# CITY OF MADISON FIRE STATION

## 1100 MARY MAGNAN BLVD
## MADISON, GA 30650

RFP 2027-3500-01

ATTACHMENT B

Prepared by
2WR of Georgia
11 9th Street, Suite 120
Columbus, Georgia 31901
Project Number 25-02527

**SECTION 000102**
**PROJECT INFORMATION**

## PART 1 GENERAL

### 1.01 PROJECT IDENTIFICATION

A. Project Name: Fire Station #22 for Madison, Georgia

B. Project Number 25-02527

Mary Magan Boulevard, Madison, Georgia 30650

C. The Owner, hereinafter referred to as Owner: City of Madison

D. Owner's Project Manager: Laurinda Mason, Procurement Agent

### 1.02 PROJECT DESCRIPTION

A. Summary Project Description: Construction of a new fire station..

B. Contract Scope: Construction.

### 1.03 PROJECT CONSULTANTS

A. The Architect, hereinafter referred to as Architect: 2WR of Georgia.
   1. Address: 11 Ninth Street, Suite 120.
   2. City, State, Zip: Columbus, GA 31901.
   3. Phone/Fax: 706-571-6923.
   4. E-mail: Alex@2wrarch.com.

### 1.04 PROCUREMENT DOCUMENTS

A. Availability of Documents: Complete sets of procurement documents may be obtained:
   1. From Owner at the Owner's Procurement website.

## PART 2 PRODUCTS - NOT USED

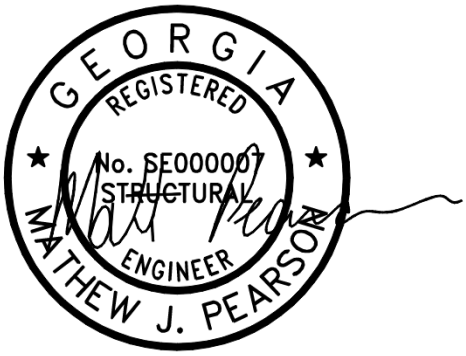
## PART 3 EXECUTION - NOT USED

**END OF SECTION**

**SECTION 000107**
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**END OF SECTION**







SIGN: 08-31-2026
EXPIRES: 12-31-2026

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**SECTION 004323**
**ALTERNATES FORM**

**PARTICULARS**

**1.01 THE FOLLOWING IS THE LIST OF ALTERNATES REFERENCED IN THE BID SUBMITTED BY:**

**1.02 (BIDDER) _____**

**1.03 TO (OWNER ): CITY OF MADISON**

**1.04 DATED _____ AND WHICH IS AN INTEGRAL PART OF THE BID FORM.**

**ALTERNATES LIST**

**2.01 THE FOLLOWING AMOUNTS SHALL BE DEDUCTED FROM THE BID AMOUNT. REFER TO SECTION 012300 - ALTERNATES.**

**ALTERNATE # 1: (DEDUCT) $ _____**

**ALTERNATE # 2: (DEDUCT) $ _____**

**ALTERNATE # 3: (DEDUCT) $ _____**

**ALTERNATE # 4: (DEDUCT) $ _____**

**ALTERNATE # 5: (DEDUCT) $ _____**

**END OF SECTION**

**SECTION 005200**
**AGREEMENT FORM**

**PART 1 GENERAL**

**1.01 FORM OF AGREEMENT**

**1.02 THE AGREEMENT TO BE EXECUTED IS ATTACHED FOLLOWING THIS PAGE.**

**1.03 MODIFICATIONS TO THE AGREEMENT FORM**

**PART 2 PRODUCTS (NOT USED)**

**PART 3 EXECUTION (NOT USED)**

**END OF SECTION**

**SECTION 011000**
**SUMMARY**

## PART 1 GENERAL

### 1.01 PROJECT

A. Project Name: 25-02527 Madison GA Fire Station

B. Owner's Name: City of Madison.

C. Architect's Name: 2WR of Georgia

D. The Project consists of the construction of a new Fire Station for the City of Madison, Georgia.

### 1.02 CONTRACT DESCRIPTION

A. Contract Type: A single prime contract based on a Stipulated Price as described in Document 005200 - Agreement Form.

### 1.03 WORK BY OWNER

A. Items noted NIC (Not in Contract) will be supplied and installed by Owner before Date of Substantial Completion. Some items include:
   1. Furnishings.
   2. Small equipment.

B. Owner will supply and install the following:
   1. Security System.
   2. Stainless steel work table.
   3. (2) Gear Drier Systems.
   4. Arctic Compressed Air System.
   5. Exercise equipment.
   6. (3) Dorm room size refrigerators.

C. Owner will supply the following for installation by Contractor:
   1. Hose Drier System.
   2. Wall Mounted TV's.

### 1.04 OWNER OCCUPANCY

A. Owner intends to occupy the Project upon Substantial Completion.

B. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.

C. Schedule the Work to accommodate Owner occupancy.

### 1.05 CONTRACTOR USE OF SITE AND PREMISES

A. Construction Operations: Limited to site.
   1. Locate and conduct construction activities in ways that will limit disturbance to site.

B. Arrange use of site and premises to allow:
   1. Work by Others.
   2. Work by Owner.

C. Provide access to and from site as required by law and by Owner:
   1. Emergency Building Exits During Construction: Keep all exits required by code open during construction period; provide temporary exit signs if exit routes are temporarily altered.
   2. Do not obstruct roadways, sidewalks, or other public ways without permit.

**END OF SECTION**

# SECTION 012100
# ALLOWANCES

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Cash allowances.

### 1.02 CASH ALLOWANCES

A. Costs Included in Cash Allowances: Cost of product to Contractor or subcontractor, less applicable trade discounts Include delivery, applicable taxes, and installation costs.

B. Contractor Responsibilities:
   1. On notification of which products have been selected, execute purchase agreement with designated supplier and installer.
   2. Arrange for and process shop drawings, product data, and samples. Arrange for delivery.
   3. Promptly inspect products upon delivery for completeness, damage, and defects. Submit claims for transportation damage.

C. Differences in costs will be adjusted by Change Order.

### 1.03 ALLOWANCES SCHEDULE

A. Include the stipulated sum of $40,000.00 for purchase and delivery of Gear Washer Extractor - Basis of Design: Continental Girbau RMG033 - 33 Pound.

## PART 2 PRODUCTS - NOT USED

## PART 3 EXECUTION - NOT USED

**END OF SECTION**

# SECTION 012200
# UNIT PRICES

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. List of unit prices, for use in preparing Bids.

B. Measurement and payment criteria applicable to Work performed under a unit price payment method.

C. Defect assessment and non-payment for rejected work.

### 1.02 RELATED REQUIREMENTS

A. Section 012000 - Price and Payment Procedures: Additional payment and modification procedures.

### 1.03 COSTS INCLUDED

A. Unit Prices included on the Bid Form shall include full compensation for all required labor, products, tools, equipment, plant, transportation, services and incidentals; erection, application or installation of an item of the Work; overhead and profit.

### 1.04 MEASUREMENT OF QUANTITIES

A. Take all measurements and compute quantities. Measurements and quantities will be verified by Owner's testing agency.

B. Assist by providing necessary equipment, workers, and survey personnel as required.

C. Measurement by Volume: Measured by cubic dimension using mean length, width and height or thickness.

### 1.05 PAYMENT

A. Payment for Work governed by unit prices will be made on the basis of the actual measurements and quantities of Work that is incorporated in or made necessary by the Work and accepted by the Architect, multiplied by the unit price.

B. Payment will not be made for any of the following:
   1. Products wasted or disposed of in a manner that is not acceptable.
   2. Products determined as unacceptable before or after placement.
   3. Products remaining on hand after completion of the Work.
   4. Loading, hauling, and disposing of rejected Products.

### 1.06 DEFECT ASSESSMENT

A. Replace Work, or portions of the Work, not complying with specified requirements.

### 1.07 SCHEDULE OF UNIT PRICES

A. Item: Structural Fill per Cubic Yard.

B. Item: Removal and disposal of bad soils per Cubic Yard.

## PART 2 PRODUCTS - NOT USED

## PART 3 EXECUTION - NOT USED

**END OF SECTION**

# SECTION 012300
# ALTERNATES

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Description of Alternates.

B. Procedures for pricing Alternates.

C. Documentation of changes to Contract Sum and Contract Time.

### 1.02 RELATED REQUIREMENTS

A. Document 004323 - Alternates Form: List of Alternates as supplement to Bid Form.

### 1.03 ACCEPTANCE OF ALTERNATES

A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at Owner's option. Accepted Alternates will be identified in the Owner-Contractor Agreement.

B. Coordinate related work and modify surrounding work to integrate the Work of each Alternate.

### 1.04 SCHEDULE OF ALTERNATES

A. Deductive Alternate No. 1 :
   1. Base Bid Item: Four Fold Sectional doors at front of apparatus bay. Replace with overhead sectional door similar to rear of apparatus bay.

B. Deductive Alternate No. 2:
   1. Base Bid Item: Credit for removing two 10'-0" diameter Essence High Velocity Fans. Provide all wiring, circuitry, and switch plates , etc for future installation of fans.

C. Deductive Alternate No. 3:
   1. Base Bid Item: Provide credit for matrerial and installation of Wardrobe Lockers within Dorm rooms.

D. Deductive Alternate No. 4:
   1. Base Bid Item: Credit for Gear Extractor equipment. Provide all wiring, circuitry, etc for future installation of Gear Extractor

## PART 2 PRODUCTS - NOT USED

## PART 3 EXECUTION - NOT USED

**END OF SECTION**

**SECTION 012600**
**CONTRACT MODIFICATION PROCEDURES**

## PART 1 GENERAL

### 1.01 SUMMARY

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

### 1.02 MINOR CHANGES IN THE WORK

A. Architect will issue through Construction Manager supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710 form included in Project Manual.

### 1.03 PROPOSAL REQUESTS

A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
   1. Work Change Proposal Requests issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
   2. Within time specified in Proposal Request or 20 days, when not otherwise specified, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
      a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
      b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
      c. Include costs of labor and supervision directly attributable to the change.
      d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

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

### 1.04 CHANGE ORDER PROCEDURES

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

**PART 2 PRODUCTS (NOT USED)**

**PART 3 EXECUTION (NOT USED)**

**END OF SECTION**

**SECTION 012900**
**PAYMENT PROCEDURES**

## PART 1 GENERAL

### 1.01 SUMMARY

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

### 1.02 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.
   1. Coordinate line items in the schedule of values with items required to be indicated as separate activities in Contractor's construction schedule.
   2. Submit the schedule of values to Architect at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment.

B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.
   1. Identification: Include the following Project identification on the schedule of values:
      a. Project name and location.
      b. Owner's name.
      c. Owner's Project number.
      d. Name of Architect.
      e. Architect's Project number.
      f. Contractor's name and address.
      g. Date of submittal.
   2. Arrange schedule of values consistent with format of AIA Document G703.
   3. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
   4. Schedule of Values Revisions: Revise the schedule of values when Change Orders or Construction Change Directives result in a change in the Contract Sum. Include at least one separate line item for each Change Order and Construction Change Directive.

### 1.03 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments, as certified by Architect and paid for by Owner.

B. Payment Application Times: The date for each progress payment is indicated in the Owner/Contractor Agreement. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.

C. Application for Payment Forms: Use AIA Document G703 and AIA Document G732 as form for Applications for Payment.
   1. Other Application for Payment forms proposed by the Contractor may be acceptable to Architect and Owner. Submit forms for approval with initial submittal of schedule of values.

D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.
   1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
   2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
   3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

4. Indicate separate amounts for work being carried out under Owner-requested project acceleration.

E. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.
   1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment for stored materials.
   2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
   3. Provide summary documentation for stored materials indicating the following:
      a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
      b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
      c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

F. Transmittal: Submit three signed and notarized original copies of each Application for Payment to Architect by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.
   1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

G. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from entities lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment subcontractors, sub-subcontractors, and suppliers for construction period covered by the previous application.
   1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
   2. When an application shows completion of an item, submit conditional final or full waivers.
   3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
   4. Submit final Application for Payment with or preceded by conditional final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
   5. Waiver Forms: Submit executed waivers of lien on forms acceptable to Owner.

H. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
   1. List of subcontractors.
   2. Schedule of values.
   3. Contractor's construction schedule (preliminary if not final).
   4. Combined Contractor's construction schedule (preliminary if not final) incorporating Work of multiple contracts, with indication of acceptance of schedule by each Contractor.
   5. Products list (preliminary if not final).
   6. Sustainable design action plans, including preliminary project materials cost data.
   7. Schedule of unit prices.
   8. Submittal schedule (preliminary if not final).
   9. List of Contractor's staff assignments.
   10. List of Contractor's principal consultants.
   11. Copies of building permits.
   12. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
   13. Initial progress report.
   14. Report of preconstruction conference.

15. Certificates of insurance and insurance policies.
16. Performance and payment bonds.
17. Data needed to acquire Owner's insurance.

I. Application for Payment at Substantial Completion: After Architect issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
   1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
      a. Complete administrative actions, submittals, and Work preceding this application, as described in Section 017700 "Closeout Procedures."
   2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

J. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
   1. Evidence of completion of Project closeout requirements.
   2. Certification of completion of final punch list items.
   3. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
   4. Updated final statement, accounting for final changes to the Contract Sum.
   5. AIA Document G706.
   6. AIA Document G706A.
   7. AIA Document G707.
   8. Evidence that claims have been settled.
   9. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
   10. Final liquidated damages settlement statement.
   11. Proof that taxes, fees, and similar obligations are paid.
   12. Waivers and releases.

**PART 2 PRODUCTS (NOT USED)**

**PART 3 EXECUTION (NOT USED)**

**END OF SECTION**

**SECTION 013100**
**PROJECT MANAGEMENT AND COORDINATION**

## PART 1 GENERAL

### 1.01 SUMMARY

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

B. Related Requirements:
   1. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
   2. Section 019113 "General Commissioning Requirements" for coordinating the Work with Owner's Commissioning Authority.

### 1.02 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.
   1. Schedule construction operations in sequence required to obtain the best results, where installation of one part of the Work depends on installation of other components, before or after its own installation.
   2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
   3. Make adequate provisions to accommodate items scheduled for later installation.

B. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
   1. Preparation of Contractor's construction schedule.
   2. Preparation of the schedule of values.
   3. Installation and removal of temporary facilities and controls.
   4. Delivery and processing of submittals.
   5. Progress meetings.
   6. Preinstallation conferences.
   7. Project closeout activities.
   8. Startup and adjustment of systems.

### 1.03 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
   1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
      a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.

b. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

B. Coordination Drawing Organization: Organize coordination drawings as follows:
1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
2. Review: Architect will review coordination drawings to confirm that, in general, the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make suitable modifications and resubmit.

C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
1. File Preparation Format:
a. Same digital data software program, version, and operating system as original Drawings.
b. DWG, Version, operating in Microsoft Windows operating system.
2. File Submittal Format: Submit or post coordination drawing files using PDF format.

**1.04 REQUEST FOR INFORMATION (RFI)**

A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
1. Architect will return without response those RFIs submitted to Architect by other entities controlled by Contractor.
2. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Project name.
2. Owner name.
3. Name of Architect
4. Architect's Project number.
5. Date.
6. Name of Contractor.
7. RFI number, numbered sequentially.
8. RFI subject.
9. Specification Section number and title and related paragraphs, as appropriate.
10. Drawing number and detail references, as appropriate.
11. Field dimensions and conditions, as appropriate.
12. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
13. Contractor's signature.
14. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

C. RFI Forms: AIA Document G716.

1. Attachments shall be electronic files in PDF format.

D. Architect's and Construction Manager's Action: Architect will review each RFI, determine action required, and respond. Allow three days for Architect's response for each RFI. RFIs received by Architect or Construction Manager after 1:00 p.m. will be considered as received the following working day.
   1. The following Contractor-generated RFIs will be returned without action:
      a. Requests for approval of submittals.
      b. Requests for approval of substitutions.
      c. Requests for approval of Contractor's means and methods.
      d. Requests for coordination information already indicated in the Contract Documents.
      e. Requests for adjustments in the Contract Time or the Contract Sum.
      f. Requests for interpretation of Architect's actions on submittals.
      g. Incomplete RFIs or inaccurately prepared RFIs.
   2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt by Architect or Construction Manager of additional information.
   3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."
      a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect and Construction Manager in writing within 5 days of receipt of the RFI response.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Include the following:
   1. Project name.
   2. Name and address of Contractor.
   3. Name and address of Architect and Construction Manager.
   4. RFI number, including RFIs that were returned without action or withdrawn.
   5. RFI description.
   6. Date the RFI was submitted.
   7. Date Architect's and Construction Manager's response was received.

F. On receipt of Architect's and Construction Manager's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect and Construction Manager within three days if Contractor disagrees with response.

## 1.05 DIGITAL PROJECT MANAGEMENT PROCEDURES

A. Architect's Data Files Not Available: Architect will not provide Architect's BIM model CAD drawing digital data files for Contractor's use during construction.

B. PDF Document Preparation: Where PDFs are required to be submitted to Architect, prepare as follows:
   1. Assemble complete submittal package into a single indexed file, incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
   2. Name file with submittal number or other unique identifier, including revision identifier.
   3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

## 1.06 PROJECT MEETINGS

A. General: Construction Manager will schedule and conduct meetings and conferences at Project site unless otherwise indicated.

B. Preconstruction Conference: Construction Manager will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement.

1. Attendees: Authorized representatives of Owner, Construction Manager, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Discuss items of significance that could affect progress, including the following:
    a. Responsibilities and personnel assignments.
    b. Tentative construction schedule.
    c. Phasing.
    d. Critical work sequencing and long lead items.
    e. Designation of key personnel and their duties.
    f. Lines of communications.
    g. Use of web-based Project software.
    h. Procedures for processing field decisions and Change Orders.
    i. Procedures for RFIs.
    j. Procedures for testing and inspecting.
    k. Procedures for processing Applications for Payment.
    l. Distribution of the Contract Documents.
    m. Submittal procedures.
    n. Preparation of Record Documents.
    o. Use of the premises
    p. Work restrictions.
    q. Working hours.
    r. Owner's occupancy requirements.
    s. Responsibility for temporary facilities and controls.
    t. Procedures for moisture and mold control.
    u. Procedures for disruptions and shutdowns.
    v. Construction waste management and recycling.
    w. Parking availability.
    x. Office, work, and storage areas.
    y. Equipment deliveries and priorities.
    z. First aid.
    aa. Security.
    bb. Progress cleaning.
3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other Sections and when required for coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect, Construction Manager of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
    a. Contract Documents.
    b. Options.
    c. Related RFIs.
    d. Related Change Orders.
    e. Purchases.
    f. Deliveries.
    g. Submittals.
    h. Sustainable design requirements.
    i. Review of mockups.

j. Possible conflicts.
k. Compatibility requirements.
l. Time schedules.
m. Weather limitations.
n. Manufacturer's written instructions.
o. Warranty requirements.
p. Compatibility of materials.
q. Acceptability of substrates.
r. Temporary facilities and controls.
s. Space and access limitations.
t. Regulations of authorities having jurisdiction.
u. Testing and inspecting requirements.
v. Installation procedures.
w. Coordination with other work.
x. Required performance results.
y. Protection of adjacent work.
z. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Project Closeout Conference: Construction Manager will schedule and conduct a project closeout conference, at a time convenient to Owner and Architect, but no later than 90 days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.
2. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
a. Preparation of Record Documents.
b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
c. Procedures for completing and archiving web-based Project software site data files.
d. Submittal of written warranties.
e. Requirements for completing sustainable design documentation.
f. Requirements for preparing operations and maintenance data.
g. Requirements for delivery of material samples, attic stock, and spare parts.
h. Requirements for demonstration and training.
i. Preparation of Contractor's punch list.
j. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
k. Submittal procedures.
l. Coordination of separate contracts.
m. Owner's partial occupancy requirements.
n. Installation of Owner's furniture, fixtures, and equipment.
o. Responsibility for removing temporary facilities and controls.
4. Minutes: Entity conducting meeting will record and distribute meeting minutes.

