismic Qualification Certification: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Electrical Supports and Seismic Restraints." Include the following:
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
    - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Field quality-control test reports including the following:
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.
  - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section Operation and Maintenance Data include the following:
  - 1. Routine maintenance requirements for switchboards and all installed components.



2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current curves, including selectable ranges for each type of overcurrent protective device.

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 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. Source Limitations: Obtain switchboards through one source from a single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with NEMA PB 2, "Deadfront Distribution Switchboards."
- F. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in sections or lengths that can be moved past obstructions in delivery path.
- B. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- C. Handle switchboards according to NEMA PB 2.1 and NECA 400.

1.7 PROJECT CONDITIONS

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
  1. Ambient Temperature: Not exceeding 104 deg F.
  2. Altitude: Not exceeding 6600 feet.
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of electric service.
  2. Indicate method of providing temporary electric service.

3. Do not proceed with interruption of electric service without Construction Manager's written permission.

#### 1.8 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork shall meet load requirements. Requirements for concrete bases for electrical equipment are specified in Division 26 "Hangers and Supports for Electrical Systems."

#### 1.9 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. Potential Transformer Fuses: 2 of each size and type.
  2. Control-Power Fuses: 2 of each size and type.
  3. Fuses for Fused Switches: Equal to 10 percent of amount installed for each size and type, but no fewer than 3 of each size and type.
  4. Indicating Lights: 3 of each size and type.

### 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 MANUFACTURED UNITS

- A. Switchboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
  1. Square D (base bid – bid price shall include Square D equipment).
  2. Siemens.
  3. Cutler-Hammer.
- B. Front-Connected, Front-Accessible Switchboard: Fixed, individually mounted main device, panel-mounted branches, and sections rear aligned.
- C. Nominal System Voltage: As noted on Drawings.
- D. Main-Bus Continuous: As noted on Drawings.
- E. Bus Short Circuit Rating: 65KA or as indicated on the drawings.

- F. Ground Bus: Extend length of switchboard.
- G. Fabricate and test switchboards according to IEEE 344 to withstand seismic forces as required.
- H. Enclosure: Steel, NEMA 250, Type 1, not over 96 in height.
- I. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- J. Enclosure Finish for Outdoor Units: Factory-applied finish in manufacturer's standard color, undersurfaces treated with corrosion-resistant undercoating.
- K. Insulation and isolation for main and vertical buses of feeder sections.
- L. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- M. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- N. No cabling between sections.
- O. Buses and Connections: Three phase, four wire, unless otherwise indicated.
  - 1. Phase- and Neutral-Bus Material: Tin-plated, high-strength, electrical-grade aluminum alloy with copper- or tin-plated, aluminum circuit-breaker line connections.
    - a. If bus is aluminum, use copper- or tin-plated aluminum for circuit-breaker line connections.
  - 2. Ground Bus: 1/4-by-2-inch- minimum-size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
  - 3. Contact Surfaces of Buses: Silver plated.
  - 4. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
  - 5. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
  - 6. Neutral Buses: 100 percent of the ampacity of phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.
- P. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.
- Q. Provide infrared scan windows, to allow thermal scanning at each cable termination location. This shall permit thermal scanning to be done without taking off covers.

## 2.3 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: NEMA AB 3, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 400 A and larger with restricted access cover.
  2. **All settings to be adjusted by manufacturer at the factory and verified by the electrical testing agency, based upon information determined by Overcurrent Protective Device Study per section 260573.**
- B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
  2. Application Listing: Appropriate for application; Type HACR for heating, air-conditioning, and refrigerating equipment.
  3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator (where indicated on drawings).
  4. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay (for main circuit breaker).
  5. **All settings to be adjusted by manufacturer at the factory and verified by the electrical testing agency, based upon information determined by Overcurrent Protective Device Study per section 260573.**
- C. Service Rated Breakers: Labeled for use as service equipment.
- D. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.
- E. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
- F. Fuses are specified in Division 26 Section "Fuses."

## 2.4 INSTRUMENTATION

- A. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:
1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
  2. Current Transformers: Ratios shall be as indicated with accuracy class and burden suitable for connected relays, meters, and instruments.
  3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kV.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
    - a. Phase Currents, Each Phase: Plus or minus 1 percent.
    - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.

- c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
  - d. Megawatts: Plus or minus 2 percent.
  - e. Megavars: Plus or minus 2 percent.
  - f. Power Factor: Plus or minus 2 percent.
  - g. Frequency: Plus or minus 0.5 percent.
  - h. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.
  - i. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.
2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door, approximately 60 inches above finished floor.

## 2.5 CONTROL POWER

- A. Control Circuits: 120 V, supplied through secondary disconnecting devices from control-power transformer.
- B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

## 2.6 ACCESSORY COMPONENTS AND FEATURES

- A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Furnish portable test set to test functions of solid-state trip devices without removal from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

## PART 3 - EXECUTION

### 3.1 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

### 3.2 EXAMINATION

- A. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.3 INSTALLATION

- A. Install switchboards and accessories according to NEMA PB 2.1 and NECA 40.
- B. Install switchboards and anchor to concrete bases according to utility or manufacturer's recommendations, seismic codes at Project, and requirements in Division 26 Section "Hangers and Supports for Electrical Systems."
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

- D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- E. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.

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

### 3.4 ADJUSTING

- A. Adjust circuit breaker trip and time delay settings to values as determined by the manufacturer, per section 260573.

### 3.5 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."
- B. Switchboard Nameplates: Label each switchboard compartment with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws. Each breaker or switch shall identify the load being served.

### 3.6 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
  - 1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- B. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing."
  - 1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.1, 7.5, 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate. Certify compliance with test parameters.
    - a. Do not perform any tests that require the circuit breaker to be removed from switchboard including primary injection testing for breakers 800A and larger.
    - b. For circuit breakers 800A and larger, verify all functions of trip unit by means of secondary injection in lieu of primary injection.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 3. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Instruments, Equipment, and Reports:

- 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- 2) Prepare a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.7 CLEANING

- A. On completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

**\*\*END OF SECTION\*\***

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### 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. Distribution panelboards.
  - 2. Lighting and appliance branch-circuit panelboards.
  - 3. Surge Protective Device panelboards.

#### 1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. RFI: Radio-frequency interference.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.



1.4 SUBMITTALS

- A. Product Data: For each type of panelboard, overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
  - 1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
    - a. Enclosure types and details for types other than NEMA 250, Type 1.
    - b. Bus configuration, current, and voltage ratings.
    - c. Short-circuit current rating of panelboards and overcurrent protective devices.
    - d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Manufacturer Seismic Qualification Certification: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Electrical Supports and Seismic Restraints." Include the following:
  - 1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
    - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Field quality-control test reports including the following:
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.
  - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data" include the following:
  - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

#### 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 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. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.
- C. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with NEMA PB 1.
- F. Comply with NFPA 70.

#### 1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
  1. Ambient Temperature: Not exceeding 104 deg F.
  2. Altitude: Not exceeding 6600 feet.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
  1. Ambient temperatures within limits specified.
  2. Altitude not exceeding 6600 feet.
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of electrical service.
  2. Do not proceed with interruption of electrical service without Construction Manager's written permission.

#### 1.7 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.8 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. Keys: Six spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

- 1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:

- a. Square D (base bid – bid price shall include Square D equipment).
    - b. Siemens.
    - c. Cutler-Hammer.

- 2. Surge Protective Device Panelboards:

- a. Square D (base bid – bid price shall include Square D equipment).
    - b. Siemens.
    - c. Cutler-Hammer.

2.2 MANUFACTURED UNITS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Electrical Supports and Seismic Restraints."

- B. Enclosures: Mounting as noted on panel schedules. NEMA PB 1, Type 1.

- 1. Rated for environmental conditions at installed location.

- a. Outdoor Locations: NEMA 250, Type 3R.
    - b. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
    - c. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

- 2. Cabinet Front: Flush or surface cabinet as noted on the Drawings, with front concealed trim clamps, piano type hinged dead front cover, hinged door, and flush lock all keyed alike.

- 3. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.

- 4. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.

- C. Phase and Ground Buses:

- 1. Material: Hard-drawn copper, 98 percent conductivity.

- 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

3. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box as called out on panel schedules.
- D. Conductor Connectors: Suitable for use with conductor material.
  1. Main and Neutral Lugs: Mechanical type.
  2. Ground Lugs and Bus Configured Terminators: Compression type.
  3. Feed-Through Lugs: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
  4. Double Lugs: Mechanical type mounted at location of main incoming lugs.
- E. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.
- F. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

## 2.3 PANELBOARD SHORT-CIRCUIT RATING

- A. Fully rated to interrupt symmetrical short-circuit current available at terminals.

## 2.4 DISTRIBUTION PANELBOARDS

- A. Main bus bars, neutral and ground, shall be copper and sized in accordance with U.L. Standards to limit temperature rise on any current carrying part to the maximums as indicated in UL67.
- B. Doors: Secured with vault-type latch with tumbler lock; keyed alike. Omit for fused-switch panelboards.
- C. Main Overcurrent Protective Devices: Circuit breaker.
- D. Branch Overcurrent Protective Devices:
  1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
  2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
  3. Fused switches.
- E. Short Circuit Rating: 50,000 AIC min. for panelboard, unless indicated otherwise on the drawings.
- F. Enclosure Size: Enclosure shall be sized to provide adequate conduit knockout space and gutter wire-bending space for all future conduits and cables. Enclosures that are too small to accommodate future conduits and cables shall be replaced at the Contractor's expense.

## 2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Main bus bars, neutral and ground, shall be copper and sized in accordance with U.L. Standards to limit temperature rise on any current carrying part to the maximums as indicated in UL67.
- B. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

- C. Short circuit rating: 25,000 AIC min. for panelboard. 22,000 AIC min for 240 Vac or 25,000 AIC min. at 480 Vac for circuit breakers.
- D. Circuit breakers used for switching fluorescent lighting or for protecting air conditioning compressors shall be so listed.
- E. Circuit breakers used for feeding electrical heat tracing shall include ground fault equipment protection rated to trip at 30 ma.

2.6 SURGE PROTECTIVE DEVICE PANELBOARDS

- A. Surge Protection Device Description: Sine-wave tracking type with the following features and accessories:
  - 1. MOV technology for each suppression mode.
  - 2. Fuses, rated at 200-kA interrupting capacity. Provide fusing for each suppression path.
  - 3. Fabrication using bolted compression lugs for internal wiring. No plug-in component modules, quick disconnect terminals or printed circuit boards shall be used in current-carrying paths.
  - 4. Direct bus bar mounting arrangement with copper bus bars for bolted connections to phase buses, neutral bus, and ground bus.
  - 5. LED indicator lights for power and protection status for each phase mounted in panelboard front cover:
    - a. Green indicates fully operational circuit.
    - b. Red indicates loss of protection.
  - 6. EMI-RFI Noise Rejection: based on MIL-STD-E220A, 50-ohm standard Insertion Loss Test:
    - a. 34dB at 100 kHz.
    - b. 51dB at 1 MHz.
    - c. 54dB at 10 MHz.
    - d. 48dB at 100 MHz.
  - 7. Redundant suppression circuits.
  - 8. Redundant replaceable modules.
- B. Peak Single-Impulse Surge Current Rating: 80 kA per phase; 40 kA per mode based on a single pulse, IEEE C62.41 standard 8 x 20 microsecond waveform. Device shall not suffer more than 10% deviation in clamping voltage at specified surge current..
- C. Minimum Repetitive Surge Current Capability: 5,000 impulse per mode in accordance with ANSI/IEEE C62.41 and ANSI/IEEE C62.45-1992 utilizing a Category C3 bi-wave at one minute intervals without suffering either performance degradation or more than 10% deviation of specified UL 1449 Suppression Voltage Ratings at specified surge current.
- D. Connection Means: Bus mounted, parallel connection.
- E. Protection modes and UL 1449 Third Edition Listed and Recognized Component SVR for grounded wye circuits with voltages of 208Y/120, 3-phase, 4-wire circuits shall not exceed the following:
  - 1. Line to Neutral: 700 V for 208Y/120.

2. Line to Ground: 700 V for 208Y/120.
  3. Neutral to Ground: 700 V for 208Y/120.
  4. Line to Line: 1500 V for 208Y/120.
- F. Protection modes and UL 1449 Second Edition Listed and Recognized Component SVR for 240/120-V, single-phase, 3-wire circuits shall not exceed the following:
1. Line to Neutral: 700 V.
  2. Line to Ground: 700 V.
  3. Neutral to Ground: 700 V.
  4. Line to Line: 1500 V
- G. Protection modes and UL 1449 SVR for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:
1. Line to Neutral: 700 V, 1500 V from high leg.
  2. Line to Ground: 700 V.
  3. Neutral to Ground: 700 V.
  4. Line to Line: 1500 V, 1500 V from high leg
- H. Protection modes and UL 1449 Second Edition Listed and Recognized Component SVR for voltages of 240, or 480, 3-phase, 3-wire, delta circuits shall not exceed the following:
1. Line to Line: 2000 V for 240 V.
  2. Line to Ground: 2000 V for 240 V.
- 2.7 OVERCURRENT PROTECTIVE DEVICES
- A. Molded-Case Circuit Breaker: UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger with restricted access cover.
  2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting with restricted access cover.
  3. Electronic trip-unit circuit breakers shall have RMS sensing; field-replaceable rating plug; and with the following field-adjustable settings with restricted access cover:
    - a. Instantaneous trip.
    - b. Long- and short-time pickup levels.
    - c. Long- and short-time time adjustments.
    - d. Ground-fault pickup level, time delay, and  $I^2t$  response.
  4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

5. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.
  6. All settings to be determined and adjusted by the electrical testing agency. Coordinate settings with manufacturer's circuit breaker curves.
- B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
  2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
  3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
  4. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
  5. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
  6. Do not use tandem circuit breakers.
  7. Provide circuit breakers U.L. listed as type GFEPCL for all self regulating heating (snow melting and heat trace) cables branch circuits.
  8. Provide lock on devices for circuit breakers when called out on panel schedules with "LOD" designation.
  9. Provide ground fault interrupt 5ma circuit breaker when called out on panel schedules with "GFI" designation.
  10. Provide shunt trip breakers when called out on panel schedules with "STB" designation.
  11. Provide smart controllable circuit breakers when called out on panel schedules with "SMT" designation.
- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
- D. Fuses are specified in Division 26 Section "Fuses."
- 2.8 ACCESSORY COMPONENTS AND FEATURES
- A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Comply with mounting and anchoring requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."