E. Progress Meetings: Construction Manager will conduct progress meetings at monthly intervals.
   1. Coordinate dates of meetings with preparation of payment requests.
   2. Attendees: In addition to representatives of Owner, Construction Manager, and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
   3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
      a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
         1) Review schedule for next period.
      b. Review present and future needs of each entity present, including the following:
         1) Interface requirements.
         2) Sequence of operations.
         3) Status of submittals.
         4) Status of sustainable design documentation.
         5) Deliveries.
         6) Off-site fabrication.
         7) Access.
         8) Site use.
         9) Temporary facilities and controls.
         10) Progress cleaning.
         11) Quality and work standards.
         12) Status of correction of deficient items.
         13) Field observations.
         14) Status of RFIs.
         15) Status of Proposal Requests.
         16) Pending changes.
         17) Status of Change Orders.
         18) Pending claims and disputes.
         19) Documentation of information for payment requests.
   4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
      a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting, where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

**PART 2 PRODUCTS (NOT USED)**

**PART 3 EXECUTION (NOT USED)**

**END OF SECTION**

**SECTION 013200**
**CONSTRUCTION PROGRESS DOCUMENTATION**

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
   1. Contractor's Construction Schedule.
   2. Construction schedule updating reports.
   3. Daily construction reports.

### 1.02 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction Project. Activities included in a construction schedule consume time and resources.
   1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
   2. Predecessor Activity: An activity that precedes another activity in the network.
   3. Successor Activity: An activity that follows another activity in the network.

B. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine the critical path of Project and when activities can be performed.

C. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

D. Event: The starting or ending point of an activity.

E. Float: The measure of leeway in starting and completing an activity.
   1. Float time belongs to Owner.
   2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
   3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

### 1.03 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:
   1. Working electronic copy of schedule file.
   2. PDF file.

B. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
   1. Submit a working digital copy of schedule, using software indicated, and labeled to comply with requirements for submittals.

### 1.04 COORDINATION

A. Coordinate Contractor's Construction Schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.
   1. Secure time commitments for performing critical elements of the Work from entities involved.
   2. Coordinate each construction activity in the network with other activities, and schedule them in proper sequence.

### 1.05 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Substantial Completion.

1. Contract completion date to not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

B. Activities: Treat each floor or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
   1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
   2. Procurement Activities: Include procurement process activities for the following long lead-time items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
   3. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with submittal schedule.
   4. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's and Construction Manager's administrative procedures necessary for certification of Substantial Completion.
   5. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and Final Completion.

C. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
   1. Unresolved issues.
   2. Unanswered Requests for Information.
   3. Rejected or unreturned submittals.
   4. Notations on returned submittals.
   5. Pending modifications affecting the Work and the Contract Time.

D. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
   1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
   2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
   3. As the Work progresses, indicate Final Completion percentage for each activity.

E. Distribution: Distribute copies of approved schedule to Architect, Construction Manager, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
   1. Post copies in Project meeting rooms and temporary field offices.
   2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

**1.06 REPORTS**

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
   1. List of subcontractors at Project site.
   2. List of separate contractors at Project site.
   3. Approximate count of personnel at Project site.
   4. Equipment at Project site.
   5. Material deliveries.
   6. High and low temperatures and general weather conditions, including presence of rain or snow.

7. Testing and inspection.
8. Accidents.
9. Meetings and significant decisions.
10. Stoppages, delays, shortages, and losses.
11. Meter readings and similar recordings.
12. Emergency procedures.
13. Orders and requests of authorities having jurisdiction.
14. Change Orders received and implemented.
15. Construction Work Change Directives received and implemented.
16. Services connected and disconnected.
17. Equipment or system tests and startups.
18. Partial completions and occupancies.
19. Substantial Completions authorized.

B. Material Location Reports: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List to be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:
   1. Material stored prior to previous report and remaining in storage.
   2. Material stored prior to previous report and since removed from storage and installed.
   3. Material stored following previous report and remaining in storage.

C. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

D. Unusual Event Reports: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, responses by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.
   1. Submit unusual event reports directly to Owner within one day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.

**PART 2 PRODUCTS (NOT USED)**

**PART 3 EXECUTION (NOT USED)**

**END OF SECTION**

# SECTION 013233
# PHOTOGRAPHIC DOCUMENTATION

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes administrative and procedural requirements for the following:
   1. Concealed Work photographs.
   2. Periodic construction photographs.
   3. Final Completion construction photographs.

B. Related Requirements:
   1. Section 017700 "Closeout Procedures" for submitting photographic documentation as Project Record Documents at Project closeout.
   2. Section 311000 "Site Clearing" for photographic documentation before site clearing operations commence.

### 1.02 INFORMATIONAL SUBMITTALS

A. Digital Photographs: Submit image files within three days of taking photographs.
   1. Submit photos by uploading to web-based Project management software site. Include copy of key plan indicating each photograph's location and direction.
   2. Identification: Provide the following information with each image description:
      a. Name of Project.
      b. Name and contact information for photographer.
      c. Name of Contractor.
      d. Date photograph was taken.

### 1.03 FORMATS AND MEDIA

A. Digital Photographs: Provide color images in JPG format, produced by a digital camera with minimum sensor size of 12 megapixels, and at an image resolution of not less than 3200 by 2400 pixels. Use flash in low light levels or backlit conditions.

B. Digital Images: Submit digital media as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.

C. Metadata: Record accurate date and time from camera.

D. File Names: Name media files with date Project area and sequential numbering suffix.

### 1.04 CONSTRUCTION PHOTOGRAPHS

A. General: Take photographs with maximum depth of field and in focus.
   1. Maintain key plan with each set of construction photographs that identifies each photographic location.

B. Concealed Work Photographs: Before proceeding with installing work that will conceal other work, take photographs sufficient in number, with annotated descriptions, to record nature and location of concealed Work, including, but not limited to, the following:
   1. Underground utilities.
   2. Under slab services.
   3. Piping.
   4. Electrical conduit.
   5. Waterproofing and weather-resistant barriers.

C. Periodic Construction Photographs: Take 20 photographs weekly. Select vantage points to show status of construction and progress since last photographs were taken.

D. Final Completion Construction Photographs: Take 20 photographs after date of Substantial Completion for submission as Project Record Documents. Architect will inform photographer of desired vantage points.

**PART 2 PRODUCTS (NOT USED)**

**PART 3 EXECUTION (NOT USED)**

**END OF SECTION**

# SECTION 013300
# SUBMITTAL PROCEDURES

## PART 1 GENERAL

### 1.01 SUMMARY

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

### 1.02 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

### 1.03 SUBMITTAL SCHEDULE

A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.

### 1.04 SUBMITTAL FORMATS

A. Submittal Information: Include the following information in each submittal:
   1. Project name.
   2. Date.
   3. Name of Architect.
   4. Name of Construction Manager.
   5. Name of Contractor.
   6. Name of firm or entity that prepared submittal.
   7. Names of subcontractor, manufacturer, and supplier.
   8. Category and type of submittal.
   9. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
   10. Remarks.
   11. Signature of transmitter.

B. Options: Identify options requiring selection by Architect.

C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.

D. Electronic Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.

E. Submittals Utilizing Web-Based Project Software: Prepare submittals as PDF files or other format indicated by Project management software.

### 1.05 SUBMITTAL PROCEDURES

A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

1. Email: Prepare submittals as PDF package and transmit to Architect by sending via email. Include PDF transmittal form. Include information in email subject line as requested by Architect.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
   1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
   2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
   3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
   1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
   2. Resubmittal Review: Allow 15 days for review of each resubmittal.

D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

**1.06 SUBMITTAL REQUIREMENTS**

A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
   1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
   2. Mark each copy of each submittal to show which products and options are applicable.
   3. Include the following information, as applicable:
      a. Manufacturer's product specifications.
      b. Standard color charts.
   4. Submit Product Data before Shop Drawings, and before or concurrently with Samples.

B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
   1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
      a. Identification of products.
      b. Seal and signature of professional engineer if specified.

C. Samples: Submit Samples for review of type, color, pattern, and texture for a check of these characteristics with other materials.
   1. Transmit Samples that contain multiple, related components, such as accessories together in one submittal package.
   2. Identification: Permanently attach label on unexposed side of Samples that includes the following:
      a. Project name and submittal number.
      b. Generic description of Sample.
      c. Product name and name of manufacturer.
      d. Sample source.

e. Number and title of applicable Specification Section.
f. Specification paragraph number and generic name of each item.

3. Email Transmittal: Provide PDF transmittal. Include digital image file illustrating Sample characteristics and identification information for record.
4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
   a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
   b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units, showing the full range of colors, textures, and patterns available.
   a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.

## 1.07 DELEGATED DESIGN SERVICES

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 insufficient to perform services or certification required, submit a written request for additional information to Architect.

B. Delegated Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
   1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

## 1.08 CONTRACTOR'S REVIEW

A. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.

B. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
   1. Architect will not review submittals received from Contractor that do not have Contractor's review and approval.

## 1.09 ARCHITECT'S REVIEW

A. Action Submittals: Architect will review each submittal, indicate corrections or revisions required, and return.
   1. PDF Submittals: Architect will indicate, via markup on each submittal, the appropriate action.

B. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.

C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Architect will return without review submittals received from sources other than Contractor.

F. Submittals not required by the Contract Documents will be returned by Architect without action.

**PART 2 PRODUCTS (NOT USED)**

**PART 3 EXECUTION (NOT USED)**

**END OF SECTION**

**SECTION 014000**
**QUALITY REQUIREMENTS**

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
   1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
   2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
   3. Requirements for Contractor to provide quality-assurance and quality-control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

C. Related Requirements:
   1. Section 012100 "Allowances" for testing and inspection allowances.

### 1.02 DEFINITIONS

A. Experienced: When used with an entity or individual, "experienced," unless otherwise further described, means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

B. Field Quality-Control Tests and Inspections: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, subcontractor, or sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
   1. Use of trade-specific terminology in referring to a Work result does not require that certain construction activities specified apply exclusively to specific trade(s).

D. Mockups: Physical assemblies of portions of the Work constructed to establish the standard by which the Work will be judged. Mockups are not Samples.
   1. Mockups are used for one or more of the following:
      a. Verify selections made under Sample submittals.
      b. Demonstrate aesthetic effects.
      c. Demonstrate the qualities of products and workmanship.
      d. Demonstrate successful installation of interfaces between components and systems.
      e. Perform preconstruction testing to determine system performance.
   2. Product Mockups: Mockups that may include multiple products, materials, or systems specified in a single Section.
   3. In-Place Mockups: Mockups constructed on-site in their actual final location as part of permanent construction.

E. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria. Unless otherwise indicated, copies of reports of tests or inspections performed for other than the Project do not meet this definition.

F. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) in accordance with 29 CFR 1910.7, by a testing agency accredited in

accordance with NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

G. Source Quality-Control Tests and Inspections: Tests and inspections that are performed at the source (e.g., plant, mill, factory, or shop).

H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. The term "testing laboratory" has the same meaning as the term "testing agency."

I. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work, to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

J. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work, to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Architect

## 1.03 REFERENCE STANDARDS

A. 29 CFR 1910 - Occupational Safety and Health Standards; Current Edition.

B. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection; 2026.

C. test - sddds; sdds.

## 1.04 DELEGATED DESIGN SERVICES

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 Architect.

B. Delegated Design Services Statement: Submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

## 1.05 CONFLICTING REQUIREMENTS

A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements is specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, inform the Architect regarding the conflict and obtain clarification prior to proceeding with the Work. Refer conflicting requirements that are different, but apparently equal, to Architect for clarification before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified is the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

## 1.06 ACTION SUBMITTALS

A. Mockup Shop Drawings:
   1. Include plans, sections, elevations, and details, indicating materials and size of mockup construction.
   2. Indicate manufacturer and model number of individual components.
   3. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

### 1.07 INFORMATIONAL SUBMITTALS

A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.

B. Qualification Data: For Contractor's quality-control personnel.

C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:
   1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
   2. Primary wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.

D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
   1. Specification Section number and title.
   2. Entity responsible for performing tests and inspections.
   3. Description of test and inspection.
   4. Identification of applicable standards.
   5. Identification of test and inspection methods.
   6. Number of tests and inspections required.
   7. Time schedule or time span for tests and inspections.
   8. Requirements for obtaining samples.
   9. Unique characteristics of each quality-control service.

F. Reports: Prepare and submit certified written reports and documents as specified.

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

### 1.08 CONTRACTOR'S QUALITY-CONTROL PLAN

A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice to Proceed, and not less than five days prior to preconstruction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities and to coordinate Owner's quality-assurance and quality-control activities. Coordinate with Contractor's Construction Schedule.

B. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
   1. Project quality-control manager.

C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.

D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:
   1. Contractor-performed tests and inspections, including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.

2. Special inspections required by authorities having jurisdiction and indicated on the Statement of Special Inspections.
3. Owner-performed tests and inspections indicated in the Contract Documents.

E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring the Work into compliance with standards of workmanship established by Contract requirements and approved mockups.

F. Monitoring and Documentation: Maintain testing and inspection reports, including log of approved and rejected results. Include Work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming Work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

**1.09 REPORTS AND DOCUMENTS**

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
1. Date of issue.
2. Project title and number.
3. Name, address, telephone number, and email address of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample-taking and testing and inspection.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, telephone number, and email address of technical representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement of whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, telephone number, and email address of factory-authorized service representative making report.
2. Statement that equipment complies with requirements.
3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
4. Statement of whether conditions, products, and installation will affect warranty.

5. Other required items indicated in individual Specification Sections.

**1.10 QUALITY ASSURANCE**

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

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.

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

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

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

F. Specialists: Certain Specification Sections require that specific construction activities be performed by entities who are recognized experts in those operations. Specialists will satisfy qualification requirements indicated and engage in the activities indicated.
   1. Requirements of authorities having jurisdiction supersede requirements for specialists.

G. Testing and Inspecting Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented in accordance with ASTM E329, and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

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

I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect, demonstrate, repair, and perform service on installations of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
   1. Contractor's Responsibilities:
      a. Provide test specimens representative of proposed products and construction.
      b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
      c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
      d. Build site-assembled test assemblies and mockups, using installers who will perform same tasks for Project.
      e. When testing is complete, remove test specimens and test assemblies, do not reuse products on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect, with copy to Contractor. Interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from the Contract Documents.

K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
1. Build mockups of size indicated.
2. Build mockups in location indicated or, if not indicated, as directed by Architect.
3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
4. Employ supervisory personnel who will oversee mockup construction. Employ workers who will be employed to perform same tasks during the construction at Project.
5. Demonstrate the proposed range of aesthetic effects and workmanship.
6. Obtain Architect's approval of mockups before starting corresponding Work, fabrication, or construction.
   a. Allow seven days for initial review and each re-review of each mockup.
7. Promptly correct unsatisfactory conditions noted by Architect's preliminary review, to the satisfaction of the Architect, before completion of final mockup.
8. Approval of mockups by the Architect does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
9. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
10. Demolish and remove mockups when directed unless otherwise indicated.

**1.11 QUALITY CONTROL**

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
2. Payment for these services will be made from testing and inspection allowances specified in Section 012100 "Allowances," as authorized by Change Orders.
3. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
2. Engage a qualified testing agency to perform quality-control services.
   a. Contractor will not employ same entity engaged by Owner, unless agreed to in writing by Owner.
3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
5. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

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

E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

G. Contractor's Associated Requirements and Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
   1. Access to the Work.
   2. Incidental labor and facilities necessary to facilitate tests and inspections.
   3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
   4. Facilities for storage and field curing of test samples.
   5. Delivery of samples to testing agencies.
   6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
   7. Security and protection for samples and for testing and inspection equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.
   1. Schedule times for tests, inspections, obtaining samples, and similar activities.

I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Coordinate and submit concurrently with Contractor's Construction Schedule. Update and submit with each Application for Payment.
   1. Schedule Contents: Include tests, inspections, and quality-control services, including Contractor- and Owner-retained services, commissioning activities, and other Project-required services paid for by other entities.
   2. Distribution: Distribute schedule to Owner, Architect, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

### 1.12 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Owner will engage a qualified special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner and as follows:
   1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
   2. Notifying Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
   3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect with copy to Contractor and to authorities having jurisdiction.
   4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
   5. Interpreting tests and inspections and stating in each report whether tested and inspected Work complies with or deviates from the Contract Documents.
   6. Retesting and reinspecting corrected Work.

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION

### 3.01 TEST AND INSPECTION LOG

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

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's reference during normal working hours.
   1. Submit log at Project closeout as part of Project Record Documents.

### 3.02 REPAIR AND PROTECTION

A. General: On completion of testing, inspection, sample-taking, and similar services, repair damaged construction and restore substrates and finishes.
   1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

**END OF SECTION**

**SECTION 014339**
**MOCKUPS**

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section Includes:
   1. Integrated exterior mockups.

B. Related Requirements:
   1. Section 014000 "Quality Requirements" for quality assurance requirements for aesthetic and workmanship mockups specified in other Sections.

### 1.02 ALLOWANCES

A. See Section 012100 "Allowances" for description of allowances affecting items specified in this Section.

### 1.03 DEFINITIONS

A. Integrated Exterior Mockups: Mockups of the exterior envelope constructed on-site as freestanding temporary built elements, consisting of multiple products, assemblies, and subassemblies.

B. Preconstruction Laboratory Mockups: Integrated exterior mockups constructed at testing facility to verify performance characteristics.

C. Room Mockups: Mockups of typical interior spaces complete with wall, floor, and ceiling finishes; doors; windows; millwork; casework; specialties; furnishings and equipment; and lighting as indicated.

### 1.04 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review coordination of equipment and furnishings provided by the Owner for room mockups.
   2. Review locations and extent of mockups.
   3. Review and finalize schedule for mockups, and verify availability of materials, personnel, equipment, and facilities needed to complete mockups and maintain schedule for the Work.

### 1.05 QUALITY ASSURANCE

A. Build mockups to do the following:
   1. Verify selections made under Sample submittals.
   2. Demonstrate aesthetic effects.
   3. Demonstrate the qualities of products and workmanship.
   4. Demonstrate acceptable coordination between components and systems.

B. Fabrication: Before fabricating or installing portions of the Work requiring mockups, build mockups for each form of construction and finish required. Use materials and installation methods as required for the Work.
   1. Build mockups of size indicated.
   2. Build mockups in location indicated or, if not indicated, as directed by Architect.
   3. Employ supervisory personnel who will oversee mockup construction. Employ workers who will be employed to perform same tasks during the construction at Project.
   4. Demonstrate the proposed range of aesthetic effects and workmanship.
   5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   6. Demolish and remove mockups when directed unless otherwise indicated.

C. Notifications:

1. Notify Architect seven days in advance of the dates and times when mockups will be constructed.
2. Allow seven days for initial review and each re-review of each mockup.

D. Approval: Obtain Architect's approval of mockups before starting fabrication or construction of corresponding Work.
1. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

### 1.06 COORDINATION

A. Coordinate schedule for construction of mockups, so construction, testing, and review of mockups do not impact Project schedule.

## PART 2 PRODUCTS

### 2.01 INTEGRATED EXTERIOR MOCKUPS

A. Construct integrated exterior mockups according to approved mockup Shop Drawings. Construct mockups to demonstrate constructability, coordination of trades, and sequencing of Work; and to ensure materials, components, subassemblies, assemblies, and interfaces integrate into a system complying with indicated performance and aesthetic requirements.