- C. Mount top of trim 74 inches above finished floor, unless otherwise indicated.
- D. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- E. Install overcurrent protective devices and controllers.
  - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Stub four 1-inch empty conduits from recessed panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- I. Color code circuit breakers and disconnect switches of fire alarm systems and emergency circuits with red paint. Provide lock-on clips on the circuit breaker handles.

### 3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads or created by retrofitting. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Coordinate final directory room names and numbers with (owner) (facility engineer).
- C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

### 3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding."
- B. Connect wiring according to Division 26 Section "Conductors and Cables."

### 3.4 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
  - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- B. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing"
  - 1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters. Perform electrical tests on all breakers and switches 200A and above or that constitute a component of an emergency distribution system. Main circuit breakers in branch circuit panelboards 225A and below are not required to be tested.



2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
1. Measure as directed during period of normal system loading.
  2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
  3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
  4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.
- D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scanning of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.
1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  2. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- 3.5 CLEANING
- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

**\*\*END OF SECTION\*\***

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### 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. Single and duplex receptacles, ground-fault circuit interrupters, integral surge suppression units, and isolated-ground receptacles.
2. Single- and double-pole snap switches and dimmer switches.
3. Device wall plates.
4. Pin and sleeve connectors and receptacles.
5. Floor service fittings, poke-through assemblies, access floor boxes, and service poles.

#### 1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. PVC: Polyvinyl chloride.

- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

#### 1.4 REFERENCES

- A. DSCC W-C-596G: Federal Specification Connector, Electrical, Power, General Specification.
- B. DSCC W-C-896F: Federal Specification Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).
- C. IEC 309-1, Part 1: General Requirements: Plugs, Socket-Outlets and Couplers for Industrial Purposes
- D. NEMA FB 11: Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations.
- E. NEMA WD 1: General Requirements for Wiring Devices.
- F. NEMA WD 6: Wiring Device – Dimensional Requirements.
- G. UL 20: General-Use Snap Switches.
- H. UL 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.
- I. UL 486B: Wire Connectors for Use with Aluminum Conductors.
- J. UL 498: Electrical Attachment Plugs and Receptacles.
- K. UL 943: Ground Fault Circuit Interrupters.

#### 1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations for each type of product indicated.
- B. Qualification Data: For testing agency.

#### 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association 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. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NFPA 70.

1.7 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
  - 1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 RECEPTACLES

- A. **All receptacles shall be tamper resistant (adjust model numbers listed below as required).**
- B. Straight-Blade and Locking Receptacles: Heavy-Duty grade.
- C. Straight-Blade-Type Receptacles: Comply with NEMA WD 1, NEMA WD 6, DSCC W-C-596G, and UL 498. Configuration 5-20R duplex receptacle.
  - 1. Manufacturers:
    - a. Hubbell Incorporated; Wiring Device-Kellems HBL 5362.
- D. Self-Test GFCI's: Duplex GFCI Convenience Receptacles, 125 V, 20 A. Comply with NEMA WD1, NEMA WD6 configuration 5-20R, UL 498, Federal Specification W-C-596 and UL 943, Class A, and include indicator light that is lighted when device is tripped. Must have self-test feature and SafeLock protection™: conducts an automatic test every second, ensuring its always ready to protect. If the device fails the self-test, the indicator light flashes to signal that the GFCI should be replaced. With SafeLock Protection™, if critical components are damaged and ground fault protection is lost, power to receptacle must be discontinued.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work, include, but are not limited to the following:
  - 2. Products: Subject to compliance with requirements, provide one of the following:
    - a. Pass & Seymour/Legrand; Wiring Devices Division: 2096.
    - b. Hubbell equal.
- E. Industrial Heavy-Duty Pin and Sleeve Devices: Comply with IEC 309-1.
- F. Hazardous (Classified) Location Receptacles: Comply with NEMA FB 11.

2.3 WALL SWITCHES

- A. Manufacturers:
  - 1. Hubbell Incorporated; Wiring Device-Kellems 1220 Series.
- B. Device body: Plastic toggle handle.

- C. Single- and Double-Pole Switches: Comply with DSCC W-C-896F and UL 20.
- D. Provide single-pole, two-pole, three-way and four-way switches as indicated.
- E. Provide pilot light where indicated.
- F. Provide key type where indicated. Furnish a minimum of six keys to Owner.
  - 1. Switch shall be Hubbell 1220 series (or equal as specified above) with locking coverplate.
  - 2. Coverplate shall be Hubbell HBL96062, straight keyed cylinder type lock, with stainless steel finish.
- G. Combination Switch and Receptacle: Both devices in a single gang unit with plaster ears and removable tab connector that permit separate or common feed connection.
  - 1. Switch: 20 A, 120/277-V ac.
  - 2. Receptacle: NEMA WD 6, Configuration 5-20R.

## 2.4 DIGITAL TIME SWITCHES

- A. General:
  - 1. Watt Stopper TS-400 or equal. Operation on 100 to 300 volts.
  - 2. Digital time switch turns lights off automatically after pre-set time. Pushbutton operation with time setting from 5 minutes to 12 hours.
  - 3. Back-lit LCD shows timer countdown.

## 2.5 DIMMER SWITCHES

- A. General:
  - 1. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible frequency and EMI/RFI filters.
  - 2. Dimmer switches shall provide full-range, variable control of light intensity utilizing a continuous Square Law dimming curve.
  - 3. Provide protected memory during temporary power failures that restores lights to same level of intensity set prior to power interruption.
  - 4. Provide dimmer switches UL listed for the type of load being served (incandescent, fluorescent, magnetic low voltage transformer, electronic low voltage transformer). Universal load-type dimmer switches shall not be acceptable.
  - 5. Provide dimmers that provide no adverse effects on other components of the electrical system being served (low voltage transformers, ballasts, lamps, etc.).
- B. Incandescent Lamp Dimmers:
  - 1. Manufacturers:
    - a. Lutron Model N-2000-W.

- b. Leviton Model 82000-W.
    - c. Hubbell equal.
  - 2. Modular, 120 V, 60 Hz with continuously adjustable control; single pole with soft tap or other quiet switch; and 5-inch wire connecting leads.
  - 3. Dimmer switches serving magnetic low voltage transformers shall be designed to control and provide a symmetrical ac waveform to the input of the magnetic low voltage transformer and not cause the transformer to operate above its rated operating current or temperature.
  - 4. Dimmer switches serving solid-state low-voltage transformers shall not affect the sound rating of the transformer and not cause lamp flicker at any point in the dimming range.
  - 5. Control: Continuously adjustable slider with slide-to-off; with single-pole or three-way switching to suit connections.
  - 6. Power Rating: 2000 W.
- C. Fluorescent Lamp Dimmer Switches:
- 1. Manufacturers:
    - a. Hubbell Incorporated; Wiring Device-Kellems
    - b. Lutron.
    - c. Leviton.
  - 2. Modular; single-pole, compatible with electronic dimming ballast provided with fluorescent light fixtures and rated for the specified load and voltage; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.
  - 3. Control: Continuously adjustable slider with pre-set; single-pole or three-way switching to suit connections.
  - 4. Power rating: 1200 W.

## 2.6 WALL PLATES

- A. Manufacturers:
- 1. Provide wall plates and corresponding wiring devices from same manufacturer.
- B. Single and combination types to match corresponding wiring devices.
- 1. Plate-Securing Screws: Metal with head color to match plate finish.
  - 2. Material for Finished Spaces: 0.035-inch- thick, satin-finished stainless steel.
  - 3. Material for Unfinished Spaces: Galvanized steel.
  - 4. Material for Wet Locations: Gasketed Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."
    - a. Manufacturers:
      - 1) Red Dot Model CKSGV (cast aluminum), Thomas & Betts.

## 2.7 FLOOR SERVICE FITTINGS

- A. Manufacturers:
  - 1. Wiremold.
- B. Type: Modular, fully adjustable recessed-type, with services indicated suitable for wiring method used.
- C. Compartments: Provide barrier separating power from telecommunications cabling. Provide recessed-type floor service fittings with independent compartments and feed through wiring capability.
- D. Service Plate: Provide service plate type as indicated. Provide protective ring for flush service plates.
- E. Power Receptacle(s): NEMA WD 6, Configuration 5-20R Heavy-duty grade duplex receptacle, black finish, unless otherwise indicated.
- F. Telecommunications Outlet: Blank cover with bushed cable opening.

## 2.8 FINISHES

- A. Color:
  - 1. Wiring Devices Connected to Normal Power System: White at each school, unless otherwise indicated or required by NFPA 70.
  - 2. Wiring Devices Connected to Emergency Power System: Red.
  - 3. Wall Switches: White, unless otherwise indicated.
  - 4. Dimmer Switches: White, unless otherwise indicated.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Prior to installation of devices, verify wall openings are neatly cut and will be completely covered by wall plates, clean debris from outlet boxes and provide extension rings to bring outlet boxes flush with finished surface.
- C. Install devices and assemblies level, plumb, and square with building lines.
- D. Install wall dimmers to achieve full rating specified and indicated after derating for ganging according to manufacturer's written instructions.
- E. Arrangement of Devices:
  - 1. Coordinate locations of outlet boxes provided under Division 26 Section "Raceways and Boxes" to obtain mounting heights indicated on Drawings.
  - 2. Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top.

3. Where multiple switches, dimmers, and/or occupancy sensors are adjacent to each other, provide a single cover plate. Custom fabricate, if required, for all combinations. Provide separate boxes or barriers as required for the application.
  4. Install horizontally mounted receptacles with grounding pole on the left.
  5. Install GFCI receptacles so that the "Push To Test" and "Reset" designations can be read correctly. If printed in both directions, install with ground pole on top.
  6. Install switches with OFF position down.
- F. Install cover plates on switch, receptacle, and blank outlets in finished areas.
- G. Use oversized plates for outlets installed in masonry walls.
- H. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.
- I. Remove wall plates and protect devices and assemblies during painting.
- J. Coordinate installation of access floor boxes with access floor system provided by Architectural trades.
- K. Install properly oriented access floor boxes into cutouts in access floor tiles and secure to tiles per Manufacturer's instructions.
- L. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.
- M. Adjust devices and wall plates to be flush and level. Three corners of wall plates must be in contact with wall surfaces. Devices shall be solidly mounted against the box.
- 3.2 IDENTIFICATION
- A. Comply with Division 26 Section "Electrical Identification."
1. Receptacles: Identify panelboard and circuit number from which served. Use adhesive label as specified in Division 26 Section "Electrical Identification" with black-filled lettering on back side of wall plate, and durable wire markers or tags inside outlet boxes.
- 3.3 CONNECTIONS
- A. Ground equipment according to Division 26 Section "Grounding and Bonding." Connect wiring device grounding terminal to outlet box with bonding jumper. Use of quick ground strap or screw is not acceptable.
- B. Connect wiring according to Division 26 Section "Conductors and Cables." Connect wiring devices by wrapping conductor around screw terminal or by using back wiring and tightening the screw securely.
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- 3.4 FIELD QUALITY CONTROL
- A. Perform the following field tests and inspections and prepare test reports:



1. Inspect each wiring device for defects.
  2. Operate each wall switch with circuit energized and verify proper operation.
  3. After installing wiring devices and after electrical circuitry has been energized, test each receptacle for proper polarity, ground continuity, and compliance with requirements.
  4. Test each GFCI receptacle for proper operation with both local and remote fault simulations according to manufacturer's written instructions.
- B. Remove malfunctioning units, replace with new units, and retest as specified above.

**\*\*END OF SECTION\*\***

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### 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. Cartridge fuses rated 600 V and less for use in switches, switchboards, and controllers.

#### 1.3 SUBMITTALS

- A. Product Data: Include the following for each fuse type indicated:

- 1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
- 2. Let-through current curves for fuses with current-limiting characteristics.
- 3. Time-current curves, coordination charts and tables, and related data.
- 4. Fuse size for elevator feeders and elevator disconnect switches.

- B. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

- 1. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
- 2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

- C. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals.
  - 1. In addition to items specified in Division 1 Section " Operation and Maintenance Data," include the following:
    - a. Let-through current curves for fuses with current-limiting characteristics.
    - b. Time-current curves, coordination charts and tables, and related data.
    - c. Ambient temperature adjustment information.

#### 1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses from a single manufacturer.
- 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:
  - 1. NEMA FU 1 – Low Voltage Cartridge Fuses.
  - 2. NFPA 70 – National Electrical Code.
  - 3. UL 198C – High-Interrupting-Capacity Fuses, Current-Limiting Types.
  - 4. UL 198E – Class R Fuses.
  - 5. UL 512 – Fuseholders.

#### 1.5 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

#### 1.6 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

#### 1.7 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. Fuses: Quantity equal to 10% percent of each fuse type and size, but no fewer than 3 of each type and size.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cooper Bussman, Inc.
  - 2. Eagle Electric Mfg. Co., Inc.; Cooper Industries, Inc.
  - 3. Ferraz Shawmut, Inc.

4. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

## 2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.
  1. Service Entrance: Class L, time delay.
  2. Feeders: Class J, time delay.
  3. Motor Branch Circuits: Class RK5, time delay.
  4. Other Branch Circuits: Class J, time delay.

## 2.3 FLUORESCENT AND H.I.D. LIGHTING BALLAST FUSES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Cooper Bussman, Inc. – GLR fuses with HLR holder.
  2. Tracor, Inc.; Littelfuse, Inc. Subsidiary – LGR fuses with LHR-000 holder.
  3. Ferraz Shawmut, Inc. – SLR fuses.
- B. Provide each fluorescent and HID lighting ballast with individual protection on the line side.
- C. Provide fuse and holder mounted within or as part of the fixture.
- D. Provide fuse size and type recommended by the fixture manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Fuses shall be shipped separately. Any fuses shipped installed in equipment, shall be replaced by the Electrical Contractor with new fuses as specified above prior to energization at no additional expense to Owner. All fuses shall be stored in moisture free packaging at job site and shall be installed immediately prior to energization of the circuit in which it is applied.
- B. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuses.

### 3.3 IDENTIFICATION

- A. Install labels indicating fuse replacement information on inside door of each fused switch.

**\*\*END OF SECTION\*\***

## ENCLOSED SWITCHES AND CIRCUIT BREAKERS

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 26 Section "Fuses".

#### 1.2 SUMMARY

- A. This Section includes the following individually mounted, enclosed switches and circuit breakers:
  - 1. Fusible switches.
  - 2. Nonfusible switches.
  - 3. Molded-case circuit breakers.
  - 4. Molded-case switches.
  - 5. Enclosures.