B. Design and construct foundation and superstructure to support free-standing integrated exterior mockups.

C. Build integrated exterior mockups using installers and construction methods that will be used in completed construction.

D. Use specified products that have been approved by Architect. Coordinate installation of materials and products specified in individual Specification Sections that include Work included in integrated exterior mockups.

E. The Work of integrated exterior mockups includes, but is not limited to, the following:
1. Masonry veneer.
2. Air and weather barriers.
3. Thermal insulation.
4. Through-wall flashing.
5. Flashing and sheet metal trim.
6. Joint sealants.
7. Metal wall panels.
8. Aluminum windows.
9. Glazing.

F. Photographic Documentation: Document construction of integrated exterior mockups with photographs in accordance with Section 013233 "Photographic Documentation." Provide photographs showing details of interface of different materials and assemblies.
1. Document testing procedures, including water leakage and other deficiencies. Photograph modifications to component interfaces intended to correct deficiencies.

G. Provide and document modifications to construction details and interfaces between components and systems required to properly sequence the Work, or to pass performance testing requirements. Obtain Architect's approval for modifications.

H. Retain approved mockups constructed in place. Incorporate fully into the Work.

**PART 3 EXECUTION**

**3.01 NOT USED**

**END OF SECTION**

**SECTION 014533**

**CODE REQUIRED SPECIAL INSPECTIONS AND PROCEDURES**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes administrative and procedural requirements required for compliance with the International Building Code, Chapter 17, Structural Tests and Special Inspections.

B. Structural testing and special inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve contractor of responsibility for compliance with other construction document requirements.

1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the construction document requirements.
3. Requirements for contractor to provide quality-assurance and -control services required by architect, owner, or authorities having jurisdiction are not limited by provisions of this section.

C. The owner will engage one or more qualified special inspectors and / or testing agencies to conduct structural tests and special inspections specified in this section and related sections and as maybe specified in other divisions of these specifications.

### 1.3 DEFINITIONS

A. Approved Agency: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved by the building official.

B. Construction Documents: Written, graphic and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the elements of a project necessary for obtaining a building permit. Construction Documents include all supplemental instructions, sketches, addenda, and revisions to the drawings and specifications issued by the registered design professional beyond those issued for a building permit.

C. Shop Drawings / Submittal Data: Written, graphic and pictorial documents prepared and / or assembled by the contractor based on the Construction Documents.

D. Structural Observation: Visual observation of the structural system by a representative of the registered design professional’s office for general conformance to the approved construction

documents. Structural observations are not considered part of the structural tests and special inspections and do not replace inspections and testing by the testing agency or special inspector.

E. Special Inspector: A qualified person who demonstrating competence, to the satisfaction of the code enforcement official and registered design professional in responsible charge, for inspection of the particular type of construction or operation requiring special inspection. The special inspector shall be a licensed professional engineer or engineering intern or a qualified representative from the testing agency.

F. Special Inspection, Continuous: The full-time observation of work requiring special inspection by an approved special inspector who is present in the area where the work is being performed.

G. Special Inspection, Periodic: The part-time or intermittent observation of work requiring special inspection by an approved special inspector who is present in the area where the work has been or is being performed and at the completion of the work.

H. Testing Agency: A qualified materials testing laboratory under the responsible charge of a licensed professional engineer, approved by the code enforcement official and the registered design professional in responsible charge, to measure, examine, test, calibrate, or otherwise determine the characteristics or performance of construction materials and verify confirmation with construction documents.

## 1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications:
   1. Minimum qualifications of inspection and testing agencies and their personnel shall comply with ASTM E329-03 Standard Specification for Agencies in the Testing and / or Inspection of Materials Used in Construction.
      a. Inspectors and individuals performing tests shall be certified for the work being performed as outlined in the appendix of the ASTM E329. Certification by organizations other than those listed must be submitted to the building official for consideration before proceeding with work.
   2. In addition to these requirements, local jurisdiction may have additional requirements. It is the responsibility of the testing and inspection agencies to meet local requirements and comply with local procedures.

## 1.5 CONFLICTING REQUIREMENTS, REPORTS, AND TEST RESULTS

A. General: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to the registered design professional in responsible charge for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to the registered design profession in responsible charge for a decision before proceeding.

C. The special inspector's reports and testing agencies' results shall have precedence over reports and test results provided by the contractor.

D. Where a conflict exists between the construction documents and approved shop drawings / submittal data, the construction documents shall govern unless the shop drawings / submittal data are more restrictive. All conflicts shall be brought to the attention of the registered design professional in responsible charge.

## 1.6 SUBMITTALS BY SPECIAL INSPECTOR AND / OR TESTING AGENCY

A. Special inspectors shall keep and distribute records of inspections. The special inspector shall furnish inspection reports to the building official, and to the registered design professional in responsible charge, contractor, architect, and owner. Reports shall indicate that work inspected was done in conformance to approved construction documents. Discrepancies shall be brought to the immediate attention of the contractor for correction. If the discrepancies are not corrected, the discrepancies shall be brought to the attention of the building official and to the registered design professional in responsible charge prior to the completion of that phase of the work. A final report documenting required special inspections and correction of any discrepancies noted in the inspections shall be submitted at a point in time agreed upon by the permit applicant and the building official prior to the start of work.
   1. Special inspection reports and test results shall include, but not be limited to, the following:
      a. Date of inspection.
      b. Description of inspections or tests performed including location (reference grid lines, floors, elevations, etc.).
      c. Statement noting that the work, material, and / or product conforms or does not conform to the construction document requirements.
         1) Name and signature of contractor's representative who was notified of work, material, and / or products that do not meet the construction document requirements.
      d. Name and signature of special inspector and / or testing agency representative performing the work.

B. Schedule of Non-Compliant Work: Each agent shall maintain a log of work that does not meet the requirements of the construction documents. Include reference to original inspection / test report and subsequent dates of re-inspection / retesting.

C. Reports and tests shall be submitted within 1 week of inspection or test. Schedule of Non-Compliant Work shall be updated daily and submitted at monthly intervals.

D. Final Report of Special Inspections. Submitted by each agent listed in the schedule of Structural Testing and Special Inspections.

# PART 2 - EXECUTION

## 2.1 CONTRACTOR'S RESPONSIBILITY

A. The contractor shall coordinate the inspection and testing services with the progress of the work. The contractor shall provide sufficient notice to allow proper scheduling of all personnel. The contractor shall provide safe access for performing inspection and on site testing.

B. The contractor shall submit schedules to the owner, registered design professionals and testing and inspecting agencies. Schedules will note milestones and durations of time for materials requiring structural tests and special inspections.

C. Each contractor responsible for the construction of a seismic-force-resisting system, designated seismic system, or component listed in the quality assurance plan shall submit a written contractor's statement of responsibility to the building official and to the owner prior to the commencement of work on the system or component. The contractor's statement of responsibility shall contain the following:
   1. Acknowledgment of awareness of the special requirements contained in the quality assurance plan.
   2. Acknowledgment that control will be exercised to obtain conformance with the construction documents approved by the building official.
   3. Procedures for exercising control within the contractor's organization, the method and frequency of reporting and the distribution of the reports.
   4. Identification and qualifications of the person(s) exercising such control and their position(s) in the organization.

D. Each contractor responsible for the construction of a main windforce-resisting system or a wind-resisting component listed in the quality assurance plan shall submit a written statement of responsibility to the building official and the owner prior to the commencement of work on the system or component. The contractor's statement of responsibility shall contain the following:
   1. Acknowledgment of awareness of the special requirements contained in the quality assurance plan.
   2. Acknowledgment that control will be exercised to obtain conformance with the construction documents approved by the building official.
   3. Procedures for exercising control within the contractor's organization, the method and frequency of reporting and the distribution of the reports.
   4. Identification and qualifications of the person(s) exercising such control and their position(s) in the organization.

E. The contractor shall repair and / or replace work that does not meet the requirements of the construction documents.
   1. Contractor shall engage an engineer / architect to prepare repair and / or replacement procedures.
   2. Engineer / architect shall be registered in the state in which the project is located. Engineer shall be acceptable to the registered design professional in responsible charge, code enforcement official, and owner.
   3. Procedures shall be submitted for review and acceptance by the registered design professional in responsible charge, code enforcement official, and owner before proceeding with corrective action.

F. The contractor shall be responsible for costs of:
   1. Re-testing and re-inspection of materials, work, and / or products that do not meet the requirements of the construction documents and shop drawings / submittal data.
   2. Review of proposed repair and / or replacement procedures by the registered design professional in responsible charge and the inspectors and testing agencies.
   3. Repair or replacement of work that does not meet the requirements of the construction documents.

## 2.2 STRUCTURAL OBSERVATIONS

A. Structural observations may be made periodically as determined by the registered design professional in responsible charge.

## 2.3 TESTING AND INSPECTION

A. Testing and inspection shall be in accordance with the attached Schedule of Special Inspections.

B. Reference related specifications for the minimum level of inspections and testing. Provide additional inspections and testing as necessary to determine compliance with the construction drawings.

**PART 3 - SCHEDULES AND FORMS**

**Statement of Special Inspections**
**Requirements for Seismic Resistance**

See the Schedule of Special Inspections for inspection and testing requirements.

**Seismic Design Category: C**

**Statement of Special Inspection for Seismic Resistance Required (Yes/No): No**
**Description of seismic force-resisting system subject to special inspection and testing for seismic resistance:**
(Required for Seismic Design Categories C, D, E or F)
**Statement of Responsibility:**
Each contractor responsible for the construction or fabrication of a system or component described above must submit a Statement of Responsibility.

**Statement of Special Inspections**
**Requirements for Wind Resistance**

See the Schedule of Special Inspections for inspection and testing requirements.

**Basic Wind Speed (3 second gust): 120 m.p.h.**

**Wind Exposure Category: B**

**Statement of Special Inspection for Wind Resistance Required (Yes/No): Yes**
(Required in wind exposure Category B, where the basic wind speed is 120 miles per hour or greater. Required in wind exposure Category C or D, where the basic wind speed is 110 miles per hour or greater)

**Description of main wind force-resisting system subject to special inspection for wind resistance:**

**Description of wind force-resisting components subject to special inspection for wind resistance:**

**Statement of Responsibility:**
Each contractor responsible for the construction or fabrication of a system or component described above must submit a Statement of Responsibility.

SCHEDULE OF SPECIAL INSPECTIONS (See plans)

**3.1 FINAL REPORT OF SPECIAL INSPECTIONS.**

**END OF SECTION**

# SECTION 015723
# TEMPORARY STORM WATER POLLUTION CONTROL

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section Includes:
   1. Temporary stormwater pollution controls.

### 1.02 STORMWATER POLLUTION PREVENTION PLAN

A. The Stormwater Pollution Prevention Plan (SWPPP) is part of the Contract Documents and is bound into this Project Manual.

### 1.03 INFORMATIONAL SUBMITTALS

A. Stormwater Pollution Prevention Plan (SWPP): Within 15 days of date established for commencement of the Work, submit completed SWPPP.

### 1.04 QUALITY ASSURANCE

A. Stormwater Pollution Prevention Plan (SWPPP) Coordinator: Experienced individual or firm with a record of successful water pollution control management coordination of projects with similar requirements.
   1. SWPPP Coordinator shall complete and finalize the SWPPP form.
   2. SWPPP Coordinator shall be responsible for inspections and maintaining of all requirements of the SWPPP.

## PART 2 PRODUCTS

### 2.01 TEMPORARY STORMWATER POLLUTION CONTROLS

A. Provide temporary stormwater pollution controls as required by the SWPPP.

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. Comply with all best management practices, general requirements, performance requirements, reporting requirements, and all other requirements included in the SWPPP.

B. Locate stormwater pollution controls in accordance with the SWPPP.

C. Conduct construction as required to comply with the SWPPP and that minimize possible contamination or pollution or other undesirable effects.
   1. Inspect, repair, and maintain SWPPP controls during construction.
      a. Inspect all SWPPP controls not less than every seven days, and after each occurrence of a storm event, as outlined in the SWPPP.

D. Remove SWPPP controls at completion of construction and restore and stabilize areas disturbed during construction.

**END OF SECTION**

**SECTION 016000**
**PRODUCT REQUIREMENTS**

## PART 1 GENERAL

### 1.01 SUMMARY

A. The Work of This Section Includes: Administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

B. Related Requirements:
   1. Section 012500 "Substitution Procedures" for requests for substitutions.

### 1.02 DEFINITIONS

A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
   1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
   2. New Products: Items that have not previously been incorporated into another project or facility. Salvaged items or items reused from other projects are not considered new products. Items that are manufactured or fabricated to include recycled content materials are considered new products unless otherwise indicated.
   3. Comparable Product: Product by named manufacturer that is demonstrated and approved through the comparable product submittal process described in "Comparable Products" Article, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. Published attributes and characteristics of basis-of-design product establish salient characteristics of products.
   1. Evaluating Comparable Products: In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification. Manufacturer's published attributes and characteristics of basis-of-design product also establish salient characteristics of products for purposes of evaluating comparable products.

C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications; submit a comparable product request or substitution request, if applicable.

D. Comparable Product Request Submittal: An action submittal requesting consideration of a comparable product, including the following information:
   1. Identification of basis-of-design product or fabrication or installation method to be replaced, including Specification Section number and title and Drawing numbers and titles.
   2. Data indicating compliance with the requirements specified in "Comparable Products" Article.

E. Basis-of-Design Product Specification Submittal: An action submittal complying with requirements in Section 013300 "Submittal Procedures."

F. Substitution: Refer to Section 012500 "Substitution Procedures" for definition and limitations on substitutions.

### 1.03 QUALITY ASSURANCE

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

### 1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products, using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

### 1.05 PRODUCT WARRANTIES

A. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
   1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
   2. Specified Form: When specified forms are included in the Project Manual, prepare a written document, using indicated form properly executed.
   3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

## PART 2 PRODUCTS

### 2.01 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
   1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
   2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
   3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
   4. Where products are accompanied by the term "as selected," Architect will make selection.
   5. Descriptive, performance, and reference standard requirements in Specifications establish salient characteristics of products.

B. Product Selection Procedures:
   1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
      a. Sole product may be indicated by the phrase "Subject to compliance with requirements, provide the following."
   2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
      a. Sole manufacturer/source may be indicated by the phrase "Subject to compliance with requirements, provide products by the following."
   3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.

a. Limited list of products may be indicated by the phrase "Subject to compliance with requirements, provide one of the following."

4. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.
   a. Limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, provide products by one of the following."
5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications may additionally indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
   a. For approval of products by unnamed manufacturers, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.

**2.02 COMPARABLE PRODUCTS**

A. Architect's Action on Comparable Products Submittal: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for a comparable product. Architect will notify Contractor through Construction Manager of approval or rejection of proposed comparable product within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
   1. Architect's Approval of Submittal: Marked with approval notation from Architect's action stamp. See Section 013300 "Submittal Procedures."
   2. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.

**PART 3 EXECUTION (NOT USED)**

**END OF SECTION**

# SECTION 017300
# EXECUTION

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work, including, but not limited to, the following:
   1. Construction layout.
   2. Cutting and patching.
   3. Coordination of Owner's portion of the Work.
   4. Progress cleaning.
   5. Protection of installed construction.
   6. Correction of the Work.

B. Related Requirements:
   1. Section 011000 "Summary" for coordination of Owner-furnished products, and limits on use of Project site.
   2. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, replacing defective work, and final cleaning.

### 1.02 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.

B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

### 1.03 REFERENCE STANDARDS

A. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2027.

B. test - sddds; sdds.

### 1.04 CLOSEOUT SUBMITTALS

A. Final Property Survey: Submit 10 copies showing the Work performed and record survey data.

### 1.05 QUALITY ASSURANCE

A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of specified products and equipment.

## PART 2 PRODUCTS

### 2.01 MATERIALS

A. Comply with requirements specified in other Sections.

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

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

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
   1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, gas service piping, and water-service piping; underground electrical services; and other utilities.
   2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
   1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
   2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
   3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

### 3.02 PREPARATION

A. Existing Utility Information: Furnish information to local utility Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect through Construction Manager in accordance with requirements in Section 013100 "Project Management and Coordination."

### 3.03 INSTALLATION

A. Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
   1. Make vertical work plumb, and make horizontal work level.
   2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
   3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
   4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces, unless otherwise indicated on Drawings.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure satisfactory results as judged by Architect. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations, so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy of type expected for Project.

E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on-site and placement in permanent locations.

F. Tools and Equipment: Select tools or equipment that minimize production of excessive noise levels.

G. Templates: Obtain and distribute to the parties involved templates for Work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions with manufacturer.
   1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
   2. Allow for building movement, including thermal expansion and contraction.
   3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

I. Joints: Make joints of uniform width. Where joint locations in exposed Work are not indicated, arrange joints for the best visual effect, as judged by Architect. Fit exposed connections together to form hairline joints.

**3.04 CUTTING AND PATCHING**

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
   1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Temporary Support: Provide temporary support of Work to be cut.

C. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

D. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
   1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
   2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
   3. Concrete Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
   4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.

5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
6. Proceed with patching after construction operations requiring cutting are complete.

E. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as practicable, as judged by Architect. Provide materials and comply with installation requirements specified in other Sections, where applicable.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
    a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
    b. Restore damaged pipe covering to its original condition.
3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
    a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch, corner to corner of wall and edge to edge of ceiling. Provide additional coats until patch blends with adjacent surfaces.
4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.

F. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

**3.05 PROGRESS CLEANING**

A. Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.
3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, in accordance with regulations.
    a. Use containers intended for holding waste materials of type to be stored.
4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the Work.
1. Remove liquid spills promptly.
2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces in accordance with written instructions of manufacturer or fabricator of product installed, using only cleaning materials

specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 017419 "Construction Waste Management and Disposal."

H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

**3.06 PROTECTION OF INSTALLED CONSTRUCTION**

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.

C. Comply with manufacturer's written instructions for temperature and relative humidity.

**3.07 CORRECTION OF THE WORK**

A. Repair or remove and replace damaged, defective, or nonconforming Work. Restore damaged substrates and finishes.

1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.

B. Repair Work previously completed and subsequently damaged during construction period. Repair to like-new condition.

C. Restore permanent facilities used during construction to their specified condition.

D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.

E. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.

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

**END OF SECTION**

# SECTION 017419
# CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

## PART 1 GENERAL

### 1.01 SUMMARY

A. The Work of this Section includes administrative and procedural requirements for the following:
   1. Disposing of nonhazardous construction waste.

### 1.02 DEFINITIONS

A. Construction Waste: Building, structure, and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Demolition Waste: Building, structure, and site improvement materials resulting from demolition operations.

C. Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on Owner's property.

### 1.03 ACTION SUBMITTALS

A. Waste Management Plan: Submit plan within 7 days of date established for the Notice to Proceed. Plan must include the following:

### 1.04 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with transportation and disposal regulations of authorities having jurisdiction.

B. Waste Management Conference(s): Conduct conference(s) at Project site to comply with requirements in Section 013100 "Project Management and Coordination."

### 1.05 WASTE MANAGEMENT PLAN

A. General: Develop a waste management plan in accordance with requirements in this Section. Plan must include provisions for waste identification, waste reduction work plan, and cost/revenue analysis. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.

## PART 2 PRODUCTS

## PART 3 EXECUTION

### 3.01 PLAN IMPLEMENTATION

A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during entire duration of the Contract.
   1. Comply with operation, termination, and removal requirements in Section 015000 "Temporary Facilities and Controls."

B. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
   1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged and recycled.
   2. Comply with Section 015000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

### 3.02 DISPOSAL OF WASTE

A. Except for items or materials to be salvaged or recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Unless otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning:
1. Do not burn waste materials.