1.3 DEFINITIONS

- A. GD: General duty.
- B. GFCI: Ground-fault circuit interrupter.
- C. HD: Heavy duty.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.

1.4 REFERENCES

- A. NECA 1: Practices for Good Workmanship in Electrical Contracting.
- B. NETA ATS: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- C. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. NEMA AB 1: Molded Case Circuit Breakers and Molded Case Switches.
- E. NEMA FU 1: Low Voltage Cartridge Fuses.
- F. NEMA KS 1: Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- G. NEMA PB1.1: General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.
- H. NEMA PB2.1: General Instructions for Proper Installation, Operation, and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.
- I. NFPA 70: National Electrical Code.

1.5 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
  - 1. Enclosure types and details for types other than NEMA 250, Type 1.
  - 2. Current and voltage ratings.
  - 3. Short-circuit current rating.
  - 4. UL listing for series rating of installed devices.
  - 5. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- B. Shop Drawings: Diagram power, signal, and control wiring.

- C. Manufacturer Seismic Qualification Certification: Submit certification that enclosed switches and circuit breakers, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
  - 1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
    - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Qualification Data: For testing agency.
- E. Field quality-control test reports including the following:
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.
  - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- F. Manufacturer's field service report.
- G. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures," include the following:
  - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
  - 2. Time-current curves, including selectable ranges for each type of circuit breaker.

#### 1.6 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.

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- 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.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
  - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
  - 2. Altitude: Not exceeding 6600 feet.

1.8 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.9 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. Spares: For the following:
    - a. Potential Transformer Fuses: 2 of each size and type.
    - b. Control-Power Fuses: 2 of each size and type
    - c. Fuses for Fusible Switches: Equal to 10 percent of amount installed for each size and type, but no fewer than 3 of each size and type.

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 FUSIBLE AND NONFUSIBLE SWITCHES

- A. Manufacturers:
  - 1. Square D (base bid – bid price shall include Square D equipment)
  - 2. Siemens.



3. Culter-Hammer.

- B. Fusible Switch: NEMA KS 1, quick make, quick-break load interrupter enclosed knife switch Type HD, with clips or bolt pads to accommodate specified fuses, externally operable lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Nonfusible Switch: NEMA KS 1, quick make, quick-break load interrupter enclosed knife switch Type HD, externally operable lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- D. Double Throw Safety Switch (Manual Transfer Switch): U. L. listed and suitable for use in accordance with Article 702 of the National Electrical Code. Designed for manual transfer of loads from one supply to another. Three pole with solid neutral. Externally operable handle padlockable in either position. Provide pad lock and two sets of keys.
- E. Accessories:
  - 1. Provide early break auxiliary contacts in motor disconnect switches for motors that are fed from variable frequency controllers.
  - 2. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 3. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.
  - 4. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.
  - 5. Switch shall be Service Entrance rated.

2.3 TOGGLE DISCONNECT SWITCH

- A. Manufacturers:
  - 1. Double Pole:
    - a. Hubbell 1372.
    - b. Leviton 6808G-DAC.
    - c. Pass & Seymour 7812.
    - d. Bryant 30102.
  - 2. Three Pole:
    - a. Hubbell 1379.
    - b. Leviton 7810GD.
    - c. Pass & Seymour 7813.
    - d. Bryant 30103.
- B. Description: Heavy duty, 30A, 600 volt, double or three pole as required, single throw, motor rated switch without overload protection. Provide NEMA 1 enclosure and padlock attachment.

2.4 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers:

1. Square D/Group Schneider (base bid – bid price shall include Square D equipment).
- B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
  1. Lugs: Mechanical style suitable for number, size, trip ratings, and conductor material.
  2. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
  3. Enclosure: Provide handle capable of being locked in the open position with padlock.

## 2.5 ENCLOSURES

- A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.
  1. Indoor Dry Locations: NEMA 250, Type 1.
  2. Outdoor Locations: NEMA 250, Type 3R.
  3. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
  4. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 CONCRETE BASES

- A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.
- B. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 3.

### 3.3 INSTALLATION

- A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.
- B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.
- C. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- D. Install switches with off position down.

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- E. Install NEMA KS 1 enclosed switch where indicated for motor loads ½ HP and larger and equipment loads greater than 30A.
- F. Install toggle disconnect switch, surface mounted, where indicated for motor loads less than ½ HP and equipment loads 30A. and less.
- G. Install fuses in fusible disconnect switches.
- H. Install flexible liquid tight conduit from toggle disconnect switch to portable equipment. Leave a 6'-0" (1830 mm) whip.
- I. Install flexible liquid tight conduit from toggle disconnect switch to stationary equipment.
- J. Install control wiring from early break contacts in motor disconnect switch to variable frequency controllers to shut down controller when switch is open.
- K. Install equipment on exterior foundation walls at least one inch (25 mm) from wall to permit vertical flow of air behind breaker and switch enclosures.
- L. Support enclosures independent of connecting conduit or raceway system.
- M. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

### 3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."
- B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 26 Section "Electrical Identification."
- C. Provide adhesive label as specified in Division 26 Section "Electrical Identification" on inside door of each switch indicating UL fuse class and size for replacement.

### 3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Prepare for acceptance testing as follows:
  - 1. Inspect mechanical and electrical connections.
  - 2. Verify switch and relay type and labeling verification.
  - 3. Verify rating of installed fuses.
  - 4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.
- C. Testing Agency: Engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

D. Perform the following field tests and inspections and prepare test reports:

1. Test mounting and anchorage devices according to requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches. Certify compliance with test parameters.
3. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.6 for molded-case circuit breakers. Test all NEMA AB1, molded case circuit breakers with thermal magnetic trip or auxiliary, solid-state trip units 100A and larger. Certify compliance with test parameters.
  - a. Visual and Mechanical Inspection
    - 1) Circuit breaker shall be checked for proper mounting and compare nameplate data to Drawings and Specifications.
    - 2) Operate circuit breaker to ensure smooth operation.
    - 3) Inspect case for cracks or other defects.
    - 4) Check internals on unsealed units.
  - b. Electrical Tests
    - 1) Perform a contact resistance test.
    - 2) Perform an insulation resistance test at 1000 volts dc from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase.
    - 3) Perform long time delay time-current characteristic tests by passing three hundred percent (300%) rated current through each pole separately. Record trip time. Make external adjustments as required to meet time current curves.
    - 4) Determine short time pickup and delay by primary current injection.
    - 5) Determine ground fault pickup and time delay by primary current injection.
    - 6) Determine instantaneous pickup current by primary injection using run-up or pulse method.
    - 7) Perform adjustments for final settings in accordance with coordination study.
    - 8) For circuit breakers 800A and larger, verify all functions of trip unit by means of secondary injection in lieu of primary injection.
  - c. Test Values
    - 1) Compare contact resistance or millivolt drop values to adjacent poles and similar breakers. Investigate deviations of more than fifty percent (50%). Investigate any value exceeding manufacturer's recommendations.
    - 2) Insulation resistance shall not be less than 100 megohms.
    - 3) Trip characteristic of breakers shall fall within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
    - 4) All trip times shall fall within N.E.T.A. Acceptance Testing Specifications, Table 10.7 Circuit breakers exceeding specified trip time at three hundred percent (300%) of pickup shall be tagged defective.
    - 5) Instantaneous pickup values shall be within values shown on N.E.T.A. Acceptance Testing Specifications, Table 10.8 or manufacturer's recommendations.

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4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.6 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip and time delay settings to values as instructed by the Engineer.

3.7 CLEANING

- A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.
- B. Inspect exposed surfaces and repair damaged finishes.

**\*\*END OF SECTION\*\***

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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 ac, enclosed controllers rated 600 V and less, of the following types:	
1. Across-the-line, manual and magnetic controllers.	
2. Reduced-voltage controllers.	
3. Multispeed controllers.	
B. Related Sections include the following:	
1. Division 26 Section "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.	

2. Division 23 Section "Variable Frequency Controllers" for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on constant torque loads in ranges up to 200 hp.

### 1.3 SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each enclosed controller.
  1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
    - a. Each installed unit's type and details.
    - b. Nameplate legends.
    - c. Short-circuit current rating of integrated unit.
    - d. UL listing for series rating of overcurrent protective devices in combination controllers.
    - e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.
  2. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around enclosed controllers where pipe and ducts are prohibited. Show enclosed controller layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- D. Manufacturer Seismic Qualification Certification: Submit certification that enclosed controllers, accessories, and components will withstand seismic forces defined in Division 26 Section "Electrical Supports and Seismic Restraints." Include the following:
  1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
    - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Qualification Data: For manufacturer and testing agency.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures," include the following:

1. Routine maintenance requirements for enclosed controllers and all installed components.
  2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
- H. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- I. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

#### 1.4 REFERENCES

- A. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
- B. ANSI/UL 198C - High-Intensity Capacity Fuses; Current-Limiting Types.
- C. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service.
- D. FS W-F-870 - Fuseholders (For Plug and Enclosed Cartridge Fuses).
- E. FS W-S-865 - Switch, Box, (Enclosed), Surface-Mounted.
- F. NECA 402-2000 – Recommended Practice for Installing and Maintaining Motor Control Centers.
- G. NEMA AB 1 - Molded Case Circuit Breakers.
- H. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.
- I. NEMA KS 1 - Enclosed Switches.
- J. ANSI/NFPA 70 - National Electrical Code.

#### 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. 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.
- C. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with NFPA 70.
- F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.



1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prior to beginning work on any system, verify all existing conditions that affect the work and coordinate with all other trade Contractors. Determine that the work can be installed as indicated or immediately report to the Architect/Engineer errors, inconsistencies or ambiguities.
- B. Deliver products to site under provisions of Section 26 0100. Store and protect products under provisions of Section 26 0100.
- C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- D. Handle in accordance with manufacturer's written instructions. Lift large equipment only with lugs provided for the purpose. Handle carefully to avoid damage to motor control center components, enclosure, and finish.
- E. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.7 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations of each contactor and indicate circuits controlled. Submit under provisions of 26 0100.

1.8 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
  - 1. Notify Construction Manager no fewer than three days in advance of proposed interruption of electrical service.
  - 2. Indicate method of providing temporary utilities.
  - 3. Do not proceed with interruption of electrical service without Construction Manager's written permission.

1.9 COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."
- D. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.
- E. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.10 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
  - 2. Indicating Lights: Two of each type installed.
  - 3. Keys: Furnish 2 of each to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Square D (base bid – bid price shall include Square D equipment).
  - 2. Siemens.
  - 3. Cutler-Hammer.

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

- A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED." Provide manual controller for 120 volt or 208 volt operation, as indicated on the drawings.
  - 1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.
- B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated. Provide magnetic controller for 120 volt or 208 volt operation, as indicated on the drawings.
  - 1. Control Circuit: 120 V; obtained from integral control power transformer with sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
  - 2. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 20 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
- C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.
  - 1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.

## 2.3 ENCLOSURES

- A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
  - 1. Outdoor Locations: NEMA 250, Type 3R.
  - 2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
  - 3. Other Wet or Damp Indoor Locations: NEMA 250, Type 3R.
  - 4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

## 2.4 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Push-Button Stations, Pilot Lights: NEMA ICS 2, heavy-duty type.
- C. Indicating Lights: Run (Red), off or ready (Green).
- D. Auxiliary Contacts: Provide two normally open (N.O.) and two normally closed (N.C.) contacts.
- E. Selector Switch: NEMA ISC 2, mounted in front cover to read "hand/off/auto," provide auxiliary contact for auto position monitoring.
- F. Control Relays: Auxiliary and adjustable time-delay relays.
- G. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.

## 2.5 FACTORY FINISHES

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

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.
  - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 APPLICATIONS

- A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.
- B. Select horsepower rating of controllers to suit motor controlled.

### 3.3 INSTALLATION

- A. See Division 26 Section "Basic Electrical Materials and Methods" for general installation requirements.

- B. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Basic Electrical Materials and Methods."
- C. Install freestanding equipment on concrete bases.
- D. Comply with mounting and anchoring requirements specified in Division 26 Section "Electrical Supports and Seismic Restraints."
- E. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."
- F. Install motor control equipment and contactors in accordance with manufacturer's instructions.
- G. Select and install heater elements in motor starters to match installed motor characteristics.
- H. Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

### 3.4 CONCRETE BASES

- A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.
- B. Concrete base is specified in Division 26 Section "Basic Electrical Materials and Methods," and concrete materials and installation requirements are specified in Division 3.

### 3.5 IDENTIFICATION

- A. Identify enclosed controller, components, and control wiring according to Division 26 Section "Electrical Identification."

### 3.6 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers according to Division 26 Section "Conductors and Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
  - 1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
  - 2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

### 3.7 CONNECTIONS

- A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding."

3.8 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
3. Report results in writing.

C. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing"

1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS, "Motor Control - Motor Starters." Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.9 ADJUSTING

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

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers. Refer to Division 1 Section "Closeout Procedures."

**\*\*END OF SECTION\*\***

## SURGE PROTECTIVE DEVICES

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### 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 work of this section.
- B. Related Sections include the following:
  - 1. Division 26 Section "Electrical General Requirements."

#### 1.2 SUMMARY

- A. These specifications describe the requirements for a high energy surge protective devices system (abbreviated as SPD in this specification and on all drawings). The specified system shall provide effective high energy surge current diversion and be suitable for application in ANSI/IEEE C62.41 Category A, B, and C environments, as tested by ANSI/IEEE C62.45. The system shall be connected in parallel with the protected system; no series connected elements shall be used, which could constitute a single point failure.

#### 1.3 RELATED SPECIFICATION

- A. Main Distribution Switchboard Section 26 2413.
- B. Panelboards Section 26 2416.

#### 1.4 REFERENCES

- A. The Transient Voltage Surge Suppression System shall be designed and manufactured to the following standards.
- B. American National Standards Institute and Institute of Electrical and Electronic Engineers (ANSI/IEEE, C62.1, C62.41 and C62.45).
- C. Federal Information Processing Standards Publication 94 (FIPS PUB 94).
- D. National Electrical Manufacturers Association (NEMA LS-1).

- E. National Fire Protection Association (NFPA 70, 75, and 78).
- F. Underwriters Laboratories (UL 1449, Third Edition, UL 1283).
- G. National Electric Code (NEC 285).

1.5 SYSTEM DESCRIPTION

- A. Environmental Requirements:
  - 1. Storage temperature range shall be -55 to +85 degrees C (-67 to +185 degrees F).
  - 2. Operating temperature range shall be -40 to +50 degrees C (-40 to +122 degrees F).
  - 3. Operation shall be reliable in an environment with 0% to 95% non-condensing relative humidity.
  - 4. The audible noise level of the specified system shall be less than 45 dBA at 5 feet (1.5 m).
- B. Transient voltage surge suppression system with integral EMI/RFI filtering (abbreviated as SPD in this specification and on all drawings). The specified system shall provide effective high energy surge current diversion and be suitable for application in ANSI/IEEE C62.41 Category A, B, and C environments, as tested by ANSI/IEEE C62.45. The system shall be connected in parallel with the protected system; no series connected elements shall be used, which could constitute a single point failure.
- C. Provide documentation of specified system's UL 1449, Third Edition, listing and suppression ratings which shall be included as required product data submittal information.
- D. The SPD system may be mounted integral to the Main Distribution Panelboards or integral to the Electronic Grade Panelboards as indicated on the drawings and specified as follows:

1.6 MAIN DISTRIBUTION PANELBOARDS AND BRANCH CIRCUIT PANELBOARDS

- A. Electrical Characteristics
  - 1. Nominal Line Voltage:
    - a. 120/208 voltage, three phase, 4 wire plus ground, as indicated on drawings (MDP and SPD Branch Circuit Panelboards).
  - 2. Maximum Continuous Line Current:
    - a. As noted on drawings.
  - 3. Maximum Continuous Operating Voltage:
    - a. >115% of nominal.
  - 4. Operating Frequency:
    - a. 47-63 Hz.
  - 5. Protection Modes:
    - a. Line to line.

- b. Line to neutral.
  - c. Line to ground.
  - d. Neutral to ground.
- 6. Connection Means:
  - a. Direct bus connection, parallel connection.
- 7. Main Distribution Panelboard Maximum Surge Current:
  - a. Maximum surge current shall be based on a single pulse, IEEE C62.41 standard 8 x 20 microsecond wave form. Device shall not suffer more than 10% deviation in clamping voltage at specified surge current.
    - 1) Per Phase Total: 240 kA.
    - 2) Per Mode: 120 kA.
- 8. Branch Circuit Panelboards Maximum Surge Current:
  - a. Maximum surge current shall be based on a single pulse, IEEE C62.41 standard 8 x 20 microsecond wave form. Device shall not suffer more than 10% deviation in clamping voltage at specified surge current.
    - 1) Per Phase Total: 80 kA.
    - 2) Per Mode: 40 kA.
- 9. UL 1449 voltage suppression rating:
  - a. L-N, L-G, N-G: 700 volts for 208/120V systems.
  - b. L-L: 1500 volts for 208/120V systems.
  - c. L-N, L-G, N-G: 1200 volts for 480/277V systems.
  - d. L-L: 2000 volts for 480/277V systems.
- 10. AC tracking filter with EMI/RFI filtering.
- 11. EMI-RFI Noise Rejection Based on MIL-STD-E220A Methodology:
  - a. 100 KHZ : 50dB
- 12. Surge Life Cycle:
  - a. Capable of surviving 1000 sequential category C3 combination wave surges as defined by ANSI/IEEE C62.41 and ANSI/IEE C62.45, without failing the specified UL 1449 suppression ratings.
- 13. Internal Connections:
  - a. All internal wiring within the SPD device subject to surge currents shall be made of low impedance copper bus bar. Modular, parallel SPD design shall consist of 40mm metal oxide varistors individually fused at 200KAIC for each suppression mode.



1.7 DOCUMENTATION

- A. The manufacturer shall furnish an installation manual with installation, start up, and operating instructions for the specified system.
- B. Electrical and mechanical drawings shall be provided by the manufacturer which show unit dimensions, weights, component and connection locations, mounting provisions, connection details, and wiring diagram.
- C. Documentation of specified system's UL 1449 listing and clamping voltage ratings shall be included as required product data submittal information.
- D. A list of recommended spare parts shall be supplied at the customer's request.

1.8 WARRANTY

- A. The manufacturer shall provide a full five-year warranty from date of shipment against any part failure when installed in compliance with manufacturer's written instructions, UL listing requirements, and any applicable national or local electrical codes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Square D (base bid).

2.2 ACCESSORIES

- A. Unit Status indicators
  - 1. Red and green LED indicators shall be provided on the front cover to redundantly indicate unit module status. The absence of the green light and the presence of the red light shall reliably indicate that one or more surge current diversion modules has failed and that service is needed to restore full operation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Service entrance suppressors shall be installed in the switchboard.
- B. Locate suppressor on load side of main disconnect device, as close as possible to the phase conductors and ground/neutral bar.
- C. A breaker shall be provided in the main distribution panelboard to directly connect the SPD unit. This breaker shall be directly integrated to the suppressor and switchboard bus using bolted bus bar connections.
- D. The suppressor and integral disconnect shall be installed to the switchboard using a direct bus bar connection. SPD to disconnect conductors shall be as short and straight as possible, less than 5 feet.
- E. All monitoring diagnostics features (indicator lights) shall be mounted on the front of the switchboard, adjacent to SPD.

3.2 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed the manufacturer.

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- B. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.
- C. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

**\*\*END OF SECTION\*\***

# INTERIOR LIGHTING

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## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

- A. This Section includes the following:

1. Interior lighting fixtures with lamps and ballasts.
2. Lighting fixtures mounted on exterior building surfaces.
3. Emergency lighting units.
4. Exit signs.
5. Accessories, including lighting fixture retrofitting.

- B. Related Sections include the following:

SECTION 265100  
INTERIOR  
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1. Division 26 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.
2. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

- A. BF: Ballast factor. Ratio of light output of a given lamp(s) operated by the subject ballast to the light output of the same lamp(s) when operated on an ANSI reference circuit.
- B. CRI: Color rendering index.
- C. CU: Coefficient of utilization.
- D. LER: Luminaire efficiency rating, which is calculated according to NEMA LE 5. This value can be estimated from photometric data using the following formula:
  1. LER is equal to the product of total rated lamp lumens times BF times luminaire efficiency, divided by input watts.
- E. RCR: Room cavity ratio.

1.4 SUBMITTALS

- A. Submit under provisions of Section 26 0010.
- B. Product Data: For each type of lighting fixture scheduled, arranged in order of fixture designation. Submit as one package, bound together. Include data on features, accessories, finishes, and the following:
  1. Physical description of fixture, including dimensions and verification of indicated parameters.
  2. Emergency lighting unit battery and charger.
  3. Fluorescent and high-intensity-discharge ballasts.
  4. Air and Thermal Performance Data: For air-handling fixtures. Furnish data required in "Submittals" Article in Division 23 Section "Diffusers, Registers, and Grilles."
  5. Sound Performance Data: For air-handling fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Division 15 Section "Diffusers, Registers and Grilles."
  6. Lamps.
  7. Photometric performance data.
- C. Shop Drawings: Show details of nonstandard or custom fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
- D. Wiring Diagrams: Power, signal, and control wiring.
- E. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Suspended ceiling components.
  2. Structural members to which lighting-fixture suspension systems will be attached.
  3. Other items in finished ceiling, including the following:
    - a. Air outlets and inlets.
    - b. Speakers.
    - c. Sprinklers.
    - d. Access panels.
  4. Perimeter moldings.
- F. Samples for Verification: For interior lighting fixtures designated for sample submission in the Interior Lighting Fixture Schedule.
1. Lamps: Specified units installed.
  2. Ballast: 120-V models of specified ballast types.
  3. Accessories: Cords and plugs.
- G. Product Certificates: For each type of ballast for dimmer-controlled fixtures, signed by product manufacturer.
- H. Source quality-control test reports.
- I. Field quality-control test reports.
- J. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
1. Catalog data for each fixture. Include the diffuser, ballast, and lamps installed in that fixture.
- K. Warranties: Special warranties specified in this Section.
- 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:
1. NFPA 70 - National Electrical Code.
  2. NECA/IESNA 500-1998 – Recommended Practice for Installing Indoor Commercial Lighting Systems.
  3. NECA/IESNA 502-1999 – Recommended Practice for Installing Industrial Lighting Systems.
  4. Resource Conservation and Recovery Act (RCRA), May 1994.
  5. Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).
  6. Code of Federal Regulations (47 CFR 37342).

7. Michigan Department of State Police, Fire Marshall Division Policy Number 11-06 "Plastic Materials as Interior Finishes" pertaining to the use of plastic lenses in lighting fixtures for health care facilities.
  8. Michigan Department of Community Industry Services requirements that all lamps shall be protected from breakage. Exposed lamps are not acceptable.
  - C. FMG Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.
  - D. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.
- 1.6 COORDINATION
- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.
- 1.7 WARRANTY
- A. Special Warranty for Emergency Lighting Unit Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
    1. Warranty Period: 10 years from date of Substantial Completion at each project. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
  - B. Special Warranty for Fluorescent Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.
    1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion at each project.
  - C. Manufacturer's Special Warranty for T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
    1. Warranty Period: One year from date of Substantial Completion at each project.
- 1.8 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. Lamps: 20 of each type and rating installed.
    2. Plastic Diffusers and Lenses: 6 of each type and rating installed.
    3. Fluorescent Emergency Battery Units: 3 of each type and rating installed.
    4. Ballasts: 6 of each type and rating 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. Products: Subject to compliance with requirements, provide one of the products specified.

### 2.2 FIXTURES AND COMPONENTS, GENERAL

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.
- C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- D. HID Fixtures: Comply with UL 1572. Where LER is specified, test according to NEMA LE 5B.
- E. Metal Parts: Free of burrs and sharp corners and edges.
- F. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- H. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
1. White Surfaces: 85 percent.
  2. Specular Surfaces: 83 percent.
  3. Diffusing Specular Surfaces: 75 percent.
  4. Laminated Silver Metallized Film: 90 percent.
- I. Plastic Diffusers, Covers, and Globes:
1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
    - a. Lens Thickness: At least 0.125 inch minimum unless different thickness is scheduled.
    - b. UV stabilized.
  2. Glass: Annealed crystal glass, unless otherwise indicated.
- J. Electromagnetic-Interference Filters: A component of fixture assembly. Suppress conducted electromagnetic-interference as required by MIL-STD-461D. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.

- K. Air-Handling Fluorescent Fixtures: For use with plenum ceiling for air return and heat extraction and for attaching an air-diffuser-boot assembly specified in Division 15 Section "Diffusers, Registers, and Grilles."
  - 1. Air Supply Units: Slots in one or both side trims join with air-diffuser-boot assemblies.
  - 2. Heat Removal Units: Air path leads through lamp cavity.
  - 3. Combination Heat Removal and Air Supply Unit: Heat is removed through lamp cavity at both ends of the fixture door with air supply same as for air supply units.
  - 4. Dampers: Operable from outside fixture for control of return-air volume.
  - 5. Static Fixtures: Air supply slots are blanked off, and fixture appearance matches active units.
- L. General: Install ballasts, lamps, and specified accessories at factory. Replace and install any damaged lamps on project site.

## 2.3 LIGHTING FIXTURES

- A. As indicated on the drawings.

## 2.4 FLUORESCENT LAMP BALLASTS

- A. Description: Include the following features, unless otherwise indicated:
  - 1. Designed for type and quantity of lamps indicated at full light output except for emergency lamps powered by in-fixture battery-packs.
  - 2. Externally fused with slow-blow type rated between 2.65 and 3.0 times the line current.
- B. Program rapid start electronic ballasts for linear lamps shall include the following features, unless otherwise indicated:
  - 1. Products:
    - a. Advance.
    - b. Universal Lighting.
  - 2. Comply with NEMA C82.11.
  - 3. Ballast Type: Programmed rapid start, unless otherwise indicated.
  - 4. Programmed Start: Ballasts with two-step lamp starting to extend life of frequently started lamps.
  - 5. Sound Rating: A.
  - 6. Total harmonic distortion rating of less than 10 percent according to NEMA C82.11. Input current third harmonic content shall not exceed 10%.
  - 7. Lamp end-of-life detection and shutdown circuit.
  - 8. Transient Voltage Protection: IEEE C62.41, Category A.



9. Operating Frequency: 25 kHz or higher, and operate without visible flicker.
  10. Lamp Current Crest Factor: Less than 1.7.
  11. Parallel Lamp Circuits: Multiple lamp ballasts connected to maintain full light output on surviving lamps if one or more lamps fail.
  12. Power factor shall be 90% minimum.
  13. Ballast factor shall be .875 to 1.00.
- C. Electromagnetic ballasts for linear lamps shall have the following features, unless otherwise indicated:
1. Products:
    - a. Advance.
    - b. Universal Lighting Technologies
  2. Comply with NEMA C82.1.
  3. Type: Energy-saving, high power factor, Class P, automatic-reset thermal protection.
  4. Ballast Manufacturer Certification: Indicated by label.
  5. Provide lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
  6. Provide ballast suitable for lamps specified.
  7. Ballast shall not exceed sound level above Class A.
- D. Ballasts for dimmer-controlled fixtures shall comply with general and fixture-related requirements above for electronic ballasts and the following features:
1. Products:
    - a. Advance: Mark 10.
    - b. Lutron.
  2. Dimming Range: 100 to 5 percent of rated lamp lumens.
  3. Ballast Input Watts: Can be reduced to 20 percent of normal.
  4. Compatibility: Certified by manufacturer for use with specific dimming system indicated.
  5. Provide ballast suitable for specified lamp type.
- E. Ballasts for Low-Temperature Environments:
1. Temperatures 0 deg F and Higher: Electronic or electromagnetic type rated for 0 deg F minus 17 deg C starting temperature.
  2. Temperatures Minus 20 deg F (Minus 29 deg C) and Higher: Electromagnetic type designed for use with high-output lamps.

- F. Ballasts for Low Electromagnetic-Interference Environments: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for consumer equipment.

## 2.5 EXIT SIGNS

- A. General: Comply with UL 924; for sign colors and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
  - 1. Lamps for AC Operation: Incandescent, 2 for each fixture, 50,000 hours of rated lamp life.
  - 2. Lamps for AC Operation: Fluorescent, 2 for each fixture, 20,000 hours of rated lamp life.
  - 3. Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum of rated lamp life.
  - 4. Additional Lamps for DC Operation: Two minimum, bayonet-base type, for connection to external dc source.
- C. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
  - 1. Battery: Sealed, maintenance-free, nickel-cadmium type with special warranty.
  - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
  - 3. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
- D. Provide edge lit signs with a mirror plaque background.