**END OF SECTION**

**SECTION 017700**
**CLOSEOUT PROCEDURES**

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes administrative and procedural requirements for Contract closeout, including, but not limited to, the following:
   1. Substantial Completion procedures.
   2. Final Completion procedures.
   3. List of incomplete items.
   4. Submittal of Project warranties.
   5. Final cleaning.

B. Related Requirements:
   1. Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
   2. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
   3. Section 017900 "Demonstration and Training" for requirements to train Owner's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

### 1.02 ACTION SUBMITTALS

A. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

### 1.03 CLOSEOUT SUBMITTALS

A. Certificates of Release: From authorities having jurisdiction.

B. Certificate of Insurance: For continuing coverage.

### 1.04 SUBSTANTIAL COMPLETION PROCEDURES

A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's "punch list"), indicating the value of each item on the list and reasons why the Work is incomplete.

B. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect and Construction Manager will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

### 1.05 FINAL COMPLETION PROCEDURES

A. Submittals Prior to Final Completion: Before requesting final inspection for determining Final Completion, complete the following:
   1. Submit a final Application for Payment in accordance with Section 012900 "Payment Procedures."
   2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list will state that each item has been completed or otherwise resolved for acceptance.
   3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.

B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect and Construction Manager will either proceed with inspection or

notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

### 1.06 LIST OF INCOMPLETE ITEMS

A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
   1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor, listed by room or space number.
   2. Organize items applying to each space by major element, including categories for ceilings, individual walls, floors, equipment, and building systems.
   3. Include the following information at the top of each page:
      a. Project name.
      b. Date.
      c. Name of Architect and Construction Manager.
      d. Name of Contractor.
      e. Page number.
   4. Submit list of incomplete items in the following format:
      a. MS Excel Electronic File: Architect, through Construction Manager, will return annotated file.
      b. PDF Electronic File: Architect, through Construction Manager, will return annotated file.

### 1.07 SUBMITTAL OF PROJECT WARRANTIES

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

B. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.

C. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
   1. Submit by email to Architect.

D. Provide additional copies of each warranty to include in operation and maintenance manuals.

## PART 2 PRODUCTS

### 2.01 MATERIALS

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

## PART 3 EXECUTION

### 3.01 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
   1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
      a. Clean Project site of rubbish, waste material, litter, and other foreign substances.

b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
c. Rake grounds that are not planted, mulched, or paved to a smooth, even-textured surface.
d. Remove tools, construction equipment, machinery, and surplus material from Project site.
e. Remove snow and ice to provide safe access to building.
f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
g. Remove debris and surface dust from limited-access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
h. Clean flooring, removing debris, dirt, and staining; clean in accordance with manufacturer's instructions.
i. Vacuum and mop concrete.
j. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean in accordance with manufacturer's instructions if visible soil or stains remain.
k. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
l. Remove labels that are not permanent.
m. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
n. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
p. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
q. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.
r. Clean strainers.
s. Leave Project clean and ready for occupancy.

C. Construction Waste Disposal: Comply with waste-disposal requirements in Section 017419 "Construction Waste Management and Disposal."

**3.02 CORRECTION OF THE WORK**

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

**END OF SECTION**

# SECTION 017823
# OPERATION AND MAINTENANCE DATA

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section Includes: Administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
   1. Operation and maintenance documentation directory manuals.
   2. Emergency manuals.
   3. Systems and equipment operation manuals.
   4. Systems and equipment maintenance manuals.
   5. Product maintenance manuals.

B. Related Requirements:
   1. Section 011200 "Multiple Contract Summary" for coordinating operation and maintenance manuals covering the Work of multiple contracts.
   2. Section 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
   3. Section 018626 "Electrical Performance Requirements" for requirements for Electrical Preventative Maintenance (EPM) Program binders that form part of the operation and maintenance data of this Section and include additional requirements for operation, maintenance, and emergency procedures, for electrical systems and equipment.
   4. Section 019113 "General Commissioning Requirements" for verification and compilation of data into operation and maintenance manuals.

### 1.02 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

### 1.03 REFERENCE STANDARDS

A. 8 - test; 1.

B. ASHRAE Guideline 4 - Preparation of Operations and Maintenance Documentation for HVAC&R Systems; 2019.

### 1.04 CLOSEOUT SUBMITTALS

A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
   1. Architect will comment on whether content of operation and maintenance submittals is acceptable.
   2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Format: Submit operation and maintenance manuals in the following format:
   1. Submit on digital media acceptable to Architect. Enable reviewer comments on draft submittals.
   2. Submit three paper copies. Architect will return two copies.

C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training. Architect will comment on whether general scope and content of manual are acceptable.

D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Architect will return copy with comments.

1. Correct or revise each manual to comply with Architect's comments. Submit copies of each corrected manual within 15 days of receipt of Architect's and prior to commencing demonstration and training.

E. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

## 1.05 FORMAT OF OPERATION AND MAINTENANCE MANUALS

A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
   1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
   2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

B. Manuals, Paper Copy: Submit manuals in the form of hard-copy, bound and labeled volumes.
   1. Binders: Heavy-duty, three-ring, vinyl-covered, post-type binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
      a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
      b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.
   2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
   3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment. Enclose title pages and directories in clear plastic sleeves.
   4. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
   5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
      a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
      b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

## 1.06 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

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

B. Title Page: Include the following information:
   1. Subject matter included in manual.
   2. Name and address of Project.
   3. Name and address of Owner.
   4. Date of submittal.
   5. Name and contact information for Contractor.
   6. Name and contact information for Construction Manager.
   7. Name and contact information for Architect.
   8. Name and contact information for Commissioning Authority.
   9. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
   10. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
   1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation in accordance with ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

## 1.07 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY MANUAL

A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals. List items and their location to facilitate ready access to desired information. Include the following:
   1. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
   2. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
   3. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

## 1.08 EMERGENCY MANUALS

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

B. Content: Organize manual into a separate section for each of the following:
   1. Type of emergency.
   2. Emergency instructions.
   3. Emergency procedures.

C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
   1. Fire.
   2. Flood.
   3. Gas leak.
   4. Water leak.
   5. Power failure.

6. Water outage.
7. System, subsystem, or equipment failure.
8. Chemical release or spill.

D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

E. Emergency Procedures: Include the following, as applicable:
1. Instructions on stopping.
2. Shutdown instructions for each type of emergency.
3. Operating instructions for conditions outside normal operating limits.
4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

**1.09 SYSTEMS AND EQUIPMENT OPERATION MANUALS**

A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Performance and design criteria if Contractor has delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

C. Descriptions: Include the following:
1. Product name and model number. Use designations for products indicated on Contract Documents.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

D. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.

6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

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

**1.10 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS**

A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.
   1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
   2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.

C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:
   1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
      a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
   2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
   3. Identification and nomenclature of parts and components.
   4. List of items recommended to be stocked as spare parts.

E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
   1. Test and inspection instructions.
   2. Troubleshooting guide.
   3. Precautions against improper maintenance.
   4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   5. Aligning, adjusting, and checking instructions.
   6. Demonstration and training video recording, if available.

F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
   1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
   2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

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

I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
   1. Include procedures to follow and required notifications for warranty claims.

J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
   1. Do not use original project record documents as part of maintenance manuals.

## 1.11 PRODUCT MAINTENANCE MANUALS

A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Product Information: Include the following, as applicable:
   1. Product name and model number.
   2. Manufacturer's name.
   3. Color, pattern, and texture.
   4. Material and chemical composition.
   5. Reordering information for specially manufactured products.

E. Maintenance Procedures: Include manufacturer's written recommendations and the following:
   1. Inspection procedures.
   2. Types of cleaning agents to be used and methods of cleaning.
   3. List of cleaning agents and methods of cleaning detrimental to product.
   4. Schedule for routine cleaning and maintenance.
   5. Repair instructions.

F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
   1. Include procedures to follow and required notifications for warranty claims.

**PART 2 PRODUCTS (NOT USED)**

**PART 3 EXECUTION (NOT USED)**

**END OF SECTION**

**SECTION 017839**
**PROJECT RECORD DOCUMENTS**

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes administrative and procedural requirements for Project Record Documents, including the following:
   1. Record Drawings.
   2. Record specifications.
   3. Record Product Data.
   4. Miscellaneous record submittals.

B. Related Requirements:
   1. Section 011200 "Multiple Contract Summary" for coordinating Project Record Documents covering the Work of multiple contracts.
   2. Section 017300 "Execution" for final property survey.
   3. Section 017700 "Closeout Procedures" for general closeout procedures.
   4. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

### 1.02 CLOSEOUT SUBMITTALS

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

B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and Contract modifications.

C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.
   1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit annotated PDF electronic files and directories of each submittal.

E. Reports: Submit written report weekly indicating items incorporated into Project Record Documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

### 1.03 RECORD DRAWINGS

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

B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
   1. Format: Same digital data software program, version, and operating system as for the original Contract Drawings.
   2. Format: DWG, Version 2010, Microsoft Windows operating system.
   3. Format: Annotated PDF electronic file with comment function enabled.
   4. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
   5. Refer instances of uncertainty to Architect for resolution.
   6. Architect will furnish Contractor with one set of digital data files of the Contract Drawings for use in recording information.
      a. See Section 013100 "Project Management and Coordination" for requirements related to use of Architect's digital data files.
      b. Architect will provide data file layer information. Record markups in separate layers.

C. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
   1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
   2. Format: Annotated PDF electronic file with comment function enabled.
   3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
   4. Identification: As follows:
      a. Project name.
      b. Date.
      c. Designation "PROJECT RECORD DRAWINGS."
      d. Name of Architect.
      e. Name of Contractor.

**1.04 RECORD SPECIFICATIONS**

A. Preparation: Mark Specifications to indicate the actual product installation, where installation varies from that indicated in Specifications, addenda, and Contract modifications.
   1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
   2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
   3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
   4. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.
   5. Note related Change Orders, Record Product Data, and Record Drawings where applicable.

B. Format: Submit record specifications as annotated PDF electronic file and scanned PDF electronic file(s) of marked-up paper copy of Specifications.

**1.05 RECORD PRODUCT DATA**

A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and revisions to Project Record Documents as they occur; do not wait until end of Project.

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

C. Format: Submit Record Product Data as annotated PDF electronic files.
   1. Include Record Product Data directory organized by Specification Section number and title, electronically linked to each item of Record Product Data.

**1.06 MISCELLANEOUS RECORD SUBMITTALS**

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

B. Format: Submit miscellaneous record submittals as PDF electronic file.
   1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

### 1.07 MAINTENANCE OF RECORD DOCUMENTS

A. Maintenance of Record Documents: Store Record Documents in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Architect's reference during normal working hours.

**PART 2 PRODUCTS (NOT USED)**

**PART 3 EXECUTION (NOT USED)**

**END OF SECTION**

# SECTION 017900
# DEMONSTRATION AND TRAINING

## PART 1 GENERAL

### 1.01 REFERENCE STANDARDS

A. test - sddds; sdds.

### 1.02 SUMMARY

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

### 1.03 INFORMATIONAL SUBMITTALS

A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
   1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.

B. Qualification Data: For instructor

C. Attendance Record: For each training module, submit list of participants and length of instruction time.

D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

### 1.04 CLOSEOUT SUBMITTALS

A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.
   1. Identification: On each copy, provide an applied label with the following information:
      a. Name of Project.
      b. Name and address of videographer.
      c. Name of Architect.
      d. Name of Construction Manager.
      e. Name of Contractor.
      f. Date of video recording.
   2. Transcript:
      a. Prepared and bound in format matching operation and maintenance manuals. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding video recording. Include name of Project and date of video recording on each page.
      b. Prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include name of Project and date of video recording on each page.
   3. At completion of training, submit complete training manual(s) for Owner's use prepared in same paper and PDF file format required for operation and maintenance manuals specified in Section 017823 "Operation and Maintenance Data."

### 1.05 QUALITY ASSURANCE

A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project,

and whose work has resulted in training or education with a record of successful learning performance.

B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.

C. Videographer Qualifications: A professional videographer who is experienced photographing demonstration and training events similar to those required.

D. Pre-instruction Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:
   1. Inspect and discuss locations and other facilities required for instruction.
   2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
   3. Review required content of instruction.
   4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

**1.06 COORDINATION**

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data have been reviewed and approved by Architect.

**1.07 INSTRUCTION PROGRAM**

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
   1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
      a. System, subsystem, and equipment descriptions.
      b. Performance and design criteria if Contractor is delegated design responsibility.
      c. Operating standards.
      d. Regulatory requirements.
      e. Equipment function.
      f. Operating characteristics.
      g. Limiting conditions.
      h. Performance curves.
   2. Documentation: Review the following items in detail:
      a. Emergency manuals.
      b. Systems and equipment operation manuals.
      c. Systems and equipment maintenance manuals.
      d. Product maintenance manuals.
      e. Project Record Documents.
      f. Identification systems.
      g. Warranties and bonds.
      h. Maintenance service agreements and similar continuing commitments.
   3. Emergencies: Include the following, as applicable:

a. Instructions on meaning of warnings, trouble indications, and error messages.
b. Instructions on stopping.
c. Shutdown instructions for each type of emergency.
d. Operating instructions for conditions outside of normal operating limits.
e. Sequences for electric or electronic systems.
f. Special operating instructions and procedures.

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

**1.08 PREPARATION**

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."

B. Set up instructional equipment at instruction location.

**1.09 INSTRUCTION**

A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.

B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
   1. Architect will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
   2. Owner will furnish an instructor to describe Owner's operational philosophy.
   3. Owner will furnish Contractor with names and positions of participants.

C. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
   1. Schedule training with Owner through Architect with at least seven days' advance notice.

D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a written performance-based test.

F. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

## 1.10 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

A. General: Engage a qualified commercial videographer to record demonstration and training video recordings. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.
   1. At beginning of each training module, record each chart containing learning objective and lesson outline.

B. Digital Video Recordings: Provide high-resolution, digital video in MPEG format, produced by a digital camera with minimum sensor resolution of 12 megapixels and capable of recording in full HD mode.
   1. Submit video recordings on CD-ROM or thumb drive.
   2. File Hierarchy: Organize folder structure and file locations in accordance with Project Manual table of contents. Provide complete screen-based menu.
   3. File Names: Utilize file names based on name of equipment generally described in video segment, as identified in Project specifications.
   4. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the equipment demonstration and training recording that describes the following for each Contractor involved on the Project, arranged in accordance with Project Manual table of contents:
      a. Name of Contractor/Installer.
      b. Business address.
      c. Business phone number.
      d. Point of contact.
      e. Email address.

C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.
   1. Film training session(s) in segments not to exceed 15 minutes.
      a. Produce segments to present a single significant piece of equipment per segment.
      b. Organize segments with multiple pieces of equipment to follow order of Project Manual table of contents.

c. Where a training session on a particular piece of equipment exceeds 15 minutes, stop filming and pause training session. Begin training session again upon commencement of new filming segment.

D. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.
   1. Furnish additional portable lighting as required.

E. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.

F. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.

G. Preproduced Video Recordings: Provide video recordings used as a component of training modules in same format as recordings of live training.

**PART 2 PRODUCTS (NOT USED)**

**PART 3 EXECUTION (NOT USED)**

**END OF SECTION**

**SECTION 032000**

**CONCRETE REINFORCING**

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Steel reinforcement bars.
2. Welded-wire reinforcement.

### 1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Each type of steel reinforcement.

B. Shop Drawings: Comply with ACI SP-066:

1. Include placing drawings that detail fabrication, bending, and placement.
2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.

### 1.3 INFORMATIONAL SUBMITTALS

### 1.4 QUALITY ASSURANCE

## PART 2 - PRODUCTS

### 2.1 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.

B. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.

### 2.2 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

## 3.1 PREPARATION

A. Protection of In-Place Conditions:

1. Do not cut or puncture vapor retarder.
2. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

## 3.2 INSTALLATION OF STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.

B. Accurately position, support, and secure reinforcement against displacement.

1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
2. Do not tack weld crossing reinforcing bars.

C. Preserve clearance between bars of not less than 1 inch, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.

D. Provide concrete coverage in accordance with ACI 318.

E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

F. Splices: Lap splices as indicated on Drawings.

1. Bars indicated to be continuous, and all vertical bars to be lapped not less than 36 bar diameters at splices, or 24 inches, whichever is greater.
2. Stagger splices in accordance with ACI 318.
3. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.
4. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.

G. Install welded-wire reinforcement in longest practicable lengths.

1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."
2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches for plain wire.
3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
4. Lace overlaps with wire.

## 3.3 JOINTS

A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement.
2. Continue reinforcement across construction joints unless otherwise indicated.

3. Do not continue reinforcement through sides of strip placements of floors and slabs.

## 3.4 INSTALLATION TOLERANCES

A. Comply with ACI 117.

**END OF SECTION**

**SECTION 033000**

**CAST-IN-PLACE CONCRETE**

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.

B. Related Requirements:

1. Section 032000 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.
2. Section 035300 "Concrete Topping" for emery- and iron-aggregate concrete floor toppings.

### 1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each of the following.

1. Portland cement.
2. Fly ash.
3. Aggregates.
4. Admixtures:
   a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.
5. Vapor retarders.
6. Joint fillers.

B. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.
2. Minimum 28-day compressive strength.
3. Durability exposure class.
4. Maximum w/cm.
5. Calculated equilibrium unit weight, for lightweight concrete.
6. Slump limit.

7. Air content.
8. Nominal maximum aggregate size.
9. Steel-fiber reinforcement content.
10. Synthetic micro-fiber content.
11. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
12. Include manufacturer's certification that permeability-reducing admixture is compatible with mix design.
13. Include certification that dosage rate for permeability-reducing admixture matches dosage rate used in performance compliance test.
14. Intended placement method.
15. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

## 1.4 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACI Flatwork Concrete Finisher/Technician or an ACI Concrete Flatwork Technician with experience installing and finishing concrete, incorporating permeability-reducing admixtures.

1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.

B. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Control Technical Manager.

1. Personnel performing laboratory tests to be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor to be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

D. Field Quality-Control Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests to be qualified as an ACI Concrete Field Testing Technician, Grade 1, in accordance with ACI CPP 610.1 or an equivalent certification program.

## 1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94/C94M and ACI 301.

## 1.6 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 301 and ACI 306.1 and as follows.

1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
2. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
3. Do not use frozen materials or materials containing ice or snow.
4. Do not place concrete in contact with surfaces less than 35 deg F, other than reinforcing steel.
5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:

1. Maintain concrete temperature at time of discharge to not exceed 95 deg F.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

## 1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/ termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

# PART 2 - PRODUCTS

## 2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

## 2.2 CONCRETE MATERIALS

A. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, Type I/II, white.
2. Fly Ash: ASTM C618, Class C or F.

B. Normal-Weight Aggregates: ASTM C33/C33M, Class 3M coarse aggregate or better, graded. Provide aggregates from a single source.

1. Alkali-Silica Reaction: Comply with one of the following:
   a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.

b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.
c. Alkali Content in Concrete: Not more than 4 lb./cu. yd. for moderately reactive aggregate or 3 lb./cu. yd. for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301.

2. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.
3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Air-Entraining Admixture: ASTM C260/C260M.

D. Water and Water Used to Make Ice: ASTM C94/C94M, potable or complying with ASTM C1602/C1602M, including all limits listed in Table 2 and the requirements of paragraph 5.4.

## 2.3 VAPOR RETARDERS

A. Sheet Vapor Retarder, Class A: ASTM E1745, Class A; not less than 15 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive tape.

## RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber.

## 2.05 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301.

1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:

1. Fly Ash or Other Pozzolans: 15 percent by mass.

C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

1. Use admixture in concrete, as required, for placement and workability.

## 2.06 CONCRETE MIXTURES

A. Class A: Normal-weight concrete used for footings, grade beams, and tie beams.

1. Exposure Class: ACI 318 F1 S1 W1 C1.
2. Minimum Compressive Strength: 4000 psi at 28 days.
3. Maximum w/cm: 0.45.
4. Slump Limit: 5 inches, plus or minus 1 inch.
5. Air Content:

a. Exposure Class F1: 5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.

6. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

B. Class B: Normal-weight concrete used for foundation walls.

1. Exposure Class: ACI 318 F1 S1 W1 C1.
2. Minimum Compressive Strength: 4000 psi at 28 days.
3. Maximum w/cm: 0.45.
4. Slump Limit: 5 inches, plus or minus 1 inch.
5. Air Content:
   a. Exposure Class F1: 5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size
6. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
7. Add Xypex Waterproofing Admixture C500, or equivalent, at a rate of 2.5% by weight of cementitious material to all foundation retaining walls. Xypex representative to review and confirm appropriate dosage in mix design submittal.
8.

C. Class C: Normal-weight concrete used for interior slabs-on-ground.

1. Exposure Class: ACI 318 F0 S0 W0 C0.
2. Minimum Compressive Strength: 3500 psi at 28 days.
3. Maximum w/cm: 0.50.
4. Minimum Cementitious Materials Content: 520 lb/cu. yd.
5. Slump Limit: 5 inches, plus or minus 1 inch.
6. Air Content:
   a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.
7. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
8. Add Vapor Lock 20/21 (ASTM C494 Type S), or equivalent, to all interior slabs on grade. Dosage to be manufacturers standard dosage and should be added to concrete mix in accordance with manufacturer's instructions. Dosage must be included in mix design submittal and must be reviewed and confirmed by a Vapor Lock representative.
9. Reinforce all slabs on grade with 6x6-W2.1xW2.1 unless noted otherwise.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Verification of Conditions:

1. Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
2. Do not proceed until unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:

1. Daily access to the work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
4. Security and protection for test samples and for testing and inspection equipment at Project site.

## 3.3 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.
3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

## 3.4 INSTALLATION OF VAPOR RETARDER

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.

1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
2. Face laps away from exposed direction of concrete pour.
3. Lap vapor retarder over footings and grade beams not less than 6 inches, sealing vapor retarder to concrete.
4. Lap joints 6 inches and seal with manufacturer's recommended tape.
5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
7. Protect vapor retarder during placement of reinforcement and concrete.
    a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches on all sides, and sealing to vapor retarder.

B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder in accordance with manufacturer's written instructions.

## 3.5 JOINTS

A. Construct joints true to line, with faces perpendicular to surface plane of concrete.

B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.

1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
2. Place joints perpendicular to main reinforcement.
   a. Continue reinforcement across construction joints unless otherwise indicated.
   b. Do not continue reinforcement through sides of strip placements of floors and slabs.
3. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
4. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
6. Space vertical joints in walls as indicated on Drawings. Unless otherwise indicated on Drawings, locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.
7. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
8. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-third of concrete thickness as follows:

1. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.

## 3.6 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.

1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.

B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.

C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect in writing, but not to exceed the amount indicated on the concrete delivery ticket.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, but not to exceed the amount indicated on the concrete delivery ticket.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.

1. If a section cannot be placed continuously, provide construction joints as indicated.
2. Deposit concrete to avoid segregation.
3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.
    a. Do not use vibrators to transport concrete inside forms.
    b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
    c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
    d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Do not place concrete floors and slabs in a checkerboard sequence.
2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Maintain reinforcement in position on chairs during concrete placement.
4. Screed slab surfaces with a straightedge and strike off to correct elevations.
5. Level concrete, cut high areas, and fill low areas.
6. Slope surfaces uniformly to drains where required.
7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

## 3.7 FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:

1. ACI 301 Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.
    a. Patch voids larger than 1-1/2 inches wide or 1/2 inch deep.
    b. Remove projections larger than 1 inch.
    c. Tie holes do not require patching.
    d. Surface Tolerance: ACI 117 Class D.
    e. Apply to concrete surfaces not exposed to public view.
2. ACI 301 Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.
    a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
    b. Remove projections larger than 1/4 inch.
    c. Patch tie holes.
    d. Surface Tolerance: ACI 117 Class B.
    e. Locations: Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.
3. ACI 301 Surface Finish SF-3.0:
    a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
    b. Remove projections larger than 1/8 inch.
    c. Patch tie holes.
    d. Surface Tolerance: ACI 117 Class A.
    e. Locations: Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.

B. Related Unformed Surfaces:

1. At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a color and texture matching adjacent formed surfaces.
2. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

## 3.8 FINISHING FLOORS AND SLABS

A. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Float Finish:

1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
2. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 tolerances for conventional concrete.
3. Apply float finish to surfaces to receive trowel finish.

## 3.9 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling In:

1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
2. Mix, place, and cure concrete, as specified, to blend with in-place construction.
3. Provide other miscellaneous concrete filling indicated or required to complete the Work.

## 3.10 TOLERANCES

A. Conform to ACI 117.

## 3.11 JOINT FILLING

A. Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least one month(s).
2. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints.

D. Overfill joint, and trim joint filler flush with top of joint after hardening.

## 3.12 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

1. Testing agency to be responsible for providing curing container for composite samples on Site and verifying that field-cured composite samples are cured in accordance with ASTM C31/C31M.
2. Testing agency to immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
3. Testing agency to report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.
    a. Test reports to include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:
        1) Project name.
        2) Name of testing agency.
        3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
        4) Name of concrete manufacturer.
        5) Date and time of inspection, sampling, and field testing.
        6) Date and time of concrete placement.
        7) Location in Work of concrete represented by samples.
        8) Date and time sample was obtained.
        9) Truck and batch ticket numbers.
        10) Design compressive strength at 28 days.
        11) Concrete mixture designation, proportions, and materials.
        12) Field test results.
        13) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
        14) Type of fracture and compressive break strengths at seven days and 28 days.

C. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.

D. Inspections:

1. Headed bolts and studs.
2. Verification of use of required design mixture.
3. Concrete placement, including conveying and depositing.
4. Curing procedures and maintenance of curing temperature.
5. Verification of concrete strength before removal of shores and forms from beams and slabs.
6. Batch Plant Inspections: On a random basis, as determined by Architect.

E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M to be performed in accordance with the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.

a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143/C143M:
   a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   b. Perform additional tests when concrete consistency appears to change.
3. Slump Flow: ASTM C1611/C1611M:
   a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   b. Perform additional tests when concrete consistency appears to change.
4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete;
   a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
5. Concrete Temperature: ASTM C1064/C1064M:
   a. One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
6. Unit Weight: ASTM C567/C567M fresh unit weight of structural lightweight concrete.
   a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
7. Compression Test Specimens: ASTM C31/C31M:
   a. Cast and laboratory cure two sets of three 6-inch by 12-inch or 4-inch by 8-inch cylinder specimens for each composite sample.
   b. Cast, initial cure, and field cure two sets of two standard cylinder specimens for each composite sample.
8. Compressive-Strength Tests: ASTM C39/C39M.
   a. Test one set of two laboratory-cured specimens at seven days and one set of two specimens at 28 days.
   b. Test one set of two field-cured specimens at seven days and one set of two specimens at 28 days.
   c. A compressive-strength test to be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor to evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
10. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi.
11. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
12. Additional Tests:
    a. Testing and inspecting agency to make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
    b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.
       1) Acceptance criteria for concrete strength to be in accordance with ACI 301, Section 1.6.6.3.
13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

F. Measure floor and slab flatness and levelness in accordance with ASTM E1155 within 48 hours of completion of floor finishing and promptly report test results to Architect.

## 3.13 PROTECTION

A. Protect concrete surfaces as follows:

1. Protect from petroleum stains.
2. Diaper hydraulic equipment used over concrete surfaces.
3. Prohibit vehicles from interior concrete slabs.
4. Prohibit use of pipe-cutting machinery over concrete surfaces.
5. Prohibit placement of steel items on concrete surfaces.
6. Prohibit use of acids or acidic detergents over concrete surfaces.
7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.
8. Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using Floor Slab Protective Covering.

**END OF SECTION**

**SECTION 042000**
**UNIT MASONRY**

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section Includes:
   1. Concrete masonry units.
   2. Lintels.
   3. Brick.
   4. Mortar and grout materials.
   5. Reinforcement.
   6. Ties and anchors.
   7. Embedded flashing.
   8. Accessories.
   9. Mortar and grout mixes.

B. Products Installed but not Furnished under This Section:
   1. Steel lintels in unit masonry.
   2. Steel shelf angles for supporting unit masonry.
   3. Cavity wall insulation adhered to masonry backup.

C. Related Requirements:
   1. Section 072100 "Thermal Insulation" for cavity wall insulation.
   2. Section 076200 "Sheet Metal Flashing and Trim" for exposed sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.

### 1.02 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

### 1.03 REFERENCE STANDARDS

A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

B. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2026.

C. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2026.

D. ASTM A951/A951M - Standard Specification for Steel Wire for Masonry Joint Reinforcement; 2026.

E. ASTM A996/A996M - Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement; 2024.

F. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2024.

G. ASTM B32 - Standard Specification for Solder Metal; 2020.

H. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2026.

I. ASTM C55 - Standard Specification for Dry-Cast Concrete Building Brick; 2025.

J. ASTM C62 - Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale); 2023.

K. ASTM C67/C67M - Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile; 2025.

L. ASTM C90 - Standard Specification for Dry-Cast Loadbearing Concrete Masonry Units; 2024a.

M. ASTM C91/C91M - Standard Specification for Masonry Cement; 2025.
N. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 50 mm [2 in.] Cube Specimens); 2024.
O. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete; 2026.
P. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar; 2026.
Q. ASTM C150/C150M - Standard Specification for Portland Cement; 2024.
R. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes; 2024.
S. ASTM C270 - Standard Specification for Mortar for Unit Masonry; 2026.
T. ASTM C404 - Standard Specification for Aggregates for Masonry Grout; 2026.
U. ASTM C476 - Standard Specification for Grout for Masonry; 2023.
V. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2024.
W. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018 (Reapproved 2024).
X. ASTM C979/C979M - Standard Specification for Pigments for Integrally Colored Concrete; 2024.
Y. ASTM C1019 - Standard Test Method for Sampling and Testing Grout for Masonry; 2026.
Z. ASTM C1384 - Standard Specification for Admixtures for Masonry Mortars; 2023.
AA. ASTM D226/D226M - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing; 2025.
BB. ASTM D1056 - Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber; 2020.

**1.04 PREINSTALLATION MEETINGS**

A. Preinstallation Conference: Conduct conference at Project site.

**1.05 ACTION SUBMITTALS**

A. Product Data: For each type of product.
B. Shop Drawings: For the following:
   1. Masonry Units: Indicate sizes, profiles, coursing, and locations of special shapes.
   2. Reinforcing Steel: Indicate bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315R. Indicate elevations of reinforced walls.
   3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
C. Samples for Initial Selection:
   1. Concrete face brick, in the form of small-scale units.
   2. Clay face, Hollow brick, in the form of straps of five or more bricks.
   3. Colored mortar.
   4. Weep/cavity vents.
D. Samples for Verification: For each type and color of the following:
   1. Clay face, Hollow brick, in the form of straps of five or more bricks.
   2. Special brick shapes.
   3. Pigmented, colored-aggregate mortar. Make Samples using same sand and mortar ingredients to be used on Project.
   4. Weep/cavity vents.
   5. Cavity drainage material.
   6. Accessories embedded in masonry.

**1.06 INFORMATIONAL SUBMITTALS**

A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers,

source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.

1. Submittal is for information only. Receipt of list does not constitute approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.

B. Material Certificates: For each type of the following:
   1. Masonry units.
      a. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
      b. For exposed brick, include test report for efflorescence in accordance with ASTM C67/C67M.
      c. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
   2. Cementitious materials. Include name of manufacturer, brand name, and type.
   3. Mortar admixtures.
   4. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
   5. Grout mixes. Include description of type and proportions of ingredients.
   6. Reinforcing bars.
   7. Joint reinforcement.
   8. Anchors, ties, and metal accessories.

C. Delegated design engineer qualifications.

D. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
   1. Include test reports for mortar mixes required to comply with property specification. Test in accordance with ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
   2. Include test reports, in accordance with ASTM C1019, for grout mixes 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 in accordance with TMS 602.

F. Cold-Weather, and, Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

## 1.07 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

## 1.08 FIELD CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
   1. Extend cover a minimum of 24 inches (609.6 mm) down both sides of walls, and hold cover securely in place.
   2. Where one wythe of multi wythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches (609.6 mm) down face next to unconstructed wythe, and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
   1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
   2. Protect sills, ledges, and projections from mortar droppings.
   3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
   4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602.
   1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602.

## PART 2 PRODUCTS

### 2.01 SOURCE LIMITATIONS

A. Obtain exposed masonry units from a single source, manufacturer.

B. For cementitious mortar components, obtain each color and grade from single source with resources to provide materials of consistent quality in appearance and physical properties.

### 2.02 PERFORMANCE REQUIREMENTS

A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.
   1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) in accordance with TMS 602.

### 2.03 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 602, except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work and will be within 20 feet (609.6 cm) vertically and horizontally of a walking surface.

C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

1. Where fire-resistance-rated construction is indicated, units are listed by UL or a qualified testing agency acceptable to authorities having jurisdiction.

**2.04 CONCRETE MASONRY UNITS**

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
   1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
   2. Provide square-edged units for outside corners unless otherwise indicated.

B. CMUs: ASTM C90, lightweight.
   1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi (13100.04 kPa).
   2. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
   3. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.

**2.05 LINTELS**

A. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, 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.

**2.06 BRICK**

A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:
   1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.

B. Building (Common) Brick: ASTM C62, Grade MW or Grade SW.
   1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 4950 psi (34129.06 kPa).
   2. Size (Actual Dimensions): 3-5/8 inches wide by 2-1/4 inches (57 mm) high by 7-5/8 inches long.

**2.07 MORTAR AND GROUT MATERIALS**

A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
   1. Alkali content will not be more than 0.1 percent when tested in accordance with ASTM C114.

B. Hydrated Lime: ASTM C207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of Portland cement and hydrated lime containing no other ingredients.

D. MASONRY CEMENT WILL NOT BE ALLOWED TO BE USED ON THIS PROJECT.

E. Mortar Cement: ASTM C1329/C1329M.

F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.
   1. Manufacturers: Subject to compliance with requirements, provide one of the following:
      a. Davis Colors.
      b. Euclid Chemical Company.
      c. Lanxess Corporation.

G. Colored Cement Products: Packaged blend made from Portland cement and hydrated lime and mortar pigments, all complying with specified requirements, and containing no other ingredients.
   1. Colored Portland Cement -Lime Mix:
      a. Manufacturers: Subject to compliance with requirements, products by one of the following:
         1) Argos USA LLC
         2) Essroc.
         3) Holcim (US) Inc
   2. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
   3. Pigments do not exceed 10 percent of Portland cement by weight.
   4. Pigments do not exceed 5 percent of mortar cement by weight.

H. Aggregate for Mortar: ASTM C144.
   1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
   2. For joints less than ¼ inch 0.25 inch (6.4 mm) thick, use aggregate graded with 100 percent passing the No 16. (0.05 inch (1.18 mm)) sieve.
   3. White-Mortar Aggregates: natural white sand or crushed white stone.
   4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

I. Aggregate for Grout: ASTM C404.

J. Cold-Weather Admixture: Non-Chloride, noncorrosive, accelerating admixture complying with ASTM C494/C494M, Type C or ASTM C1384, and recommended by manufacturer for use in masonry mortar of composition indicated.

K. Water: Potable.

**2.08 REINFORCEMENT**

A. Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, Grade 60.

B. Masonry-Joint Reinforcement, General: ASTM A951/A951M.
   1. Interior Walls: Hot-dip galvanized carbon steel.
   2. Exterior Walls: Hot-dip galvanized carbon steel.
   3. Wire Size for Side Rods: 0.148-inch diameter.
   4. Wire Size for Cross Rods: 0.148-inch diameter.
   5. Wire Size for Veneer Ties: 0.148-inch diameter.
   6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (406.4 mm) o.c.
   7. Provide in lengths of not less than 10 feet (304.8 cm), with prefabricated corner and tee units.

C. Masonry-Joint Reinforcement for Single-Wythe Masonry: Ladder type with single pair of side rods.

D. Masonry-Joint Reinforcement for Multiwythe Masonry:
   1. Adjustable (two-piece) type, ladder truss design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum horizontal play of 1/16 inch (1.59 mm) and maximum vertical adjustment of 1-1/4 inches (32 mm). Size ties to extend at least halfway through facing wythe but with at least 5/8 inch (16mm) cover on outside face.

**2.09 TIES AND ANCHORS**

A. General: Ties and anchors extend at least 1-1/2 inches (38 mm) into veneer but with at least a 5/8-inch cover on outside face.

B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M, with ASTM A153/A153M, Class B-2 coating.

C. Individual Wire Ties: Basis of Desing: Tapcon Sure Tie #4530
1. Provide adjustable #4510 Sure Tie triangle wire ties.
2. Provide #4530 Tapcon Sure Tie Anchors with Blue Climaseal finish per ASTM B117.
3. Where wythes do not align, use adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches (32 mm).
4. Wire: Fabricate from 3/16-inch - diameter, hot-dip galvanized steel wire.

D. Adjustable Anchors for Connecting to Structural Steel Framing: 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- diameter, hot-dip galvanized steel wire.
2. Tie Section: Triangular-shaped wire tie made from 0.187-inch-diameter, hot-dip galvanized steel wire.

**2.10 EMBEDDED FLASHING**

1. General: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:
   a. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.016 inch (0.41 mm) thick.
   b. Fabricate continuous flashings in sections 96 inches (2438.4 mm) long minimum, but not exceeding 12 feet (365.76 cm). Provide splice plates at joints of formed, smooth metal flashing.
   c. Fabricate through-wall flashing with drip edge unless otherwise indicated. Fabricate by extending flashing 1/2 inch (12.7 mm) out from wall, with outer edge bent down 30 degrees and hemmed.
   d. Fabricate metal drip edges from stainless steel. Extend at least 3 inches (76.2 mm) into wall and 1/2 inch (12.7 mm) out from wall, with outer edge bent down 30 degrees and hemmed.
   e. Fabricate metal expansion-joint strips from stainless steel to shapes indicated.
   f. Solder metal items at corners.

B. Flexible Flashing: Use the following unless otherwise indicated:
1. Self-adhering, Stainless Steel Fabric Flashing: Composite, flashing product consisting of 2 mil (0.0508 mm) of Type 304 stainless steel sheet, bonded to a layer of polymeric fabric with a butyl adhesive, to produce an overall thickness of 10mil (0.25mm).
   a. Applications: Use 10-mil-(0.25mm) thick flashing at windows, doors, and small wall penetrations; not at base of walls. Use 40 mil (1.016 mm) thick flashing at base of walls.

C. Solder and Sealants for Sheet Metal Flashings: As specified in Section 076200 "Sheet Metal Flashing and Trim."
1. Solder for Stainless Steel: ASTM B32, Grade Sn60, with acid flux of type recommended by stainless steel sheet manufacturer.
2. Elastomeric Sealant: ASTM C920, chemically curing silicone sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and remain watertight.

D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

E. Termination Bars for Flexible Flashing: Stainless steel bars 1/8 inch by 1-1/8 inch.

## 2.11 ACCESSORIES

A. Compressible Filler: Pre-molded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene, urethane, or, PVC.

B. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

C. Weep/Cavity Vents: Use the following unless otherwise indicated:
   1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe, in color selected from manufacturer's standard.

D. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
   1. Mortar Deflector: Strips, full depth of cavity and 10 inches (254 mm) high, with dovetail-shaped notches that prevent clogging with mortar droppings.