## 2.6 EMERGENCY LIGHTING UNITS

- A. General: Self-contained units complying with UL 924.
  - 1. Battery: Sealed, maintenance-free, lead-acid type with minimum 10-year nominal life and special warranty.
  - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
  - 3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
  - 4. Wire Guard: Where indicated, heavy-chrome-plated wire guard protects lamp heads or fixtures.
  - 5. Integral Time-Delay Relay: Holds unit on for fixed interval when power is restored after an outage; time delay permits high-intensity-discharge lamps to restrike and develop adequate output.

2.7 FLUORESCENT EMERGENCY BATTERY UNITS

- A. Internal Type: Self-contained, modular, battery-inverter unit factory mounted within fixture body. Comply with UL 924.
1. Emergency Connection: Operate one fluorescent lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
  2. Night Light Connection: Emergency Light Fixtures shall NOT be connected as Night Lights.
  3. Test Switch and Light-Emitting-Diode Indicator Light: Visible and accessible without opening fixture or entering ceiling space. Install remote test switch and plate in adjacent ceiling tile.
  4. Battery: Sealed, maintenance-free, nickel-cadmium type with minimum seven-year nominal life.
  5. Charger: Fully automatic, solid-state, constant-current type.
  6. Lamp Ratings:

<u>Lamp Type</u>	<u>Minimum Lumen Output (two lamps)</u>
F28T8	1400
F54T5HO	1400
  7. Universal transformer to operate at 120 volt or 277 volt.
  8. Products, linear fluorescent:
    - a. Lithonia PS1400 (with quick disconnect).
    - b. Equal by Bodine, Dual Lite or Iota (with quick disconnect that matches the Lithonia PS1400). Do not bid if quick disconnect is not identical to the Lithonia PS1400.

2.8 EMERGENCY LOAD TRANSFER DEVICE

- A. Manufacturers:
1. Nine-24, Inc.: BLTC Series.
  2. Bodine GTD Series.
  3. Dual Lite.
  4. LVS.
  5. Side-Lite.
- B. Description: Localized load transfer switch to sense normal presence of normal power for switched circuits and switch luminaire over to emergency source upon loss of normal source. Device shall be installed integral to luminaire or mounted remotely as application required.
- C. U.L. 924 Listed.
- D. Integral test switch and indicating lamps to indicate status.

2.9 FLUORESCENT LAMPS

- A. Low-Mercury Lamps: Comply with Federal toxic characteristic leaching procedure test, and yield less than 0.2 mg of mercury per liter, when tested according to NEMA LL 1.
- B. T5HO rapid start low-mercury lamps, rated 54 W maximum, nominal length of 45.2 inches 1148 mm, 4600 initial lumens (minimum), CRI greater than 80, color temperature 4100 K, and average rated life of 30,000 hours, unless otherwise indicated.
- C. **T8 rapid-start low-mercury lamps, rated 28 W maximum, 2650 initial lumens (minimum), CRI of 80 (minimum), color temperature of 4100 K, and average rated life of 80,000 hours at 3 hours operation per start, unless otherwise indicated.**
- D. T8 rapid-start low-mercury lamps, rated 17 W maximum, nominal length of 24 inches 610 mm, 1300 initial lumens (minimum), CRI of 80 (minimum), color temperature of 4100 K, and average rated life of 60,000 hours at 3 hours operation per start, unless otherwise indicated
- E. Fluorescent Lamp Manufacturers:
  - 1. Osram Sylvania.
  - 2. General Electric.
  - 3. Philips.

2.10 FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Electrical Supports" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated, 12 gage.
- E. Wires For Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
- F. Rod Hangers: 3/16-inch- minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.
- H. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

2.11 FINISHES

- A. Fixtures: Manufacturers' standard, unless otherwise indicated.
  - 1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.
  - 2. Metallic Finish: Corrosion resistant.

2.12 FLUORESCENT FIXTURE RETROFIT MATERIALS

- A. Comply with UL 1598 listing requirements.
  - 1. Reflector Kit: UL 1598, Type I. Suitable for two- to four-lamp, surface-mounted or recessed lighting fixtures by improving reflectivity of fixture surfaces. No electrical parts are to be changed.
  - 2. Ballast and Lamp Change Kit: UL 1598, Type II. Suitable for changing existing ballast, lamps, and sockets as scheduled.

2.13 SOURCE QUALITY CONTROL

- A. Provide services of a qualified, independent testing and inspecting agency to factory test fixtures with ballasts and lamps; certify results for electrical ratings and photometric data.
- B. Factory test fixtures with ballasts and lamps; certify results for electrical ratings and photometric data.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturers instructions.
- B. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.
- C. Fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- D. Support for Fixtures in or on Grid-Type Suspended Ceilings: Use grid for support.
  - 1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from fixture corners.
  - 2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
  - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
- E. Support luminaires independent of ceiling framing. Support recessed grid luminaires from two opposite corners directly to structure. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- F. Exposed Grid Ceilings: Support surface mounted luminaires on grid ceiling directly from building structure.
- G. Install recessed luminaires to permit removal from below.
- H. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
- I. Suspended Fixture Support: As follows:
  - 1. Install suspended luminaires and exit signs using pendants supported from swivel hangers except where noted to use chain hangers. Provide pendant length required to suspend luminaire at indicated height.

2. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
  3. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
  4. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
  5. Continuous Rows: Suspend from cable.
  - J. Air-Handling Fixtures: Install with dampers closed and ready for adjustment.
  - K. Adjust aimable fixtures to provide required light intensities.
  - L. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prohibit movement.
  - M. Where fluorescent fixtures are shown with dual switches, connect all inner lamps to one switch and all outer lamps to the other switch. Dim the inner lamps where a dimmer switch is shown.
  - N. Connect night light fixtures and emergency lighting fixtures to the hot (unswitched) side of lighting circuits.
  - O. Provide green grounding conductors back to the panel ground for lighting circuits. Raceways shall not be used as grounding conductors.
  - P. Fixtures shall have their exterior labels removed and shall be thoroughly cleaned. Non-functioning lamps shall be replaced.
  - Q. Mount fluorescent emergency lighting battery packs in accordance with the manufacturer's instructions. Locate the remote test/monitor modules identically so that they are visible and they form a straight line when viewed from the end of the corridor or room. Where a suspended ceiling exists, center the modules in adjacent ceiling tiles.
  - R. Mount sealed beam emergency lighting units where shown and aim their lamps to light the egress path as uniformly as possible.
- 3.2 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 wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
  - C. Bond products and metal accessories to branch circuit equipment grounding conductor.
  - D. Connect luminaires to branch circuit outlet boxes provided under Section 16130 using 1/2" flexible conduit.
- 3.3 FIELD QUALITY CONTROL
- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
  - B. Examine each luminaire to determine suitability for lamps specified.
  - C. Verify normal operation of each fixture after installation.

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- D. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify normal transfer to battery power source and retransfer to normal.
- E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.
- F. Corroded Fixtures: During warranty period, replace fixtures that show any signs of corrosion.
- G. Check for variance in lamp color temperature throughout project.
- H. Spot check for lamp output level from start up through 10 minute duration and make rotation.
- I. All fluorescent and H.I.D. lamps shall be allowed to run a minimum of 100 hours, continuously, prior to punchlist or any dimming.
- J. A visual inspection shall be performed to verify cleanliness and alignment of the fixtures, misalignment and light leaks shall be corrected, and rattles due to ventilation system vibration shall be eliminated.

3.4 ADJUSTING

- A. Aim and adjust luminaires as directed by the Architect/Engineer.
- B. Adjust exit sign directional arrows as indicated on Drawings.
- C. Relamp luminaires that have failed lamps at Substantial Completion.
- D. Adjust all "low end trim" settings of dimming switches prior to punchlist.
- E. Adjust and calibrate all dimming system controls until the system works as designed. Contact the Architect/Engineer when dimming is complete and demonstrate operation to owner's representative and Architect/Engineer.

3.5 CLEANING

- A. Clean electrical parts to remove conductive and deleterious materials.
- B. Remove dirt and debris from enclosures and lenses.
- C. Clean photometric control surfaces as recommended by manufacturer.
- D. Clean finishes and touch up damage.

**\*\*END OF SECTION\*\***

## EXTERIOR LIGHTING

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### 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. Exterior luminaires with lamps and ballasts.
- 2. Luminaire-mounted photoelectric relays.
- 3. Poles and accessories.
- 4. Luminaire lowering devices.

- B. Related Sections include the following:

- 1. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.



1.3 DEFINITIONS

- A. CRI: Color-rendering index.
- B. HID: High-intensity discharge.
- C. Luminaire: Complete lighting fixture, including ballast housing if provided.
- D. Pole: Luminaire support structure, including tower used for large area illumination.
- E. Standard: Same definition as "Pole" above.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4.
- B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4.
- C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4.
- D. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.
  - 1. Wind speed for calculating wind load for poles exceeding 50 feet in height is 70 mph
  - 2. Wind speed for calculating wind load for poles 50 feet or less in height is 70 mph.

1.5 SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
  - 1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
  - 2. Details of attaching luminaires and accessories.
  - 3. Details of installation and construction.
  - 4. Luminaire materials.
  - 5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
    - a. For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
    - b. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
  - 6. Photoelectric relays.

7. Ballasts, including energy-efficiency data.
8. Lamps, including life, output, and energy-efficiency data.
9. Materials, dimensions, and finishes of poles.
10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
11. Anchor bolts for poles.
12. Manufactured pole foundations.

B. Shop Drawings:

1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
2. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
3. Wiring Diagrams: Power and control wiring.

C. Samples for Verification: For products designated for sample submission in Exterior Lighting Device Schedule. Each sample shall include lamps and ballasts.

D. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design.

E. Qualification Data: For agencies providing photometric data for lighting fixtures.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For luminaires and poles luminaire lowering devices to include in emergency, operation, and maintenance manuals.

H. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with IEEE C2, "National Electrical Safety Code."

- E. Comply with NFPA 70.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch deep. Do not apply tools to section of pole to be installed below ground line.
- D. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.
- E. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

#### 1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Warranty shall include parts and labor.
  - 1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
  - 2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
  - 3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
  - 4. Warranty Period for Lamps: Replace lamps and fuses that fail within 5 years from date of Substantial Completion.
  - 5. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than five years from date of Substantial Completion.

### 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. Basis of Design Product: The design of each item of exterior luminaire and its support is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

## 2.2 LUMINAIRES, GENERAL REQUIREMENTS

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
  - 1. White Surfaces: 85 percent.
  - 2. Specular Surfaces: 83 percent.
  - 3. Diffusing Specular Surfaces: 75 percent.
- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- M. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."

2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
  - a. Color: As selected from manufacturer's standard catalog of colors.
  - b. Color: Match Architect's sample of custom color.
  - c. Color: As selected by Architect from manufacturer's full range.
- N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
  2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
  3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
  4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
    - a. Color: as specified on fixture schedule.

## 2.3 FLUORESCENT BALLASTS AND LAMPS

- A. Low-Temperature Ballast Capability: Rated by its manufacturer for reliable starting and operation of indicated lamp(s) at temperatures minus 20 deg F and higher.
- B. Ballast Characteristics:
  1. Power Factor: 90 percent, minimum.
  2. Sound Rating: A.
  3. Total Harmonic Distortion Rating: Less than 10 percent.
  4. Electromagnetic Ballasts: Comply with ANSI C82.1, energy-saving, high power factor, Class P, automatic-reset thermal protection.
  5. Case Temperature for Compact Lamp Ballasts: 65 deg C, maximum.
  6. Transient-Voltage Protection: Comply with IEEE C62.41 Category A or better.
- C. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures minus 20 deg and higher.
- D. Fluorescent Lamps: Low-mercury type. Comply with the EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

## 2.4 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4.
  - 1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
  - 2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
  - 1. Materials: Shall not cause galvanic action at contact points.
  - 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
  - 3. Anchor-Bolt Template: Plywood or steel.
- D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."
- E. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

## 2.5 ALUMINUM POLES

- A. Poles: Seamless, extruded structural tube complying with ASTM B 429, Alloy 6063-T6 with access handhole in pole wall.
- B. Poles: ASTM B 209, 5052-H34 marine sheet alloy with access handhole in pole wall.
  - 1. Shape: Square, straight.
  - 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

- E. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
  - 1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
  - 2. Finish: Same as pole.
- F. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
- G. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
  - 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
  - 3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
  - 4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
    - a. Color: Dark bronze.

## 2.6 POLE ACCESSORIES

- A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.
- B. Vibration Dampener: For all steel lighting poles taller than 15', provide factory or field installed vibration dampening device to eliminate second mode or higher resonance that can occur with low velocity steady state winds. Vibration dampeners shall be installed inside of the poles. Dampening method shall be steel chain encased in a plastic tube approximately 2/3 the length of the pole. Coordinate all requirements with pole manufacturer.

## PART 3 - EXECUTION

### 3.1 LUMINAIRE INSTALLATION

- A. Install exterior lighting system per N.E.C.A./I.E.S.N.A. 501-2006.
- B. Install lamps in each luminaire.
- C. Fasten luminaire to indicated structural supports.
  - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

- D. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

### 3.2 POLE INSTALLATION

- A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:
  - 1. Fire Hydrants and Storm Drainage Piping: 60 inches.
  - 2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
  - 3. Trees: 15 feet.
- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 3 Section "Cast-in-Place Concrete."
- D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
  - 1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
  - 2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
  - 3. Install base covers, unless otherwise indicated.
  - 4. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
- E. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
  - 1. Dig holes large enough to permit use of tampers in the full depth of hole.
  - 2. Backfill in 6-inch layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.
- F. Embedded Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
  - 1. Make holes 6 inches in diameter larger than pole diameter.
  - 2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi at 28 days, and finish in a dome above finished grade.
  - 3. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.



4. Cure concrete a minimum of 72 hours before performing work on pole.

G. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch-wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.

H. Raise and set poles using web fabric slings (not chain or cable).

### 3.3 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 4 inches above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 3 Section "Cast-in-Place Concrete."

### 3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 3 Section "Cast-in-Place Concrete."

### 3.5 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceways and Boxes." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

### 3.6 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding."

1. Install grounding electrode for each pole, unless otherwise indicated.

2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding."

1. Install grounding electrode for each pole.

2. Install grounding conductor and conductor protector.

3. Ground metallic components of pole accessories and foundations.

### 3.7 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

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- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

1. Verify operation of photoelectric controls.

- C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):

- a. IESNA LM-5, "Photometric Measurements of Area and Sports Lighting."
- b. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
- c. IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
- d. IESNA LM-64, "Photometric Measurements of Parking Areas."
- e. IESNA LM-72, "Directional Positioning of Photometric Data."

- D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices. Refer to Division 1 Section "Demonstration and Training."

**\*\*END OF SECTION\*\***

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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. General Scope	
1. Expand the existing public address system, including new speakers and cable (two new classrooms at International Academy). Tone and test existing cable. Replace defective cable as required for a complete operating system.	
2. Provide complete and fully functional systems with devices and components as required and as indicated. System as shown and as specified represents design intent and is not reflective of installed quantities and miscellaneous components, except as minimums.	
1.3 SUBMITTALS	
A. Product Data: For the following:	
1. Wall and ceiling mounted speaker assemblies.	

2. Outdoor speakers.
  3. Public address/intercom system.
  4. Controls, amplifiers, and terminal equipment.
  5. Power supplies.
  6. Wiring.
- B. Shop Drawings:
1. Equipment Details: Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location of each field connection.
  2. Station-Arrangement Details: Scaled drawings for built-in equipment.
  3. Wiring Diagrams: Power, signal, and control wiring. Include the following:
    - a. Identify terminals to facilitate installation, operation, and maintenance.
    - b. Single-line diagram showing interconnection of components.
    - c. Cabling diagram showing cable routing.
- C. Qualification Data: For Installer.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For school intercom and program equipment to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Sections, include the following:
1. Record of final matching transformer-tap settings and signal ground-resistance measurement certified by Installer.
- 1.4 QUALITY ASSURANCE
- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
1. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.
- D. Comply with UL 50.
- E. The contractor shall be an established communications contractor that has had and currently maintains a locally run and operated business for at least five (5) years. The contractor shall utilize a duly authorized distributor of the equipment supplied for this project location with full Rauland's five (5) year warranty.

- F. The contractor shall show satisfactory evidence, upon request, that the supplier maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system.

## 1.5 COORDINATION

- A. Coordinate layout and installation of system components, such as ceiling mounted speaker microphones and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

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

### 2.2 SUPPLIER AND SYSTEM INTEGRATOR:

- A. Provide products through the following:
  - 1. Sound Engineering (contact Barry Gilbert at 734-522-2910): shall provide service for the Dukane P.A. equipment).
- B. Expand the existing Public Address consoles at each building as required. Provide new speakers as indicated on drawings. Provide all new components that are required in each existing P.A. console for a complete, fully functional system.

### 2.3 PUBLIC ADDRESS SYSTEM CONSOLE/EQUIPMENT

- A. The existing Public Address console is a Dukane Model MCS350. The system shall consist of a central equipment cabinet, Telapex digital card, analog card, telephone interface card (coordinate requirements with the Technology Contractor), one or more switching cards as required by number of remote stations in the system (plus 25% spare capacity), power supply, one or more power amplifiers as required, four Administration Control Consoles (ACC), remote station loudspeaker assemblies, mounting rack/cabinet and all associated material, hardware, and wiring as required for a complete system.
  - 1. The system shall provide, as a minimum, the following features and functions:
    - a. Allow administrative intercom system functions to be accessed through DTMF telephone instruments.
    - b. Microprocessor-based equipment of modular design, using plug-in connections between all modules. Field cabling shall be terminated in a labeled punch block arrangement to simplify servicing.
    - c. Allow DTMF-type telephones to call individual classroom speakers, zone page, all call page, emergency page, and activate other alarm and time tones.
    - d. Three simultaneous communication paths:
      - 1) Direct dialing, two-way communications between locations equipped with an ACC or DTMF telephone and any room station equipped with a speaker or telephone handset.
      - 2) A second intercom channel between ACCs when multiple ACCs are used in the system.

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- 3) Simultaneous program distribution directed from any ACC without interrupting intercom channels.
2. One Central Control Unit (CCU) containing all the electronics required to handle all the functions of up to 64 remote stations in a wall cabinet model and 240 remote stations in a floor rack model.
3. The capability to originate emergency calls that take precedence over all routine calls. Emergency calls may be programmed from any call-in switch, or a normal call may be converted to emergency by holding the call-in switch in the CALL position for 1.5 seconds.
4. A single queue mode capability that places all incoming calls into a single common queue and allows directing all incoming calls to the ACC and DTMF telephones during limited staff operation.
5. System check with self-diagnosis and a watchdog timer.
6. System support for up to four ACCs, each having identical functions and control features, and each of which can be programmed for specific secretarial or administrative operations.
7. Automatic gain control on intercom speech to maintain constant speech level.
8. Built-in battery backup for internal system clock to maintain correct time while system is unpowered. All other programmed data is stored in nonvolatile EEPROM memory and is retained indefinitely.
9. Automatic preannounce tone over any loudspeaker selected for two-way communications. A privacy tone will sound whenever a loudspeaker is being monitored, with capabilities to stop the tone from the ACC as desired.
10. Distribution of paging announcements from any ACC or DTMF telephone to speaker and ACC locations on an all call, zone, and multiple zone basis, to any of the eight paging zones.
11. User-programmability of room stations and loudspeakers to any of eight available paging zones, class change zones, or no zones at all.
12. Unique system tones for emergency and civil emergency pages with distribution of emergency announcements from an ACC or DTMF telephone to all locations equipped with ACCs or loudspeakers. Emergency announcements will automatically override all other programs.
13. Custodial call tone to all speakers.
14. Audio program distribution (microphone, tape, tuner, or auxiliary) capability to selected remote stations, specified zones, or all remote stations equipped with audio loudspeakers.
15. Provisions for intercom communications in facilities having unshielded, twisted-pair cable from each speaker location.
16. Provision for optional line supervision of an open circuit condition.
17. Shall synchronize system clock to an external master clock (Not Applicable).
18. Provision for handset use at remote stations.
19. Provisions to override remote sound systems during all call or emergency paging.
20. Provision for distribution of door open alarm to all or selected zones by closure of single switch contact.
21. Provide transfer of current call to another ACC.
22. Call holding capability.
23. Forwarding of calls assigned to a particular ACC to another ACC for call coverage.
24. Last number redial.
25. Speed dial access to specific remote stations.
26. Defeat of call-in tones at any ACC.
27. Ability to clear all calls registered on the ACC queue.
28. Scroll display of waiting calls and select calls to be answered in any order.
29. Ability to display ACC's number using ACC keypad.
30. Call waiting indication: Steady display for normal calls, flashing display for emergency calls in order of priority.
31. Call-in reminder in which unanswered calls repeat until answered.

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32. Provide LCD of current call/calls waiting. Current time is displayed when the ACC is in an idle state. The alphanumeric readout of incoming calls will be sorted by room number and queue position. The number of calls waiting will also be displayed in order of priority.
33. Sequential review of all incoming calls/calls waiting at each ACC with 100 percent call retention.
34. One VOX handset (for private communications), built-in microphone, speaker and PUSH TO TALK button on each ACC for intercom communications.
35. Ability for external input points to be annunciated at the ACC.
36. Selective monitoring of audio program sources by the ACC before or during distribution.
37. Initiation of manual time tones by any ACC or DTMF telephone.
38. Access code restriction of ACC system programming to protect the system configuration.
39. Ability for any ACC to direct a program to any one, group of, or all remote stations.
40. Built-in diagnostic software for each ACC.
41. Easy, menu-driven programming.
42. ACC-keypad programmable system functions, including:
  - a. Architectural alphanumeric room numbers.
  - b. Five call-in priority levels.
  - c. 12-hour or 24-hour clock display when ACC is in idle state.
  - d. 256 events, eight time schedules, eight zones and eight user-programmable tones.
43. Factory-programmable function keys for specific system operations.
44. Ability for each remote station to be programmed to annunciate at any one or all ACC's.
45. Automatic distribution of user-programmable time signals activated by a built-in master time clock. Two hundred fifty-six programmable events are available which can be programmed to eight zones and eight schedules from an ACC.
46. Programming room stations, zones, or multiple zones to receive the program source on a selected room basis from the ACC, with the ability to view rooms receiving program material on the ACC display.
47. Allow external DTMF telephones to automatically select and access room stations for communications (for future provisions).
48. Input ports for monitoring external signals to activate TC2100 functions such as off-hour door alert, emergency tones and night transfer.
49. Output ports for activation of external equipment in response to ICS functions such as clock synchronization, all call override, and telephone or CO port off-hook to the ICS.
50. An RS-232 port for interface to a PC for remote diagnostics, remote programming, system information, saving and reloading of system programming, and hard copy output of all system.
51. An RS-485 port for long distance serial communication.
52. A built-in analog tone generator providing seven tones including chime.
53. The public address system console unit shall be able to support dialing or non-dialing future telephone handsets.
54. Public Address System Console shall signal class change tones via the speaker system. Time schedules shall be programmed per the Owner's direction. Time correction shall be via internal master clock.

B. Execution:

1. Install all equipment per manufacturer's specifications. Prior to any programming, the contractor shall meet with the Owner for final approval of all system operations. Provide four (4) hours of in service to the Owner on both operation of the system and programming. The contractor shall provide the program software as required for the system.

## 2.4 FUNCTIONAL DESCRIPTION OF INTERCOM SYSTEM

- A. The system shall be capable of multiple open voice intercom paths used for intercom, paging, program distribution, or emergency paging. The system shall be initially equipped with one intercom speech path.
- B. Provide a separate circuit for each classroom and administrative office so each room can be individually addressed with bi-directional communications.
- C. All field wiring shall be individually supervised for opens or shorts to each call station and security device.
- D. Arming and disarming functions shall be performed by dial-up via the Administrative Telephone(s).
- E. The audio channel(s) shall be priority driven allowing for the highest priority signal type access to a voice channel. The system shall be user programmable to allocate, upon demand, the audio channel(s) to facilitate simultaneous intercom conversations, pages, program distributions, or combination thereof.
  - 1. Facilities for up to 6 call-in priority levels.
  - 2. Every point shall support a programmable priority level.
  - 3. Distribution of paging announcements can be made from any administrative control console, telephone, or dedicated microphone set-up.
  - 4. Emergency announcements shall have the highest priority over any other system function.
  - 5. System shall support general announcements made from a conventional microphone to facilitate reading a script and the participation of multiple announcers.
  - 6. Keying the microphone shall automatically mute all other audio programs at a lower priority in the system and transmit the microphone audio to All Rooms or specific speaker zones, as programmed into the system software.
  - 7. Corridor speakers and outside horns shall be combined into groups of owner's preference.
  - 8. Facilities to provide automatic emergency instructions to be broadcast to the entire school when an alarm is tripped. The emergency instructions are preprogrammed and require no user intervention.
  - 9. Facilities to page one or more area-wide pocket pagers when a call is placed for a specific call priority or call priorities. The pocket pager will display the calling room number and a numeric call priority.

## 2.5 EQUIPMENT AND MATERIALS

- A. Coordinate features to form an integrated system. Coordinate components with existing systems where required. Match system voltages. Match components and interconnections for optimum performance of specified functions.
- B. Expansion Capability: Increase number of stations in the future by 25 percent above those indicated without adding any internal or external components or main trunk cable conductors.



- C. Equipment: Modular type using solid-state components, fully rated for continuous duty, unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.
- D. Waterproof Equipment: Listed and labeled for duty outdoors or in damp locations.

## 2.6 MASTER CONTROL STATION

- A. Micro-processor based desktop console with LCD display.
- B. The console shall be equipped with 12-digit keypad and telephone handset to allow private conversations.
- C. Provide built-in microphone and speaker shall provide for push-to-talk intercom conversations.
- D. Incoming calls shall be enunciated on a 16-character LCD backlit digital display sorted by priority and order received.
- E. The console shall also provide the ability for the operator to place on hold, or clear any incoming calls registered in the system from the console keypad.
- F. The console shall retain the last room number dialed until another room number is dialed or previous call is cancelled.

## 2.7 PAGING AMPLIFIERS

- A. Minimum Output Power: Provide sufficient power to all corridor/classroom speakers to be tapped at 1 watt each; all outdoor speakers to be tapped at 5 watts each. Provide a minimum of 30% "headroom" amplifier power to full load status.
- B. Total Harmonic Distortion: Less than 1 percent at rated output power with load equivalent to total quantity of stations connected in all call mode.
- C. They shall be designed to operate on a line voltage of 115 AC. One amplifier shall be provided for each audio channel.
- D. Minimum Signal to Noise Ratio: 60 dB, at rated output.
- E. Frequency Response: Within plus or minus 2dB from 50 to 12,000 Hz.
- F. Amplifier Protection: Prevent damage from shorted or open circuit.

## 2.8 P.A. CALL STATION

- A. Dukane model as required, Call Switch, single gang flush mounted with stainless steel faceplate. Single normal call button. Provide wiring as required by the manufacturer.

## 2.9 CEILING AND WALL MOUNTED SPEAKERS

- A. Classroom Speakers - PA speakers shall have the following coverall characteristics:
  - 1. Diameter: 8".
  - 2. Frequency Response: 60-16000 Hz.
  - 3. Power: 15 Watts.

4. Magnet Weight: 10 ounces.

5. Single voice coil.

- a. The unit shall come with a transformer having taps of 1/2, 1, 2 and 4 watts. All speakers shall be tapped at 1 watt. Provide Soundolier 61-8W speaker grille, EZ95-8 enclosure and support rail. Provide Soundolier C10A or Engineer approved equal speaker.

- B. Flush mounted Wall speakers: Provide an 8" speaker as above with Soundolier 198-8 backbox and 161-8 matching grille.
- C. Maintenance areas and outside horns (flush): Provide a Soundolier APF-15T flush mounted horn with multitap line matching transformer. Provide outside horns (weatherproof) with a Soundolier VP-161APF baffle (painted brown) and required back box. Indoor units shall have a L20-101 grille with L20-211 backbox.
- D. Wall Mounted Volume Control: Provide a control that offers step attenuation via an autotransformer. The control shall work with either 25 volt or 70 volt lines and be rated at a minimum of 10 watts.
- E. Surface Mounted Horn Speaker (in ceiling space) - Horn loudspeakers shall be a Soundolier APF-15T surface mount horn with multitap line matching transformer. Provide with each unit a Soundolier VP-161APF baffle and required back box in **Gymnasiums**.
- F. Corridor Speakers: Provide same as classroom speakers.
- G. Surface mounted (wall or exposed ceiling speakers): Provide same as classroom speaker, with required mounting grill for Soundolier L20-213 square surface mounted enclosure.