## 2.12 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
   1. Do not use calcium chloride in mortar or grout.
   2. Use Portland cement-lime, or, mortar cement mortar unless otherwise indicated.
   3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
   4. DO NOT USE MASONRY CEMENT FOR ANY MASONRY INSTALLATION ON THIS PROJECT. IF MASONRY CEMENT IS FOUND ON THE PROJECT, ALL MASONRY INSTALLED WILL BE REJECTED, DECLARED DEFECTIVE WORK AND WILL BE IMMEDIATELY REMOVED.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.
   1. For masonry below grade or in contact with earth, use Type M.
   2. For reinforced masonry, use Type S.
   3. For exterior, above-grade, load-bearing, non-load-bearing walls, and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
   4. For interior non-load-bearing partitions, Type O may be used instead of Type N.

D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
   1. Pigments do not exceed 10 percent of Portland cement by weight.
   2. Pigments do not exceed 5 percent of mortar cement by weight.
   3. Mix to match Architect's sample.

E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
   1. Mix to match Architect's sample.

F. Grout for Unit Masonry: Comply with ASTM C476.
   1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602 for dimensions of grout spaces and pour height.
   2. Proportion grout in accordance with ASTM C476, Table 1,or,paragraph 4.2.1.2 for specified 28-day compressive strength indicated, but not less than 2000 psi (13789.52 kPa).

3. Provide grout with a slump of 8 to 11 inches (279.4 mm) as measured in accordance with ASTM C143/C143M.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
   2. Verify that foundations are within tolerances specified.
   3. Verify that reinforcing dowels are properly placed.
   4. Verify that substrates are free of substances that impair mortar bond.

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.

### 3.02 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.

F. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

### 3.03 TOLERANCES

A. Dimensions and Locations of Elements:
   1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch (12.7 mm) or minus 1/4 inch (6.35 mm).
   2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch (12.7 mm).
   3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch (6.35 mm) in a story height or 1/2 inch (12.7 mm) total.

B. Lines and Levels:
   1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch (6.35 mm) in 10 feet (304.8 cm), or 1/2-inch maximum.
   2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (304.8 cm), 1/4 inch (6.35 mm) in 20 feet (609.6 cm), or 1/2-inch maximum.
   3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch (6.35 mm) in 10 feet (304.8 cm), 3/8 inch in 20 feet (609.6 cm), or 1/2-inch maximum.
   4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (304.8 cm), 1/4 inch (6.35 mm) in 20 feet (609.6 cm), or 1/2-inch maximum.
   5. For lines and surfaces, do not vary from straight by more than 1/4 inch (6.35 mm) in 10 feet (304.8 cm), 3/8 inch in 20 feet (609.6 cm), or 1/2-inch maximum.

6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch (6.35 mm) in 10 feet (304.8 cm), or 1/2-inch maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch (1.59 mm) except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:
1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch (12.7 mm).
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch (6.35 mm).
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch (1.59 mm) from one masonry unit to the next.

**3.04 LAYING MASONRY WALLS**

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4 inches (101.6 mm). Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches (609.6 mm) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
1. Install compressible filler in joint between top of partition and underside of structure above.
2. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
3. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078443 "Joint Firestopping."

**3.05 MORTAR BEDDING AND JOINTING**

A. Lay CMUs, and, hollow brick as follows:
1. Bed face shells in mortar and make head joints of depth equal to bed joints.

2. Bed webs in mortar in all courses of piers, columns, and pilasters.
3. Bed webs in mortar in grouted masonry, including starting course on footings.
4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.

B. Lay solid masonry units and hollow brick with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Set cast-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. Allow cleaned surfaces to dry before setting.
3. Wet joint surfaces thoroughly before applying mortar.

D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

E. Cut joints flush where indicated to receive bituminous and ,cavity wall insulation, unless otherwise indicated.

**3.06 CAVITY WALLS**

A. Bond wythes of cavity walls together as follows:
1. Masonry-Joint Reinforcement: Installed in horizontal mortar joints.
a. Where bed joints of both wythes align, use type reinforcement.
b. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) reinforcement
c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable-type (two-piece-type) reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.
2. Masonry-Veneer Anchors: Comply with requirements for anchoring masonry veneers.

B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

C. Installing Cavity Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches (304.8 mm) o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. 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 indicated.
1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

**3.07 MASONRY-JOINT REINFORCEMENT**

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch (12.7 mm) elsewhere. Lap reinforcement a minimum of 6 inches (152.4 mm).
1. Space reinforcement not more than 16 inches (406.4 mm) o.c.
2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches (304.8 mm) beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

### 3.08 CONTROL AND EXPANSION JOINTS

A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry as follows:
   1. Install preformed control-joint gaskets designed to fit standard sash block.

C. Form expansion joints in brick as follows:
   1. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Section 079200 "Joint Sealants."

D. Provide horizontal, pressure-relieving joints by either leaving an airspace or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 079200 "Joint Sealants," but not less than 3/8 inch.
   1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

### 3.09 LINTELS

A. Install steel lintels where indicated.

B. Provide concrete masonry or offset angle support lintels where indicated and where openings of more than 12 inches (304.8 mm) for brick-size units and 24 inches (609.6 mm) for block-size units are indicated without structural steel or other supporting lintels.

C. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

### 3.10 FLASHING, WEEP HOLES, AND CAVITY VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install cavity vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.

B. Install flashing as follows unless otherwise indicated:
   1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
   2. At multi wythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 8 inches, and through inner wythe to within 1/2 inch (12.7 mm) of the interior face of wall in exposed masonry. Where interior face of wall is to receive furring or framing, carry flashing completely through inner wythe and turn flashing up approximately 2 inches (50.8 mm) on interior face.
   3. At multi wythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 8 inches, and 1-1/2 inches (38 mm) into the inner wythe.
   4. At lintels and shelf angles, extend flashing 6 inches (152.4 mm) minimum, to edge of next full unit at each end. At heads and sills, extend flashing 6 inches minimum, to edge of next full unit and turn ends up not less than 2 inches (50.8 mm) to form end dams.
   5. Install metal drip edges with sawtooth sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
   6. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (12.7 mm) back from outside face of wall, and adhere flexible flashing to top of metal drip edge.

C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall.

Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

D. Install reglets and nailers for flashing and other related construction where they are indicated to be built into masonry.

E. Install weep holes in exterior wythes and veneers in head joints of first course of masonry immediately above embedded flashing.
   1. Use open-head joints to form weep holes.
   2. Space weep holes 24 inches (609.6 mm) o.c. unless otherwise indicated.

F. Place pea gravel in cavities as soon as practical to a height equal to height of first course above top of flashing, but not less than 2 inches (50.8 mm), to maintain drainage.
   1. Fill cavities full height by placing pea gravel in cavities as masonry is laid, so that at any point, masonry does not extend more than 24 inches (609.6 mm) above top of pea gravel.

G. Place cavity drainage material in cavities airspace behind veneers to comply with configuration requirements for cavity drainage material in "Accessories" Article.

H. Install cavity vents in head joints in exterior wythes at spacing indicated. Use open-head joints to form cavity vents.
   1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

### 3.11 REINFORCED UNIT MASONRY

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 that of other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
   1. Comply with requirements in TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
   2. Limit height of vertical grout pours to not more than 60 inches (1524 mm).

### 3.12 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
   2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.

3. Protect adjacent stone and non masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
6. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

### 3.13 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.

C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

**END OF SECTION**

**SECTION 051200**

**STRUCTURAL STEEL FRAMING**

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Structural steel.

### 1.2 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.

### 1.3 ACTION SUBMITTALS

A. Product Data:

1. Structural-steel materials.
2. Shop primer.

B. Shop Drawings: Show fabrication of structural-steel components.

### 1.4 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU or is accredited by the IAS Fabricator Inspection Program for Structural Steel (Acceptance Criteria 172).

B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. Comply with applicable provisions of the following specifications and documents:

1. ANSI/AISC 303.
2. ANSI/AISC 360.

## 2.2 STRUCTURAL-STEEL MATERIALS

A. Channels, Angles: ASTM A36/A36M.

B. Plate and Bar: ASTM A36/A36M.

C. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade C structural tubing.

D. Welding Electrodes: Comply with AWS requirements.

## 2.3 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.

## 2.4 SHOP CONNECTIONS

A. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

## 2.5 SHOP PRIMING

A. Shop prime steel surfaces, except the following:

1. Surfaces to be field welded.
2. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
3. Surfaces enclosed in interior construction.

B. Surface Preparation of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:

1. SSPC-SP 2.

C. Priming: Immediately after surface preparation, apply primer in accordance with manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.

B. Maintain erection tolerances of structural steel within ANSI/AISC 303.

## 3.3 FIELD CONNECTIONS

A. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.

## 3.4 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform the following special inspections:

1. Verify structural-steel materials and inspect steel frame joint details.
2. Verify weld materials and inspect welds.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

1. Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M.
   a. In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
      1) Liquid Penetrant Inspection: ASTM E165/E165M.

**END OF SECTION**

**SECTION 061000**
**ROUGH CARPENTRY**

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section Includes:
   1. Wood products.
   2. Wood-preservative-treated lumber.
   3. Dimension lumber framing.
   4. Miscellaneous lumber.
   5. Plywood backing panels.

### 1.02 DEFINITIONS

A. Boards or Strips: Lumber of less than 2 inches (50.8 mm) nominal size in least dimension.

B. Dimension Lumber: Lumber of 2 inches (50.8 mm) nominal size or greater but less than 5 inches nominal size in least dimension.

C. Exposed Framing: Framing not concealed by other construction.

D. Lumber grading agencies, and abbreviations used to reference them, include the following:
   1. NLGA: National Lumber Grades Authority.
   2. SPIB: The Southern Pine Inspection Bureau.

### 1.03 REFERENCE STANDARDS

A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

B. ASTM D2898 - Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing; 2010 (Reapproved 2024).

C. ASTM D3498 - Standard Specification for Adhesives for Field-Gluing Wood Structural Panels (Plywood or Oriented Strand Board) to Wood Based Floor System Framing; 2019a.

D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

E. AWPA M4 - Standard for the Handling, Storage, Field Fabrication and Field Treatment of Preservative-Treated Wood Products; 2026.

F. AWPA U1 - Use Category System: User Specification for Treated Wood; 2025.

G. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2018, with Editorial Revision (2020).

H. ICC-ES AC58 - Acceptance Criteria for Adhesive Anchors in Cracked and Uncracked Masonry Elements; 2022.

I. ICC-ES AC70 - Acceptance Criteria for Power-Actuated Fasteners Driven into Concrete, Steel and Masonry Elements; 2019, with Editorial Revision (2021).

J. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2017, with Editorial Revision (2020).

K. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2023.

L. PS 1 - Structural Plywood; 2023.

M. PS 20 - American Softwood Lumber Standard; 2025.

### 1.04 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 in accordance with ASTM D5664.
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.

### 1.05 DELIVERY, STORAGE, AND HANDLING

A. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

## PART 2 PRODUCTS

### 2.01 WOOD PRODUCTS

A. Lumber: Comply with DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
   1. Factory mark each piece of lumber with grade stamp of grading agency.
   2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece.
   3. 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 wood products.
   4. Dress lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content:
   1. Boards: 15 percent.
   2. Dimension Lumber: 15 percent for 2-inch nominal thickness or less; 19 percent for more than 2-inch nominal thickness unless otherwise indicated.

### 2.02 WOOD-PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA U1, Use categories as follows:
   1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.
   2. For exposed items indicated to receive a stained or natural finish, chemical formulations are not to require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

B. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
   1. For exposed lumber indicated to receive a stained or natural finish, omit marking and provide certificates of treatment compliance issued by inspection agency.

C. Application: Treat items indicated on Drawings, 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.
   3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.

4. Wood framing members that are less than 18 inches (457.2 mm) above the ground in crawlspaces or unexcavated areas.
5. Wood floor plates that are installed over concrete slabs-on-grade.

## 2.03 FIRE-RETARDANT-TREATED LUMBER

A. General: Where fire-retardant-treated materials are indicated, materials are to comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire--response characteristics specified as determined by testing identical products per method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (320.04 cm) beyond the centerline of the burners at any time during the test.
   1. Treatment is not to promote corrosion of metal fasteners.
   2. Exterior Type: Treated materials are to comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering in accordance with ASTM D2898. Use for exterior locations and where indicated.
   3. Interior Type A: Treated materials are to have a moisture content of 28 percent or less when tested in accordance with ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.
   4. Design Value Adjustment Factors: Treated lumber is to be tested according to ASTM D5664 and design value adjustment factors are to be calculated according to ASTM D6841.

C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent. Kiln-dry plywood after treatment to maximum moisture content of 15 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency and other information required by authorities having jurisdiction.

E. For exposed items indicated to receive a stained or natural finish, chemical formulations are not to bleed through, contain colorants, or otherwise adversely affect finishes.

F. Application: Treat items indicated on Drawings, and the following:
   1. Concealed blocking.
   2. Plywood backing panels.

## 2.04 DIMENSION LUMBER FRAMING

A. Non-Load-Bearing Interior Partitions by Grade: Construction or No. 2 grade.
   1. Application: All interior partitions
   2. Species:
      a. Southern pine or mixed southern pine; SPIB.
      b. Spruce-pine-fir; NLGA.
      c. Hem-fir; WCLIB, or WWPA.
      d. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
      e. Eastern softwoods; NeLMA.

B. Load-Bearing Partitions by Grade: No. 2 grade.
   1. Application: Exterior walls and interior load-bearing partitions.
   2. Species:
      a. Southern pine; SPIB.
      b. Douglas fir-larch; WCLIB or WWPA.
      c. Southern pine or mixed southern pine; SPIB.
      d. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
      e. Southern pine; SPIB.
      f. Southern pine or mixed southern pine; SPIB.

g. Douglas fir-south; WWPA.
h. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.

**2.05 MISCELLANEOUS LUMBER**

A. Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
   1. Blocking.

B. Dimension Lumber Items: Construction or No. 2
   1. Spruce-pine-fir; NLGA.

C. Concealed Boards: 15 percent maximum moisture content and the following species and grades:
   1. Mixed southern pine or southern pine; No. 2 grade; SPIB.

D. Roofing Nailers: Structural- or No. 2-grade lumber or better; kiln-dried Douglas fir, southern pine, or wood having similar decay-resistant properties.

E. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

F. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

**2.06 PLYWOOD BACKING PANELS**

A. Equipment Backing Panels: Plywood, DOC PS 1, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

**2.07 FASTENERS**

A. General: Fasteners are to be of size and type indicated and comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches (38 mm) into wood substrate.
   1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M or ASTM F2329.

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 ICC-ES AC58 ICC-ES AC193 or ICC-ES AC308 as appropriate for the substrate.

**2.08 MISCELLANEOUS MATERIALS**

A. Sill-Sealer Gaskets:
   1. Glass-fiber-resilient insulation, fabricated in strip form, for use as a sill sealer; 1-inch nominal thickness, compressible to 1/32 inch (0.79 mm); selected from manufacturer's standard widths to suit width of sill members indicated.
   2. Closed-cell neoprene foam, 1/4 inch (6.35 mm) thick, selected from manufacturer's standard widths to suit width of sill members indicated.
   3. Self-adhering sheet consisting of 64 mils (1.6256 mm) of rubberized asphalt laminated on one side to a 4-mil- thick, polyethylene-film reinforcement, and with release liner on adhesive side

B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.64 mm).

C. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D3498 that is approved for use indicated by adhesive manufacturer.

D. Water-Repellent Preservative: NWWDA-tested and -accepted formulation containing 3-iodo-2-propynyl butyl carbamate, combined with an insecticide containing chloropyrifos as its active ingredient.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

B. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.

C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.

D. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.

E. Install sill sealer gasket to form continuous seal between sill plates and foundation walls.

F. Install sill sealer gasket/termite barrier in accordance with manufacturer's written instructions at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

G. Do not splice structural members between supports unless otherwise indicated.

H. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
   1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406.4 mm) o.c.

I. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
   1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
   2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches (2438.4 mm) o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal thickness.
   3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. and to solidly fill space below partitions.
   4. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet (609.6 cm) o.c.

J. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

K. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
   1. Use inorganic boron for items that are continuously protected from liquid water.
   2. Use copper naphthenate for items not continuously protected from liquid water.

L. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

M. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
   1. Table 2304.10.1, "Fastening Schedule," in ICC's International Building Code (IBC).
   2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
   3. ICC-ES evaluation report for fastener.

N. Securely attach roofing nailers to substrates by anchoring and fastening to withstand bending, shear, or other stresses imparted by Project wind loads and fastener-resistance loads as designed in accordance with ASCE/SEI 7.

O. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

**3.02 PROTECTION**

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

**END OF SECTION**

# SECTION 061600
# SHEATHING

## PART 1 GENERAL

### 1.01 REFERENCE STANDARDS

A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

B. ASTM C834 - Standard Specification for Latex Sealants; 2017 (Reapproved 2023).

C. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2022.

D. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2024.

E. ICC-ES AC70 - Acceptance Criteria for Power-Actuated Fasteners Driven into Concrete, Steel and Masonry Elements; 2019, with Editorial Revision (2021).

### 1.02 SUMMARY

A. Section Includes:
   1. Wall sheathing.
   2. Sheathing joint-and-penetration treatment materials.

B. Related Requirements:
   1. Section 061000 "Rough Carpentry" for plywood backing panels.
   2. Section 072726 "Fluid Applied Membrane Air Barrier" for water-resistive barrier applied over wall sheathing.

### 1.03 ACTION SUBMITTALS

A. Product Data:
   1. Wall sheathing.

B. Product Data Submittals: 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 plywood complies 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 plywood complies with requirements. Include physical properties of treated materials.
   3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency in accordance with ASTM D5516.
   4. For products receiving waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
   5. For air-barrier and water-resistant glass-mat gypsum sheathing, include manufacturer's technical data and tested physical and performance properties of products.

C. Shop Drawings: For air-barrier and water-resistant glass-mat gypsum sheathing assemblies.
   1. Show locations and extent of sheathing, accessories, and assemblies specific to Project conditions.
   2. Include details for sheathing joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
   3. Include details of interfaces with other materials that form part of air barrier.

### 1.04 INFORMATIONAL SUBMITTALS

A. Product Certificates: From air-barrier and water-resistant glass-mat gypsum sheathing manufacturer, certifying compatibility of sheathing accessory materials with Project materials that connect to or that come in contact with the sheathing.

B. Product Test Reports: For each air-barrier and water-resistant glass-mat gypsum sheathing assembly, indicating compliance with specified requirements, for tests performed by a qualified testing agency.

C. Field quality-control reports.

### 1.05 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

## PART 2 PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

A. Air-Barrier and Water-Resistant Glass-Mat Gypsum Sheathing Performance: Air-barrier and water-resistant glass-mat gypsum sheathing assembly, and seals with adjacent construction, are to be capable of performing as a continuous air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies are to be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed waterproofing , tie-ins to other installed air barriers, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

### 2.02 WALL SHEATHING

A. Glass-Mat Gypsum Sheathing, Walls: ASTM C1177/C1177M.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. CertainTeed; SAINT-GOBAIN
      b. Continental Building Products Inc.
      c. Georgia-Pacific Gypsum LLC
      d. Gold Bond Building Products, LLC provided by National Gypsum Company
      e. USG Corporation
   2. Type and Thickness: Regular, 1/2 inch (12.7 mm) thick.
   3. Size: 48 by 96 inches (2438.4 mm) for vertical installation.

### 2.03 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
   1. For wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Screws for Fastening Sheathing to Wood Framing: ASTM C1002.

### 2.04 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

A. Sealant for Paper-Surfaced and Glass-Mat Gypsum Sheathing: Elastomeric, medium-modulus, neutral-curing silicone joint sealant compatible with joint substrates formed by gypsum sheathing and other materials, recommended by sheathing manufacturer for application indicated and complying with requirements for elastomeric sealants specified in Section 079200 "Joint Sealants."

B. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.

1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2 inches (50.8 mm) wide, 10 by 10 or 10 by 20 threads/inch, of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.

## PART 3 EXECUTION

### 3.01 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:
   1. Table 2304.10.1, "Fastening Schedule," in the ICC's International Building Code.
   2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in the ICC's International Residential Code for One- and Two-Family Dwellings.
   3. ICC-ES evaluation report for fastener.

D. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.

E. Coordinate wall sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

### 3.02 INSTALLATION OF GYPSUM SHEATHING

A. Comply with GA-253 and with manufacturer's written instructions.
   1. Fasten gypsum sheathing to wood framing with screws.
   2. Install panels with a 3/8-inch gap where non-load-bearing construction abuts structural elements.
   3. Install panels with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.

C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent panels without forcing. Abut ends over centers of studs, and stagger end joints of adjacent panels not less than one stud spacing. Attach at perimeter and within field of panel to each stud.
   1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of panels.

D. Vertical Installation: Install vertical edges centered over studs. Abut ends and edges with those of adjacent panels. Attach at perimeter and within field of panel to each stud.
   1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of panels.
   2. For sheathing under stucco cladding, panels may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

E. Seal sheathing joints in accordance with sheathing manufacturer's written instructions.

1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

F. Air-Barrier and Water-Resistant Glass-Mat Gypsum Sheathing:
1. Install accessory materials in accordance with sheathing manufacturer's written instructions and details to form a seal with adjacent construction, to seal fasteners, and ensure continuity of air and water barrier.
   a. Coordinate the installation of sheathing with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
   b. Install transition strip on roofing membrane or base flashing, so that a minimum of 3 inches (76.2 mm) of coverage is achieved over each substrate.
2. Connect and seal sheathing material continuously to air barriers specified under other Sections as well as to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
3. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
4. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition strip, so that a minimum of 3 inches (76.2 mm) of coverage is achieved over each substrate. Maintain 3 inches of full contact over firm bearing to perimeter frames, with not less than 1 inch (25.4 mm) of full contact.
   a. Transition Strip: Roll firmly to enhance adhesion.
5. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, doors, and miscellaneous penetrations of sheathing material with foam sealant.
6. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.
7. Seal top of through-wall flashings to sheathing with an additional 6-inch- wide, transition strip.
8. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counter flashings or ending in reglets with termination mastic.
9. Repair punctures, voids, and deficient lapped seams in strips and transition strips extending 6 inches (152.4 mm) beyond repaired areas in strip direction.

## 3.03 FIELD QUALITY CONTROL

A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.

B. Air barriers will be considered defective if they do not pass tests and inspections.

C. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

D. Prepare test and inspection reports.

**END OF SECTION**

SECTION 061753

SHOP-FABRICATED WOOD TRUSSES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Wood roof trusses.
2. Wood girder trusses.

### 1.2 ACTION SUBMITTALS

A. Product Data: For metal-plate connectors, metal truss accessories, and fasteners.

B. Shop Drawings: Show fabrication and installation details for trusses.

1. Show location, pitch, span, camber, configuration, and spacing for each type of truss required.
2. Indicate sizes, stress grades, and species of lumber.
3. Indicate locations of permanent bracing required to prevent buckling of individual truss members due to design loads.
4. Indicate locations, sizes, and materials for permanent bracing required to prevent buckling of individual truss members due to design loads.
5. Indicate type, size, material, finish, design values, orientation, and location of metal connector plates.
6. Show splice details and bearing details.

### 1.3 QUALITY ASSURANCE

A. Metal Connector-Plate Manufacturer Qualifications: A manufacturer that is a member of TPI and that complies with quality-control procedures in TPI 1 for manufacture of connector plates.

1. Manufacturer's responsibilities include providing professional engineering services needed to assume engineering responsibility.
2. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

B. Fabricator Qualifications: Shop that participates in a recognized quality-assurance program, complies with quality-control procedures in TPI 1, and involves third-party inspection by an independent testing and inspecting agency acceptable to Architect and authorities having jurisdiction .

## 1.4 DELIVERY, STORAGE, AND HANDLING

A. Handle and store trusses to comply with recommendations in SBCA BCSI, "Building Component Safety Information: Guide to Good Practice for Handling, Installing, Restraining, & Bracing Metal Plate Connected Wood Trusses."

# PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design metal-plate-connected wood trusses.

B. Comply with applicable requirements and recommendations of TPI 1, TPI DSB, and SBCA BCSI.

C. Wood Structural Design Standard: Comply with applicable requirements in AF&PA's "National Design Specifications for Wood Construction" and its "Supplement."

## 2.2 DIMENSION LUMBER

A. Lumber: DOC PS 20 and applicable rules of any rules-writing agency certified by the American Lumber Standard Committee (ALSC) Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Provide dry lumber with 19 percent maximum moisture content at time of dressing.

B. Permanent Bracing: Provide wood bracing that complies with requirements for miscellaneous lumber in Section 061000 "Rough Carpentry."

## 2.3 FASTENERS

A. Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Provide fasteners for use with metal framing anchors that comply with written recommendations of metal framing manufacturer.
2. Where trusses are exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.

B. Nails, Brads, and Staples: ASTM F1667.

## 2.4 FABRICATION

A. Assemble truss members in design configuration indicated; use jigs or other means to ensure uniformity and accuracy of assembly, with joints closely fitted to comply with tolerances in TPI 1. Position members to produce design camber indicated.

1. Fabricate wood trusses within manufacturing tolerances in TPI 1.

B. Connect truss members by metal connector plates located and securely embedded simultaneously in both sides of wood members by air or hydraulic press.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install wood trusses only after supporting construction is in place and is braced and secured.

B. If trusses are delivered to Project site in more than one piece, assemble trusses before installing.

C. Hoist trusses in place by lifting equipment suited to sizes and types of trusses required, exercising care not to damage truss members or joints by out-of-plane bending or other causes.

D. Install and brace trusses according to TPI recommendations and as indicated.

E. Anchor trusses securely at bearing points; use metal truss tie-downs or floor truss hangers as applicable. Install fasteners through each fastener hole in metal framing anchors according to manufacturer's fastening schedules and written instructions.

F. Securely connect each truss ply required for forming built-up girder trusses.

G. Install and fasten permanent bracing during truss erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.

1. Install bracing to comply with Section 061000 "Rough Carpentry."
2. Install and fasten strongback bracing vertically against vertical web of parallel-chord floor trusses at centers indicated.

H. Install wood trusses within installation tolerances in TPI 1.

I. Do not alter trusses in field. Do not cut, drill, notch, or remove truss members.

J. Replace wood trusses that are damaged or do not comply with requirements.

**END OF SECTION**

# SECTION 064116
# PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

## PART 1 GENERAL

### 1.01 REFERENCE STANDARDS

A. ANSI - American National Standards Institute; N/A.

B. ANSI A208.1 - American National Standard for Particleboard; 2022.

C. ANSI A208.2 - Medium Density Fiberboard (MDF) for Interior Applications; 2022.

D. BHMA A156.9 - Cabinet Hardware; 2020.

E. BHMA A156.11 - American National Standard for Cabinet Locks; 2024.

F. BHMA A156.16 - Standard for Auxiliary Hardware; 2023.

G. BHMA A156.18 - Standard for Materials and Finishes; 2020.

H. ISO 4586-3 - High-Pressure Decorative Laminates (HPL, HPDL) – Sheets Based on Thermosetting Resins (Usually Called Laminates) – Part 3: Classification and Specifications for Laminates Less than 2 mm Thick and Intended for Bonding to Supporting Substrates; 2018.

I. PS 1 - Structural Plywood; 2023.

### 1.02 SUMMARY

A. Section Includes:
   1. Plastic-laminate-clad architectural cabinets.
   2. Cabinet hardware and accessories.
   3. Miscellaneous materials.

B. Related Requirements:
   1. Section 061000 "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing cabinets that are concealed within other construction before cabinet installation.

### 1.03 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.

### 1.04 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

### 1.05 ACTION SUBMITTALS

A. Product Data:
   1. Plastic-laminate-clad architectural cabinets.
   2. Cabinet hardware and accessories.
   3. Miscellaneous materials.

B. Product Data Submittals: For each product.

C. Shop Drawings:
   1. Include plans, elevations, sections, and attachment details.
   2. Show large-scale details.
   3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
   4. Show locations and sizes of cutouts and holes for items installed in plastic-laminate architectural cabinets.

D. Samples: For each exposed product and for each color and texture specified, in manufacturer's or manufacturer's standard size.

E. Samples for Initial Selection: For each type of exposed finish.

F. Samples for Verification: For the following:
   1. Plastic Laminates: 8 by 10 inches (254 mm), for each type, color, pattern, and surface finish required.
      a. Provide one sample applied to core material with specified edge material applied to one edge.
   2. Exposed Cabinet Hardware and Accessories: One full-size unit for each type and finish.

### 1.06 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

### 1.07 FIELD CONDITIONS

A. Environmental Limitations without Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

B. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
   1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction, and indicate measurements on Shop Drawings.

C. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

## PART 2 PRODUCTS

### 2.01 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of cabinets indicated for construction, finishes, installation, and other requirements.
   1. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with requirements of Contract Documents in addition to those of the referenced quality standard.

B. Architectural Woodwork Standards Grade: Premium.

C. Type of Construction: Frameless.

D. Door and Drawer-Front Style: Flush overlay.
   1. Reveal Dimension: 1/2 inch (12.7 mm).

E. High-Pressure Decorative Laminate: ISO 4586-3, grades as indicated or if not indicated, as required by quality standard.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. ABET Inc.
      b. Formica Corporation
      c. Laminart LLC
      d. Pionite; a Panolam Industries International, Inc. brand
      e. Wilsonart LLC

F. Exposed Surfaces:

1. Plastic-Laminate Grade: HGS VGS HGP.
2. Edges: Grade HGS Grade VGS.
3. Pattern Direction: As indicated.

G. Semi exposed Surfaces:
1. Surfaces Other Than Drawer Bodies: Thermally fused laminate panels.
a. Edges of Plastic-Laminate Shelves: PVC edge banding, 0.12 inch (3 mm) thick, matching laminate in color, pattern, and finish.
b. Edges of Thermally Fused Laminate Panel Shelves: PVC or polyester edge banding.
c. For semi exposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, ISO 4586-3, grade to match exposed surface.
2. Drawer Sides and Backs: Solid-hardwood lumber.
3. Drawer Bottoms: Hardwood plywood.

H. Dust Panels: 1/4-inch plywood or tempered hardboard above compartments and drawers unless located directly under tops.

I. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, ISO 4583-3, grade to match exposed surface.

J. Drawer Construction: Fabricate with exposed fronts fastened to sub front with mounting screws from interior of body.
1. Join sub fronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners or glued dovetail joints.

K. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
1. As indicated by laminate manufacturer's designations.
2. Match Architect's sample.
3. As selected by Architect from laminate manufacturer's full range in the following categories:
a. Solid colors, matte finish.
b. Solid colors with core same color as surface, matte finish.
c. Wood grains, gloss finish.
d. Patterns, matte finish.

## 2.02 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

B. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
1. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130.
2. Particleboard (Medium Density): ANSI A208.1, Grade M-2-Exterior Glue.
3. Softwood Plywood: DOC PS 1, medium-density overlay.
4. Thermally Fused Laminate (TFL) Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of ISO 4586.

## 2.03 CABINET HARDWARE AND ACCESSORIES

A. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, B01602, 135 degrees of opening, self-closing.

B. Back-Mounted Pulls: ANSI/BHMA A156.9, B02011.

C. Wire Pulls: Back mounted, solid metal, 4 inches (101.6 mm) long, 5/16 inch (7.94 mm) in diameter.

D. Catches: Magnetic catches, ANSI/BHMA A156.9, B03141.

E. Adjustable Shelf Standards and Supports: ANSI/BHMA A156.9, B04071; with shelf rests, B04081.

F. Shelf Rests: ANSI/BHMA A156.9, B04013; two-pin plastic with shelf hold-down clip.

G. Drawer Slides: ANSI/BHMA A156.9.
   1. Standard Duty (Grade 1 and Grade 2): Side mount.
   2. Heavy-Duty (Grade 1HD-100 and Grade 1HD-200): Side mount.
      a. Type: Full extension.
      b. Material: Galvanized steel ball bearing slides.
      c. Motion Feature: Soft close dampener.
   3. Pencil drawers not more than 3 inches (76.2 mm) high and not more than 24 inches (609.6 mm) wide, provide 50 lb load capacity.
   4. General-purpose drawers more than 3 inches (76.2 mm) high, but not more than 6 inches (152.4 mm) high and not more than 24 inches (609.6 mm) wide, provide 75 lb load capacity.
   5. File drawers more than 6 inches (152.4 mm) high or more than 24 inches (609.6 mm) wide, provide 100 lb load capacity.
   6. Lateral file drawers more than 6 inches (152.4 mm) high and more than 30 inches (762 mm) wide, provide 200 lb load capacity.
   7. Computer keyboard tray, provide 75 lb load capacity.

H. Door Locks: ANSI/BHMA A156.11, E07121.

I. Drawer Locks: ANSI/BHMA A156.11, E07041.

J. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.

K. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with ANSI/BHMA A156.18 for ANSI/BHMA finish number indicated.

L. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.

## 2.04 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln-dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

## 2.05 FABRICATION

A. Fabricate architectural cabinets to dimensions, profiles, and details indicated.

B. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
   1. Notify Architect seven days in advance of the dates and times architectural cabinet fabrication will be complete.
   2. Trial fit assemblies at manufacturer's shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.

C. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

D. Install glass to comply with applicable requirements in Section 088000 "Glazing" and in GANA's "Glazing Manual."
   1. For glass in frames, secure glass with removable stops.
   2. For exposed glass edges, polish and grind smooth.

## PART 3 EXECUTION

### 3.01 PREPARATION

A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

### 3.02 INSTALLATION

A. Architectural Woodwork Standards Grade: Install cabinets to comply with quality standard grade of item to be installed.

B. Assemble cabinets and complete fabrication at Project site to extent that it was not completed in the shop.

C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.

D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches (2438.4 mm) using concealed shims.
   1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
   2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
   3. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches (406.4 mm) o.c. with No. 10 wafer-head screws sized for not less than 1-1/2-inch penetration into wood framing, blocking, or hanging strips.

### 3.03 ADJUSTING AND CLEANING

A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects. Where not possible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean cabinets on exposed and semi exposed surfaces.

**END OF SECTION**

# SECTION 066100
# CAST POLYMER FABRICATIONS

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Quartz surfacing fabrications.

### 1.02 REFERENCE STANDARDS

A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

### 1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Manufacturer's data for fabricated units.

C. Shop Drawings: For each type of cast polymer, indicate:
   1. Plans and Elevations: Include dimensions and unit serial numbers; indicate location of fabricated units.

D. Samples: For each Counter top type, two samples, 4 inches (102 mm) in length, indicating specified color.

E. Operation and Maintenance Data: Maintenance instructions, including recommended cleaning procedures and materials.

F. Executed warranty.

### 1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with minimum three years of documented experience.

### 1.05 DELIVERY, STORAGE, AND HANDLING

A. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.

### 1.06 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Quartz Surfacing Fabrications:
   1. Basis of Design: Corian Quartz by Dupont : www.corianquartz.com.

### 2.02 REGULATORY REQUIREMENTS

A. Surface Burning Requirements:
   1. Interior Use: Flame spread index of 75 or less and smoke-development index of 450 or less; Class B interior finish classification when tested in accordance with ASTM E84.

### 2.03 QUARTZ SURFACING FABRICATIONS

A. Applications: Counter tops.
   1. Type: Slabs.
      a. Thickness: 15/32 inch (1.2 cm).
   2. Type: Thin format.
      a. Thickness: 1/4 inch (6 mm).
      b. Substrate: 3/4" plywood.
   3. Finish: As indicated on drawings.
   4. Color: As indicated on drawings.
   5. Exposed Edge Profile: As indicated on drawings.

### 2.04 FABRICATION

A. Fabricate units with embedded anchors, stiffening ribs, and sufficient strength for handling and placement stresses.

B. Fabricate cutouts where indicated.

C. Radius corners and edges with 1/4 inch (6.4 mm) minimum radius; polish exposed edges.

D. Provide consistent finish over exposed surfaces matching approved samples.

E. Fill seams and mold lines; grind smooth and finish to match adjacent cast polymer surfaces.

F. Built-Up Edges: Laminate components where design requirements indicate built-up edges; follow manufacturer's recommended procedures for laminating.

G. Fabrication Tolerances:
   1. Maximum Variation from Specified Thicknesses: 1/16 inch (1.59 mm).
   2. Maximum Variation from Specified Dimensions: 1/8 inch (3.18 mm).
   3. Maximum Variation from Dimensioned Cutout Locations: 1/4 inch (6.35 mm).

### 2.05 ACCESSORIES

A. General: Accessories recommended by cast polymer manufacturer for complete installation.

B. Adhesives: Type recommended by cast polymer manufacturer for application; not containing formaldehyde or volatile organic compounds.

C. Joint Sealants: Type recommended by cast polymer manufacturer for application.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Verify field measurements are as indicated on shop drawings.

B. Verify substrates are prepared to receive cast polymer fabrications.

C. If substrate preparation is responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

D. Verify mechanical, electrical, and other building components affecting work of this section are placed and ready to receive work of this section.

### 3.02 PREPARATION

A. Prepare substrates in accordance with manufacturer's written instructions.

### 3.03 INSTALLATION

A. Install cast polymer units in accordance with manufacturer's written instructions.

B. Install Counter top panels over continuous substrate.

C. Rigidly anchor to substrate to prevent misalignment.

### 3.04 TOLERANCES

A. Maximum Variation from True Position: 1/4 inch (6.4 mm).

B. Maximum Variation from Plumb: 1/4 inch in 10 feet (2 mm in 1 m).

C. Maximum Variation from Level: 1/4 inch in 10 feet (2 mm in 1 m).

### 3.05 CLEANING

A. Clean exposed surfaces of installed units in accordance with manufacturer's instructions.

### 3.06 PROTECTION

A. Protect installed cast polymer units from subsequent construction operations.

**END OF SECTION**

# SECTION 072100
# THERMAL INSULATION

## PART 1 GENERAL

### 1.01 REFERENCE STANDARDS

A. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2024.

B. ASTM C764 - Standard Specification for Mineral Fiber Loose-Fill Thermal Insulation; 2025.

C. ASTM C1029 - Standard Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation; 2025.

D. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2025.

E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

F. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C; 2026.

### 1.02 SUMMARY

A. Section Includes:
   1. Polyisocyanurate foam-plastic board insulation.
   2. Glass-fiber blanket insulation.

B. Related Requirements:
   1. Section 042000 "Unit Masonry" for insulation installed in masonry cells.
   2. Section 071416 "Cold Fluid-Applied Waterproofing"
   3. Section 072119 "Foamed-in-Place Insulation" for spray-applied polyurethane foam insulation.

### 1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

### 1.04 INFORMATIONAL SUBMITTALS

A. Installer's Certification: Listing type, manufacturer, and R-value of insulation installed in each element of the building thermal envelope.
   1. For blown-in or sprayed fiberglass and cellulosic-fiber loose-fill insulation, indicate initial installed thickness, settled thickness, settled R-value, installed density, coverage area, and number of bags installed.
   2. Sign, date, and post the certification in a conspicuous location on Project site.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Research Reports: For foam-plastic insulation, from ICC-ES.