## 2.10 CONDUCTORS AND CABLES

- A. Conductors: Jacketed, twisted pair and twisted multipair, untinned solid copper. Sizes as recommended by system manufacturer, but not smaller than No. 22 AWG.
- B. Insulation: Thermoplastic, not less than 1/32 inch thick.
- C. Shielding: For speaker-microphone leads and elsewhere where recommended by manufacturer; No. 22 AWG tinned, soft-copper strands formed into a braid or equivalent foil.
  - 1. Minimum Shielding Coverage on Conductors: 60 percent.
- D. Plenum Cable: Listed and labeled for plenum use.
- E. Coordinate use of existing wiring with new equipment. Verify interoperability.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Wiring Method: Install wiring in raceways except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum-board partitions where cable wiring method may be used. Use plenum cable in environmental air spaces, including plenum ceilings. Conceal cables and raceways except in unfinished spaces.

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- B. Install exposed cables parallel and perpendicular to surfaces or exposed structural members, and follow surface contours. Secure and support cables by J- hooks or similar fittings designed and installed to avoid damage to cables. Secure cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, or fittings.
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess. Use lacing bars in cabinets.
- D. Control-Circuit Wiring: Install number and size of conductors as recommended by system manufacturer for control functions indicated.
- E. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches for speaker microphones and adjacent parallel power and telephone wiring. Separate other school intercom and program equipment conductors as recommended by equipment manufacturer.
- F. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- G. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.
- H. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
- I. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.
- J. Connect wiring according to Division 26 Section "Conductors and Cables."
- K. Provide installation of all equipment specified, including all miscellaneous parts and labor for a complete, fully functioning system.

3.2 GROUNDING

- A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

3.3 SYSTEM PROGRAMMING

- A. Programming: Fully train Owner on available programming options. Record Owner's decisions and set up initial system program. Prepare a written record of decisions, implementation methodology, and final results.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:

SECTION 275123  
ELECTRICAL  
GENERAL  
REQUIREMENTS

1. Schedule tests with at least seven days' advance notice of test performance.
  2. After installing school intercom and program equipment and after electrical circuitry has been energized, test for compliance with requirements.
  3. Operational Test: Test originating station-to-station, all-call, and page messages at each intercom station. Verify proper routing and volume levels and that system is free of noise and distortion. Test each available message path from each station on system.
  4. Frequency Response Test: Determine frequency response of two transmission paths, including all-call and paging, by transmitting and recording audio tones. Minimum acceptable performance is within 3 dB from 150 to 2500 Hz.
  5. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:
    - a. Disconnect speaker microphone and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure signal-to-noise ratio at paging speakers.
    - b. Repeat test for three speaker microphones, one master station microphone, and for each separately controlled zone of paging loudspeakers.
    - c. Minimum acceptable ratio is 45 dB.
  6. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 150, 200, 400, 1000, and 2500 Hz into each intercom, paging, and all-call amplifier. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 5 percent total harmonics.
  7. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each paging zone. Maximum permissible variation in level is plus or minus 3 dB; in levels between adjacent zones, plus or minus 5 dB.
  8. Power Output Test: Measure electrical power output of each paging amplifier at normal gain settings of 150, 1000, and 2500 Hz. Maximum variation in power output at these frequencies is plus or minus 3 dB.
  9. Signal Ground Test: Measure and report ground resistance at system signal ground. Comply with testing requirements in Division 16 Section "Grounding and Bonding."
  - C. Retesting: Correct deficiencies and retest. Prepare a written record of tests.
  - D. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging and independent room speaker-line matching transformers.
  - E. Prepare written test reports.
    1. Include a record of final speaker-line matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.
- 3.5 STARTUP SERVICE
- A. Engage a factory-authorized service representative to perform startup service and initial system programming.

- B. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
- C. Complete installation and startup checks according to manufacturer's written instructions.

3.6 ADJUSTING

- A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain school intercom and program equipment. Refer to Division 1 Section "Demonstration and Training."
  - 1. Train Owner's maintenance personnel on programming equipment for starting up and shutting down, troubleshooting, servicing, and maintaining equipment.

**\*\*END OF SECTION\*\***

## FIRE ALARM

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### 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 work of this section.
- B. Related Sections include the following:
  - 1. Division 26 Section "Electrical General Requirements."

#### 1.2 SECTION INCLUDES

- A. Fire alarm and smoke detection systems. This section intends to describe a Protected Premises Fire Alarm System. The control panel shall be intelligent device addressable, analog detecting, low voltage and modular with multiplex communication techniques, in full compliance with all applicable

codes and guidelines. The features and system capacities contained in this specification shall be furnished as part of this project.

- B. The system as described shall be installed, tested, and delivered to the Owner in first class condition. The system shall include all the required hardware and software to accomplish the requirements of this specification and the contract documents, whether or not specifically itemized herein.
- C. All equipment furnished shall be new and include the latest state of the art products from a single manufacturer, engaged in the manufacturing and sale of fire detection devices for over ten years. The equipment manufacturer shall have an installed base of existing systems as a reference.

### 1.3 REFERENCES

- A. NFPA 72 - National Fire Alarm Code.
- B. NFPA 101 - Life Safety Code.
- C. U.L. 1971 - Standard for Safety Signaling Devices for the Hearing Impaired.

### 1.4 REGULATORY REQUIREMENTS

- A. System: UL (FPED) and FM listed.
- B. Conform to requirements of NFPA 101.
- C. A.D.A. Federal guidelines.
- D. Conform to State of Michigan Fire Code.
- E. Conform to International Building Code.

### 1.5 SUMMARY

- A. The Fire Alarm System shall consist of all necessary hardware equipment and software programming to perform the following functions:
  - 1. Fire Alarm and Detection Operations.
  - 2. Remote Monitoring of Sprinkler Systems.
  - 3. Remote Manual and Automatic Control of all Door Hold-open Devices, and other auxiliary functions indicated on the drawings.

### 1.6 SYSTEM DESCRIPTION

- A. General: Complete, zoned, noncoded, addressable, microprocessor-based fire detection and alarm system with manual and automatic alarm initiation, addressable analog initiating devices, and automatic alert.
- B. The fire alarm system shall allow for loading and editing special instructions and operating sequences as required. The system shall be capable of on-site programming to accommodate

system expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control panel (FACP).

- C. Resident software shall allow for full configuration of initiating circuits so that additional hardware shall not be necessary to accommodate future changes.
- D. Resident software shall allow for configuration of notification appliance and control circuits so that additional hardware shall not be necessary to accommodate changes.
- E. The system shall have the capability of recalling alarms and trouble conditions in chronological order for the purpose of recreating an event history.
- F. Signal Transmission: Notification appliance circuits shall be NFPA Style Y, Class B. Signaling line circuits shall be NFPA Style 4, Class B.
- G. Data Communication Transmission Between Control Units: Style 7, Class A.

#### 1.7 SYSTEM FUNCTIONS

- A. Signal Initiation: The manual or automatic operation of an alarm-Initiating or supervisory-operating device shall cause the FACP to transmit an appropriate signal including:
  - 1. General alarm.
  - 2. System trouble.
  - 3. Valve tamper supervisory.
  - 4. Door release.
  - 5. Fan shutdown.
  - 6. Release electrically held door locks.
  - 7. A general alarm shall be initiated by:
  - 8. Water-flow alarm switch operation.
  - 9. Smoke detection. Alarm verification is required for all smoke detector zones.
  - 10. Manual station operation.
  - 11. Heat detector operation.
- B. General Alarm: A system general alarm shall:
  - 1. Indicate the general alarm condition at the FACP.
  - 2. Identify the device that is the source of the alarm at the FACP.
  - 3. Display the alarm on an 80 character LCD display. The system alarm LED shall flash on the control panel until the alarm has been acknowledged. Once acknowledged, this same LED shall latch on. A subsequent alarm received from another zone shall flash the system alarm LED on the control unit. The display shall show the new alarm information.



4. Sound a pulsing alarm tone within the FACP until the event has been acknowledged.
  5. Operate audible and visible alarm notification signals throughout the building.
  6. Sound a continuous fire alarm signal until silenced by the alarm silence switch at the FACP.
  7. Flash all visible alarm notification appliances continuously until the System Reset Switch is operated. Any subsequent zone alarm shall reactivate the alarm notification appliances.
  8. Close fire and smoke doors normally held open by magnetic door holders.
  9. Stop supply and return fans serving zone where alarm is initiated.
  10. Close smoke dampers on system serving zone where alarm is initiated.
  11. Transmit the alarm to the proprietary supervising station.
- C. A supervisory alarm shall be initiated by:
1. Sprinkler valve tamper switch operation.
- D. Loss of primary power at the FACP shall sound a trouble signal at the FACP and shall indicate at the FACP when the system is operating on an alternate power supply.
- E. Circuit Supervision: Circuit faults shall be indicated by means of both a zone and a trouble signal at the FACP.
- F. Annunciation: Manual and automatic operation of alarm and supervisory initiating devices shall be annunciated on the FACP, indicating the location and type of device.
- G. FACP Alphanumeric Display: Shall display plain-language description of alarms, trouble signals, supervisory signals, monitoring actions, system and component status, and system commands.
- H. Independent System Monitoring: Supervise each independent smoke detector, fire suppression system and duct detector, for both normal operation and trouble.
- I. Alarm Silencing: If the "Alarm Silence" button is pressed, all audio alarm signals shall cease operation.
- J. System Reset: The "System Reset" button shall be used to return the system to its normal state after an alarm condition has been remedied.
- K. Activation of an auxiliary bypass switch shall override the selected automatic functions.
- L. Auxiliary manual controls shall be supervised so that an "off normal" position of any switch shall cause an "off normal" system trouble. The "off normal" status shall be clearly identified in plain-language on the FACP.
- M. Recording of Events: Record all alarm, supervisory, and trouble events in non-volatile memory.
- N. Smoke Sensor Sensitivity Adjustment:
1. Authorized operation of controls at the FACP shall cause the selection of specific addressable smoke sensors for adjustment, display of their current status and sensitivity settings, and control of changes in those settings.

2. Remote Controllability: Individually monitor sensors at the FACP for calibration, sensitivity, and alarm condition, and individually adjust for sensitivity from the FACP. The alarm decision for each sensor shall be determined by the control unit. The control unit shall determine the condition of each sensor by comparing the sensor value to the stored values.
- O. The actuation of the "enable one person test" program at the FACP shall activate the "One Person Testing" mode of the system which shall cause the following to occur:
1. The city circuit connection shall be bypassed.
  2. Control relay functions shall be bypassed.
  3. The FACP shall show a trouble condition.
  4. The alarm activation of any initiation device shall cause the audible notification appliances to code a number of pulses to match the zone number.
  5. The FACP shall automatically reset after signaling is complete.
  6. Any momentary opening of an initiating or notification appliance circuit wiring shall cause the audible signals to sound for 4 seconds indicating the trouble condition.
  7. The system shall have the capacity of 8 programmable, passcode protected, one person testing groups, such that only a portion of the system need be disabled during testing.
- P. Power Requirements
1. The FACP shall receive 120 VAC power via a dedicated 20A branch circuit breaker provided with a red lock-on device.
  2. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of 24 hours with 15 minutes of alarm operation at the end of this period. The system shall automatically transfer to battery standby upon power failure. All battery charging and recharging operations shall be automatic.
  3. All circuits requiring system operating power shall be 24 VDC and shall be individually fused at the control panel.
  4. The incoming power to the system shall be supervised so that any power failure must be audibly and visibly indicated at the control panel. A green "power on" LED shall be displayed continuously while incoming power is present.
  5. The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be audibly and visibly indicated at the FACP and the command center.
- Q. The system shall support 100% of addressable devices in alarm or operated at the same time, under both primary (AC) and secondary (battery) power conditions.

## 1.8 SUBMITTALS

- A. Bidders will be required to submit shop drawings and product data during the construction phase of each project. Provide the following submittals for review:

1. Complete description data indicating UL listing for all network components. Include dimensioned plans and elevations showing minimum clearances and installed features and devices.
  2. Complete sequence of operation of all functions of the network that is project specific.
  3. A list of every address of every device connected to a panel that is provided for purposes of alarm initiating, status monitoring, supervised notification appliance circuits, and auxiliary control.
  4. A listing of the manufacturer's representatives responsible for installation coordination and service.
  5. Location of all controls, alarm actuating devices and notification appliance devices as shown on drawings.
  6. Wiring diagrams from manufacturer differentiating between factory-and field- installed wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Indicate components for both field and factory wiring. Provide complete diagrams for all components and interfaces including equipment supplied by others.
  7. Operation and maintenance data for inclusion in Operating and Maintenance Manual specified in Division 1. Include data for each type product, including all features and operating sequences, both automatic and manual. Include recommendations for spare parts to be stocked at the site. Provide the names, addresses, and telephone numbers of service organizations that carry stock of repair parts for the system to be furnished.
  8. The manufacturer shall provide calculations for battery size as applicable. Battery size shall be a minimum 125% of the calculated requirement.
  9. Provide calculations for control modules indicating circuit loading with 20% spare capacity.
- B. Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the authority having jurisdiction. Include copies of annotated Contract Drawings as required to depict component locations to facilitate review. Upon receipt of comments from the Authority, submit them for review. Make resubmissions if required to make clarifications or revisions to obtain approval.
- 1.9 PROJECT RECORD DOCUMENTS
- A. Submit as built drawings locating devices and conductor runs.
  - B. Record of field tests of system.
  - C. Submit manufacturer's certificate that system meets or exceeds specified requirements.
- 1.10 OPERATION, MAINTENANCE DATA, AND CALCULATIONS
- A. Provide to the Owner's representative operating instructions, maintenance, and repair procedures.
  - B. After installation, include manufacturer representative's letter stating that system is operational.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Delivery, storage and handling of products will take place under the contract terms of each project in the construction phase of each project.

1.12 EXTRA MATERIALS

- A. Provide spare parts to the Owner's representative as noted below:
  - 1. Two keys of each type (for each project).
  - 2. Two smoke detectors (for each project).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. National Time & Signal (Expand the existing 902 FACP as required at each school).

2.2 FIRE ALARM CONTROL PANEL (FACP).

- A. General: Comply with UL 864, "Control Units for Fire-Protective Signaling Systems."
- B. Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures. Accommodate all components and allow ample gutter space for interconnection of units as well as field wiring. Identify each enclosure by an engraved, red-laminated, phenolic resin nameplate. Lettering on the enclosure nameplate shall not be less than 1-inch high.
- C. Systems: Alarm and supervisory systems are separate and independent in the FACP. The alarm-initiating zone boards in the FACP consist of plug-in modules. Construction requiring removal of field wiring for module replacement is not acceptable.
- D. Control Modules: Types and capacities required to perform all functions of the fire alarm systems plus 20% for future expansion. Local visible, and audible signals notify of alarm, supervisory, and trouble conditions
- E. Zones: Provide for all alarm and supervisory zones indicated.
- F. Resetting: Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm or trouble condition still exists.
- G. Alphanumeric Display and System Controls: Arrange to provide the basic interface between human operator at FACP and addressable system components, including annunciation, supervision, and control. A display with a minimum of 80 characters displays alarm, supervisory, and component status messages and indicates control commands to be entered into the system for control of smoke detector sensitivity and other parameters. Arrange keypad for use in entering and executing control commands.
- H. System power supplies including necessary transformers, regulators, filters and surge protection required for system operation.

- I. System processor, with internal operating system to process incoming alarm signals and issue output commands required as a result of the alarm signals and issue output. Total system response time shall not exceed 2.5 seconds on a system configured to the 3000 point capacity. All system processors shall be supervised by individual watchdog circuitry furnishing automatic restart after loss of activity. Systems with single watchdog circuits for all processors will not be accepted unless furnished with a standby CPU.
- J. A limited energy output circuit for operation of direct current (DC) audible or visual devices, leased line or city tie, shall be provided by a controllable signal module.
- K. Where control of operations requiring switching functions is indicated, there shall be provided a software controlled relay module.
  - 1. Motherboards shall be furnished as the system bus furnishing systems communications to the various plug in modules necessary for system operations.
- L. **Remote Station Signal Transmitter: Electrically supervised, capable of transmitting contact I.D. and point annunciation signals over a communication means to remote central station receiver (Audio Sentry Corporation). The electrical contractor/National Time & Signal shall coordinate all requirements with John Romano at Audio Sentry Corporation: 586-294-2941. Note: Both National Time & Signal and Audio Sentry shall be sub-contracted by the electrical contractor. Include all costs in bid. Note: this is for both Hamilton Elementary and International Academy.**

#### 2.3 REMOTE FIRE ALARM ANNUNCIATOR PANEL

- A. Provide remote annunciation and control using an 80 character, back-lit, alphanumeric, LCD readout. Alarm indication shall be identical to that at the main FACP including tone alert. Provide a minimum of four programmable control switches, alarm silence and system reset.
- B. Provide brushed aluminum trim plate.

#### 2.4 EMERGENCY POWER SUPPLY

- A. General: Components include battery, charger, and an automatic transfer switch.
- B. Battery: Sealed lead-acid or nickel cadmium type. Provide sufficient capacity to operate the complete alarm system in normal or supervisory (non-alarm) mode for a period of 24 hours. Following this period of operation on battery power, the battery shall have sufficient capacity to operate all components of the system, including all alarm indicating devices in alarm of supervisory mode for a period of 15 minutes.
- C. Magnetic door holders are not served by emergency battery power. Magnetic door holders are released after 15 seconds when normal power fails.

#### 2.5 SMOKE DETECTORS, INTELLIGENT ADDRESSABLE

- A. Furnish and install where indicated on the drawings intelligent analog smoke detectors with features and characteristics as follows:
  - 1. Photoelectric detectors shall be listed for use as open area protective coverage, in duct installation and shall be insensitive to air velocity changes.

- a. The control panel shall provide a sensitivity readout for all detectors without removal from the pluggable base. Detectors not listed for sensitivity testing and logging from the control panel are not acceptable.
  - b. Detectors shall be operational with relay bases (as applicable), audible bases, and remote indicating LED's, programmable by the control panel and controlled by the detector electronics.
- B. Provide smoke detectors above fire alarm control panel, remote annunciator panels, and remote notification appliance power supply panels.
- C. Provide smoke detectors with auxiliary set of contacts where required.

## 2.6 THERMAL DETECTOR, INTELLIGENT ADDRESSABLE

- A. The intelligent thermal detectors shall be of the rate compensated fixed temperature type and shall be listed by Underwriters Laboratories, Inc. The intelligent thermal detectors shall be individually annunciated on the control panel. The intelligent thermal detectors shall contain an integral alarm lamp.

## 2.7 DUCT SMOKE DETECTORS

- A. The air duct detector shall be listed by Underwriters Laboratories, Inc. The air duct detector shall operate on a cross-sectional air sampling principle to overcome stratification and the skin effect. The air duct detector shall consist of a standard (intelligent/analog) photoelectric detector mounted in an air duct sampling assembly and sampling tube that protrudes across the duct of the ventilating system. The air duct detector shall retain the features of the intelligent/analog photoelectric detector, and be installed in the ventilating duct as indicated in the manufacturer's instructions. Provide with addressable control module. Relay based duct detectors not acceptable.
- B. The duct mounted detector shall have an auxiliary set of contacts in order for the temperature controls contractor to tie in the starter of the fans. Contacts shall be rated 1A, 120V.

## 2.8 DUCT SMOKE DETECTOR REMOTE ALARM INDICATORS

- A. Provide remote alarm indicator station for duct smoke detectors located above ceilings or in other locations above 10 feet and/or not readily accessible.
- B. Provide LED alarm indicator designed for mounting in a single gang coverplate.

## 2.9 MANUAL STATIONS, INTELLIGENT

- A. Provide single action intelligent manual stations where shown on the drawings, to be flush or surface mounted as required.
  - 1. The manual stations shall be addressable and identifiable by the fire alarm control panel.
    - a. Address assignments shall be set mechanically or electronically and reside within the station in non volatile memory.

2.10 ADDRESSABLE INTERFACE MODULE

- A. Provide for integration of compatible two wire and shorting style contact devices into the analog signaling circuit. Intelligent analog signaling circuit interface module shall have the following capabilities:
1. Communication interaction with the analog signaling circuit having the capability of reporting alarm or trouble conditions from the devices monitored.
  2. Compatibility with ionization, photoelectric, and linear beam style smoke detectors, heat detectors, and all listed contact type devices.
  3. The module shall be addressable and identifiable by the control panel.
    - a. Address assignments shall be set mechanically or electronically and reside within the module in non volatile memory.
  4. Water Flow Switches: The water flow switches shall be provided by the mechanical contractor and wired by the electrical contractor. The switches shall be connected to the fire alarm system through the use of addressable interface modules.
  5. Tamper Switches: The tamper switches shall be provided by the mechanical contractor and wired by the electrical contractor. The switches shall be connected to the fire alarm system through the use of addressable interface modules.
  6. Provide addressable interface modules to uniquely identify each flow and tamper switch.

2.11 ADDRESSABLE CONTROL MODULE

- A. Provide for integration of auxiliary control functions into the analog signaling circuit. Intelligent analog signaling circuit control module shall have the following capabilities:
1. Communication interaction with the analog signaling circuit having the capability of initiating a control function to an auxiliary device based on a specified event.
  2. Provide NO/NC contact pairs rated at 2 amps 120 VAC or 24 VDC.

2.12 AUDIO VISUAL DEVICES

- A. Alarm Strobes (Visual): Visual alarm signals shall be furnished with minimum light intensity of 15cd average (horizontal and vertical distribution listed in accordance with UL 1971) and meet A.D.A. 75cd minimum intensity at horizontal and vertical axis and shall comply with the following:
1. Xenon strobe with minimum repetition rate of 1 HZ, not exceeding 2 HZ and a maximum duty cycle of 40% with a pulse duration of .2 seconds.
  2. Unfiltered or clear white light not exceeding 1000 candela.
  3. Visual signals shall be mounted at 96 inches above finish floor level, or six inches below ceiling level whichever is lower in accordance with NFPA 72, 1996. Provide wall mounted or ceiling mounted devices, as indicated on plans.
  4. Visual signals shall flash in synchronization in all corridors and in rooms where more than one strobe is installed.

- B. Alarm Horns: The alarm horns shall be of the polarized 24 VDC type. The mechanisms shall contain an aerospace grade aluminum diaphragm, tempered and polished armature, and tungsten contact point, all housed in a red die-cast frame and grill assembly. Horns shall have an integral strobe light that will flash during an alarm. Horns shall have a minimum sound level of 93 dB at 10 feet.
- C. Combination notification appliances (horn/strobe) consist of factory-combined, audible and visual notification units in a single mounting assembly. Provide wall mounted or ceiling mounted devices, as indicated on plans.
- D. Audible devices shall be furnished to provide minimum of 15 db above ambient sound levels. Maximum sound levels shall not exceed 120 db, provisions shall be made to adjust the audible levels accordingly.

## 2.13 AUXILIARY DEVICES

- A. Door Release: Magnetic door holder with integral diodes to reduce buzzing, 24 VDC coil voltage.

## 2.14 WIRE AND CABLE

- A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.
- B. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.
  - 1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70 Article 760, Classification CI, for power-limited fire alarm signal service. UL listed as Type FPL, and complying with requirements in UL 1424 and in UL 2196 for a 2-hour rating.
- C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
  - 1. Low-Voltage Circuits: No. 16 AWG, minimum.
  - 2. Line-Voltage Circuits: No. 12 AWG, minimum

## PART 3 - EXECUTION

### 3.1 WARRANTY

- A. All equipment and systems shall be warranted by the contractor for a period of two years following acceptance. The warranty shall include parts, labor, prompt field service, pick-up and delivery.
- B. Provide two years testing and maintenance, which shall consist of:
  - 1. Regularly and systematically examining all detectors, manual stations, panels, relays, pressure switches and accessories pertaining to the system.
  - 2. Regularly and systematically examine, adjust and clear all the electrical and mechanical components of water flow switches.
  - 3. Tests and written reports which certify that all initiating devices have been tested and which indicate the result of the inspection test as required by the authority having jurisdiction.



3.2 TESTS AND REPORTS

- A. The contractor shall perform all electrical and mechanical tests required by the equipment manufacturer's certification form. In addition, they shall measure and adjust each of the ionization detectors to the maximum stable sensitivity setting. This must be performed with the detector at its operational location and under normal operational environmental conditions in the area. Bench settings are not acceptable. All test and report costs shall be in the unit price established for each device. A checkout report shall be prepared by the installation technicians and submitted in triplicate, one copy of which will be registered with the equipment manufacturer. The report shall include, but not be limited to:
  - 1. A complete list of equipment installed and wired.
  - 2. Indication that all equipment is properly installed and functions and conforms with these specifications.
  - 3. Test of individual zones as applicable.
  - 4. Serial numbers, locations by zone and model number for each installed detector.
  - 5. Voltage (sensitivity) settings for each ionization and photoelectric detector as measured in place with the HVAC system operating.
  - 6. Response time on thermostats and flame detectors (if used).
  - 7. Technician's name, certificate number and date.
- B. After completion of all the tests and adjustments listed above, the contractor shall submit the following information to the Architect:
  - 1. "As-built" conduit layout diagrams including wire color code and/or tag number.
  - 2. Complete "as-built" wiring diagrams.
  - 3. Detailed catalog data on all installed system components.
  - 4. Copy of the test report.
- C. Final tests and inspection shall be held in the presence of engineer. The contractor shall supply personnel and required auxiliary equipment for this test without additional cost.
- D. The completed smoke detection system shall be tested to insure that it is operating properly. Acceptance of the system shall also require a demonstration of the stability of the system. This shall be adequately demonstrated if the system operates for a ninety (90) day test period.
- E. Before final acceptance of work, the contractor shall deliver five copies of a composite "Operating and Shop Maintenance Manual." Each manual shall contain, but not be limited to: a statement of guarantee including date of termination and name and phone number of the person to be called in the event of equipment failure.
- F. Individual factory issued manuals shall contain all technical information on each piece of equipment installed. In the event such manuals are not obtainable from the factory, it shall be the responsibility of the contractor to compile and include them. Advertising brochures or operational instructions shall not be used in lieu of the required technical manuals.

3.3 INSTALLATION

- A. Control and other panels shall be mounted with sufficient clearance for observation and testing.
- B. All fire alarm junction boxes must be clearly marked for easy identification as indicated in 16195. All wiring shall be in conduit unless noted otherwise on the contract documents or in the specifications. Flexible connectors shall be used for all devices mounted in suspended lay-in ceiling panels. All conduit, mounting boxes, junction boxes and panels shall be securely hung and fastened with appropriate fittings to insure positive grounding throughout the entire system.
- C. Fire alarm pull stations and horns installed in finished areas shall be mounted semi-flush and may be surface mounted in non-finished areas. Smoke detectors and thermal detectors shall be mounted on a recess mounted junction box in finished areas and to surface mounted junction boxes in non-finished areas.
- D. No wiring other than that directly associated with fire alarm detection, alarm or auxiliary fire protection functions shall be permitted in fire alarm conduits. Wiring splices are to be avoided to the extent possible, and if needed they must be made only in junction boxes and shall be crimp connected. Transposing or changing color coding of wires shall not be permitted. Wire nut-type connections are not acceptable. All conductors in conduit containing more than one wire shall be labeled on each end with "E-Z markers" or equivalent. Conductors in cabinets shall be carefully formed and harnessed so that each drops off directly opposite to its terminal. Cabinet terminals shall be numbered and coded. All controls, function switches, etc., shall be clearly labeled on all equipment panels. All wiring shall be checked and tested to insure that there are no grounds, opens or shorts.
- E. Install manual station flush mounted with operating handle 48 inches maximum above floor. Install audible and visual signal devices no more than 96 inches above highest floor level within the space or 6 inches below the ceiling, whichever is lower.
- F. Mount outlet box for electric door holder to withstand 80 pounds pulling force.
- G. Make conduit and wiring connections to door release devices, sprinkler flow switches, sprinkler valve tamper switches, panels, duct smoke detectors, and other auxiliary supervised devices.
- H. Automatic Detector Installation: NFPA 72.
- I. All gymnasiums and locker rooms fire alarm devices shall be provided with protective wire guards.
- J. Fire alarm system cable shall be plenum rated, with red outer coloring. All cable drops to devices shall be in conduit (concealed in walls). Cabling installed in open ceiling spaces shall be type FPLP, low smoke, fire resistant, with red coloring. Cabling shall be per manufacturer's recommendation, and shall be able to power the strobes and horn/strobes together, or independently.
- K. Install fire alarm cable in ceiling spaces to avoid damage. Use bridle rings and other similar means of support (lay-in ceiling areas).
- L. Cabling to the Fire Alarm Control Panel and drops to devices shall be in recessed conduit.
- M. Fire alarm cabling in exposed ceiling spaces and above drywall ceiling areas shall be in conduit. Conduit used for fire alarm system shall have couplings and junction boxes painted red.

**\*\*END OF SECTION\*\***