### 1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:
   1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
   2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
   3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

## PART 2 PRODUCTS

### 2.01 POLYISOCYANURATE FOAM-PLASTIC BOARD INSULATION

A. Polyisocyanurate Board Insulation, Glass-Fiber-Mat Faced: ASTM C1289, glass-fiber-mat faced, Type II, Class 2.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Atlas Polyiso Roof and Wall Insulation
      b. Carlisle Coatings & Waterproofing Inc
      c. Elevate; Holcim Building Envelope
      d. Hunter Panels; a Carlisle company
      e. Johns Manville; a Berkshire Hathaway company

### 2.02 GLASS-FIBER BLANKET INSULATION

A. Glass-Fiber Blanket Insulation, Unfaced: ASTM C665, Type I; passing ASTM E136 for combustion characteristics.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. CertainTeed; SAINT-GOBAIN
      b. Johns Manville; a Berkshire Hathaway company
      c. Knauf Insulation
      d. Owens Corning

### 2.03 INSULATION FASTENERS

A. Insulation Fastener Accessories: Provide double-pointed weld pins, lagging pins, quilting pins, duct liner pins, insulation hangers, specialty washers, special caps, j-hooks, capacitor discharge annular weld pins, capacitor discharge acoustical lagging pins, and other accessory materials that are recommended in writing by insulation fastener manufacturer to produce complete insulation supports.

### 2.04 ACCESSORIES

A. Insulation for Miscellaneous Voids:
   1. Glass-Fiber Insulation: ASTM C764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E84.
   2. Spray Polyurethane Foam Insulation: ASTM C1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.

B. Miscellaneous Application Accessories:
   1. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.
   2. Detailing Foam Insulation for Voids: Urethane foam complying with AAMA 812, low expansion pressure suitable for filling insulation gaps and voids adjacent to openings to protect against water, air, and sound intrusion.
   3. Tapes for Reflective Insulation and Barriers:
      a. Reinforced-foil tape for sealing tears or cuts in sheet vapor barrier.

## PART 3 EXECUTION

### 3.01 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or those that interfere with insulation attachment.

### 3.02 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products, applications and applicable codes.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Install insulation with manufacturer's R-value label exposed after insulation is installed.

D. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

E. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

### 3.03 INSTALLATION OF CAVITY-WALL INSULATION

A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches o.c. both ways on inside face and as recommended in writing by manufacturer.
   1. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions, and with faces flush.
   2. Press units firmly against inside substrates.
   3. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Section 042000 "Unit Masonry."

### 3.04 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

A. Blanket Insulation: Install in cavities formed by framing members in accordance with the following requirements:
   1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
   2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
   3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
   4. Attics: Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
   5. Where glass-fiber blankets are indicated for sound attenuation above ceilings, install unfaced blanket insulation over ceiling area in thickness indicated. Where partitions occur, extend insulation up either side of partition.
   6. For wood-framed construction, install blankets in accordance with ASTM C1320 and as follows:
      a. With faced blankets having stapling flanges, lap blanket flange over flange of adjacent blanket to maintain continuity of vapor retarder once finish material is installed over it.

B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
   1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft..
   2. Detailing Foam Insulation for Voids: Apply in accordance with manufacturer's written instructions.

C. Spray-Applied Cellulosic Insulation: Apply spray-applied insulation in accordance with manufacturer's written instructions.
   1. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked.

2. After insulation is applied, make flush with face of studs by using method recommended by insulation manufacturer.

**3.05 INSTALLATION OF BOARD INSULATION**

A. Install board insulation in accordance with manufacturer's written instructions per project applications and conditions.

**3.06 PROTECTION**

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.

B. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

**END OF SECTION**

# SECTION 072616
# UNDER SLAB VAPOR RETARDERS

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Surface preparation.

B. Application of an under-slab membrane vapor retarder system.

### 1.02 REFERENCE STANDARDS

A. ASTM D1709 - Standard Test Methods for Impact Resistance of Plastic Film by the Free-Falling Dart Method; 2024.

B. ASTM E1643 - Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs; 2024.

C. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2017 (Reapproved 2023).

D. ASTM F1249 - Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor; 2025.

### 1.03 RELATED SECTIONS

A. Section 03 30 00 – Cast-in-Place Concrete.

### 1.04 REFERENCES

A. ACI 302.2R - Concrete Slabs that Receive Moisture-Sensitive Flooring Materials—Guide.

B. ASTM D1709 - Standard Test Methods for Impact Resistance of Plastic Film by the Free-Falling Dart Method.

C. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

D. ASTM E154 - Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.

E. ASTM E1643 - Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.

F. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.

G. ASTM F1249 - Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.

H. K124/02/95 - Determination of Radon Transmittance.

### 1.05 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Procedures.

B. Submit manufacturer's product data and application instructions.

### 1.06 QUALITY ASSURANCE

A. Use an experienced installer and adequate number of skilled personnel who are thoroughly trained and experienced in the application of the membrane retarder system.

B. Obtain membrane retarder materials from a single manufacturer regularly engaged in manufacturing the product.

C. Provide products which comply with all state and local regulations controlling use of volatile organic compounds (VOCs).

### 1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to project site in manufacturer's original, unopened packaging, with labels clearly identifying the manufacturer and product name.

B. Store materials in a clean, dry area in accordance with manufacturer's instructions.

C. Protect materials during handling and application to prevent damage or contamination.

**1.08 ENVIRONMENTAL REQUIREMENTS**

A. Product is not intended for conditions subject to abuse or permanent exposure to the elements.

B. Do not apply on frozen ground.

**PART 2 PRODUCTS**

**2.01 MANUFACTURER**

A. W. R. MEADOWS, INC., PO Box 338, Hampshire, Illinois 60140-0338. (800) 342-5976. (847) 683-4500. Fax (847) 683-4544. Web Site www.wrmeadows.com.

**2.02 MATERIALS**

A. 15- Mil Plastic Vapor Retarder
   1. Below-grade vapor retarder manufactured of a new generation of polyolefin-based resin-chemical technology having the following properties:
      a. Water-Vapor Permeance, ASTM E96: 0.0063 perms.
      b. Puncture Resistance, ASTM D1709, Method B: greater than 3200 grams.
      c. Tensile Strength, ASTM E154, Section 9: 70 lb./Force/in. (12.26 kN/m).
      d. Water-Vapor Permeance, After Wet-Out/Dry-Out and Long-Term Soaking, ASTM E154-Section 8; ASTM E96-Method B: 0.0052 perms.
      e. Water-Vapor Permeance, Resistance to Plastic Flow and Elevated Temperatures, ASTM E154-Section 11, ASTM E96-Method B: 0.0067 perms.
      f. Water-Vapor Permeance, Effect Low-Temperature and Flexibility, ASTM E154, Section 12; ASTM E96-Method B: 0.0052 perms.
      g. Water-Vapor Permeance Resistance to Deterioration from Organisms and Substances in Contacting Soil, ASTM E154-Section 13; ASTM E96-Method B: 0.0052 perms.
      h. Radon Transmittance (m/s) K124/02/95: 8.7 x 10-9.
      i. Radon Coefficient (m2/s): 3.3 x 10-12.
   2. Proprietary-Based Specification:
      a. PERMINATOR 15-mil by W. R. MEADOWS.

**2.03 ACCESSORIES**

A. High density polyethylene tape with pressure sensitive adhesive: PERMINATOR TAPE by W.R. Meadows.

B. Primer-adhesive: MEL-PRIME by W. R. MEADOWS.

C. Pipe collars fabricated from PERMINATOR 15-mil vapor retarder and PERMINATOR TAPE by W. R. MEADOWS.

D. Fluid-applied waterproofing for closely spaced penetration clusters: MEL-ROL LM or MEL-ROL LM LIQUID MEMBRANE Two-Component by W. R. MEADOWS.

E. Termination bar: TERMINATION BAR by W. R. MEADOWS.

**PART 3 EXECUTION**

**3.01 EXAMINATION**

A. Examine substrates to receive the membrane retarder system are deemed appropriate in accordance with manufacturer’s current technical literature. Notify architect if substrates are not acceptable. Do not begin the Work until unacceptable conditions have been corrected.

**3.02 SURFACE PREPARATION**

A. Prepare substrates in accordance with manufacturer’s instructions and ASTM E1643. Reference ACI 302.1R-04, Chapter 4, Section 4.1.4 prior to installation of membrane retarder system.

B. Remove surface rust, scale, oils and coatings from metal surfaces to receive pressure sensitive tape. Apply primer-adhesive immediately after and allow to tack up before placing pressure sensitive adhesive tape.

**3.03 INSTALLATION**

A. Install the membrane retarder in accordance with manufacturer's instructions and ASTM E1643.

B. Unroll membrane retarder with the long dimension parallel with the direction of the placement of the concrete.

C. Lap membrane retarder over footings and seal to foundation walls. Position membrane retarder snug to all vertical pipe penetrations.

D. Overlap all lateral and end joints 6 inches (152 mm) and seal with manufacturer's pressure sensitive tape.

E. Seal all penetrations, including pipes, with manufacturer's pressure sensitive tape and pipe collar fabricated from the specified 15-mil membrane retarder.
   1. Cut a minimum 12-inch (304 mm) wide section by one and a half the pipe circumference with 15-mil membrane retarder. Cut "fingers" one half the width of the section.
   2. Wrap non-cut half of pipe collar onto pipe. Apply "fingers" of collar onto surrounding 15-mil membrane retarder.
   3. Completely tape pipe collar to pipe and surrounding 15-mil membrane retarder in accordance with this specification, manufacturer's technical data sheet and installation guidelines.

F. Repair damaged areas with patch sections of the specified membrane retarder. Apply patch sections over compromised areas. Extend 6 inches (152 mm) beyond the damaged onto surrounding membrane. Tape all sides of patch with pressure sensitive tape.

**3.04 PROTECTION**

A. Protect and prevent membrane retarder from physical damage until placement of concrete.

B. Keep UV exposure to no more than 60 days.

**END OF SECTION**

# SECTION 072726
# APPLIED MEMBRANE AIR BARRIERS, VAPOR PERMEABLE

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes fluid-applied, vapor-permeable membrane air barriers.

### 1.02 RELATED REQUIREMENTS

A. Section 06 16 00 "Sheathing" for air barrier substrates and joint treatments.

### 1.03 REFERENCE STANDARDS

A. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018 (Reapproved 2024).

B. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2025.

C. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension; 2016 (Reapproved 2021).

D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

E. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.

F. ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source; 2025a.

G. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials; 2021a.

H. ASTM E2357 - Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies; 2025.

I. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components; 2025.

### 1.04 REFERENCES

A. References, General: Versions of the following cited standards current as of the date of issue of the project apply to the Work of this Section.

B. ASTM International (ASTM): www.astm.org:

C. ASTM C1193 - Guide for Use of Joint Sealants

D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials

E. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials

F. ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source

G. ASTM E2178 - Standard Test Method for Air Permeance of Building Materials

H. ASTM E2357 - Standard Test Method for Determining Air Leakage of Air Barrier Assemblies

I. National Fire Protection Association (NFPA): www.nfpa.org:

J. NFPA 285 - Standard Fire Test Method For Evaluation Of Fire Propagation Characteristics Of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components

### 1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate installation of joint sealants with cleaning of joint sealant substrates and other operations that may impact installation or finished joint sealant work.

B. Preinstallation Conference: Conduct conference at Project Site.

C. Review requirements for air barrier products and installation, project and manufacturer's details, mockups, testing and inspection requirements, and coordination and sequencing of air barrier work with work of other Sections.

D. Review manufacturer's instructions for air barrier application meeting Project requirements for substrates specified, including three-dimensional video model demonstrating proper application of components at wall openings.

**1.06 ACTION SUBMITTALS**

A. Product Data: For each type of air barrier product specified, including:

B. Technical data indicating compliance with requirements.

C. Substrate preparation instructions and recommendations.

D. Shop Drawings: Show locations for air barrier. Show details for each type of substrate, joints, and edge conditions, including flashings, counterflashings, penetrations, transitions, and terminations.

E. Show location of transition and accessory materials providing connectivity throughout the assemblies.

**1.07 INFORMATIONAL SUBMITTALS**

A. Qualification Data: For Installer and manufacturer.

B. Manufacturer's Product Compatibility Certificate: Certify compatibility of air barrier products with adjacent materials.

C. Product Test Reports: Test data for air barrier products and air barrier assembly, by qualified testing agency, indicating proposed membrane air barrier meets performance requirements, when requested by Architect.

D. Warranty: Sample of unexecuted manufacturer and installer special warranties.

E. Field quality control reports.

**1.08 QUALITY ASSURANCE**

A. Installer Qualifications: A firm with minimum three years experience in installation of specified products in successful use on similar projects, employing workers trained by manufacturer, including a full-time on-site supervisor with a minimum of three years experience installing similar work, able to communicate verbally with Contractor, Architect, and employees.

B. Manufacturer Qualifications: A qualified manufacturer listed in this Section with minimum five years experience in manufacture of air barrier membrane as one of its principal products.

C. Manufacturer's product submitted has been in satisfactory operation on five similar installations for at least five years.

D. Approval of Manufacturers and Comparable Products: Submit the following in accordance with project substitution requirements, within time allowed for substitution review:
   1. Completed and signed Substitution Request form.
   2. Product data, including certified independent test data indicating compliance with requirements.
   3. Sample shop drawings from similar project.
   4. Project references: Minimum of five installations of similar system not less than five years old, with Owner and Architect contact information.
   5. Sample warranty.

E. Mockups: Provide air barrier mockup application within mockups required in other sections, or if not specified, in an area of not less than 150 sq. ft. (14 sq. m) of wall surface where directed by Architect for each type of backup wall construction. Include examples of surface preparation, crack and joint treatment, air barrier application, and flashing, transition, and termination conditions, to set quality standards for execution.

F. Include intersection of wall air barrier with roof air barrier and with foundation wall intersection.

### 1.09 DELIVERY, STORAGE AND HANDLING

A. Accept materials on site in manufacturer's unopened original packaging.

B. Store products in weather protected environment, clear of ground and moisture, within temperature ranges recommended by air barrier manufacturer.

C. Construction Waste: Store and dispose of packaging materials and construction waste in accordance with requirements of Division 01 Section "Construction Waste Management"

### 1.10 ENVIRONMENTAL REQUIREMENTS

A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended by air-barrier manufacturer.

B. Protect substrates from environmental conditions that affect air-barrier performance.

C. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

### 1.11 SCHEDULING

A. Coordinate installation of membrane air barrier with completion of roofing and other work requiring interface with air barrier.

B. Schedule work so air barrier applications may be inspected prior to concealment.

C. Ensure air barrier materials are cured before covering with other materials.

### 1.12 WARRANTY

A. Special Manufacturer's Warranty: Manufacturer's standard form in which air barrier manufacturer agrees to furnish and install air barrier material to repair or replace those materials installed according to manufacturer's written instructions that exhibit material defects or otherwise fail to perform as specified under normal use within warranty period specified.

B. Access for Repair: Owner shall provide unimpeded access to the Project and the air barrier system for purposes of testing, leak investigation, and repair, and shall reinstall removed cladding materials upon completion of repair.

C. Cost Limitation: Manufacturer's obligation for repair or replacement shall be limited to the original installed cost of the work.

D. Warranty Period:  years date of Substantial Completion.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Basis-of-Design Products: Provide air barrier products manufactured by Tremco, Inc., Commercial Sealants and Waterproofing Division, An RPM Company, Beachwood OH; (866) 321-6357; email: techresources@tremcoinc.com; www.tremcosealants.com, or comparable products of other manufacturer approved by Architect in accordance with Instructions to Bidders and Division  01  General Requirements.

### 2.02 MATERIALS, GENERAL

A. Source Limitations: Obtain air-barrier materials from single source from single manufacturer.

B. Compatibility: Provide membrane air barrier materials that are compatible with one another and with adjacent materials under conditions of service and application required, as demonstrated by membrane air barrier manufacturer based on testing and field experience.

### 2.03 PERFORMANCE REQUIREMENTS

A. General: Membrane air barrier shall be capable of performing as a continuous vapor-permeable air barrier and as a moisture drainage plane transitioned to adjacent flashings and discharging water to the building exterior. Membrane air barriers shall accommodate substrate movement and seal expansion and control joints, construction material transitions, opening transitions, penetrations, and perimeter conditions without moisture deterioration and air leakage exceeding performance requirements.

B. Air-Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft. (0.2 L/s x sq. m of surface area at 75 Pa), when tested according to ASTM E2357.

C. Fire Propagation Characteristics: Provide air barrier system qualified as a component of a comparable wall assembly that has been tested and passed NFPA 285.

**2.04 MEMBRANE AIR BARRIER**

A. Fluid-Applied, Vapor-Permeable Membrane Air Barrier: Elastomeric, UV-resistant, synthetic membrane, formulated for application in a range of 48 - 70 mils (wet), 25 - 35 mils (dry)

B. Basis of Design Product: Tremco, Inc., ExoAir 230.

C. Air Permeance, ASTM E2178: 0.004 cfm/sq. ft of surface area at 1.57-lbf/sq. ft. (0.02 L/s x sq. m of surface area at 75-Pa) pressure difference, maximum.

D. Vapor Permeance, ASTM E96/E96M: Minimum 12 perms (690 ng/Pa x s x sq. m).

E. Elongation, Ultimate, ASTM D412, Die C: 600 percent, minimum.

F. Combustion Characteristics: Class A, flame spread, not greater than 25; smoke developed, not greater than 450, per ASTM E84.

G. UV Resistance, QUV-B: Over 160 cycles of UV and water spray with no observable deterioration.

H. VOC Content: Less than 50 g/L.

**2.05 ACCESSORY MATERIALS**

A. General: Accessory materials as described in manufacturer's written installation instructions, recommended to produce complete air barrier assembly meeting performance requirements, and compatible with air barrier membrane material and adjacent materials.

B. Primer: Liquid primer meeting VOC limitations, recommended for substrate by membrane air barrier manufacturer, when installing modified bituminous self-adhered membranes.

C. Basis of Design Product: Tremco, Inc., ExoAir Primer

D. Transitions:

E. High Temperature Flashing Strip and Underlayment: Butyl, 18 mil thick self-adhering composite sheet consisting of 12 mils of butyl laminated to 6 mil polyethylene film; thermally stable under intermittent, non-continuous exposure up to 240 deg F (115 deg C). Fixed EA 110AT to show once at the proper mils.
   1. Basis of Design Product: Tremco, Inc., ExoAir 110AT.

F. Opening Transition Assembly: Cured low-modulus silicone extrusion, with reinforcing ribs, sized to fit opening widths, with aluminum race for insertion into aluminum framing extrusions, with the following characteristics:
   1. Basis of Design Product: Tremco, Inc., Proglaze ETA Engineered Transition Assembly. Tear Strength: 110 lb/in (19.3 kN/m)

G. Preformed Silicone-Sealant Extrusion: Manufacturer's standard system consisting of cured low-modulus silicone extrusion, sized to fit opening widths, with manufacturer's recommended silicone sealant for bonding extrusions to substrates.
   1. Basis of Design Product: Tremco, Inc.; Spectrem SimpleSeal.

H. Reinforcing Fabric: High strength mesh fabric consisting of open-weave glass fiber saturated with synthetic resins formulated for high moisture resistance, for reinforcing of liquid applications; not less than 2.5 oz/sq. yd (85 g/sq. m).

I. Basis of Design Product: Tremco, Inc., Tremco 2011.

J. Liquid Joint Sealants:

K. ASTM C920, single-component polyurethane, approved by air barrier manufacturer for adhesion and compatibility with membrane air barrier and accessories.
   1. Basis of Design Product: Tremco, Inc., Dymonic 100.

L. ASTM C920, single-component, neutral-curing silicone, approved by air barrier manufacturer for adhesion and compatibility with membrane air barrier and accessories post installation of the membrane.
   1. Basis of Design Product: Tremco, Inc., Spectrem 1.

M. Single-component STPU, approved by air barrier manufacturer for adhesion and compatibility with membrane air barrier and accessories.
   1. Basis of Design Product: Tremco, Inc., ExoAir DualFlash®.
      a. Sprayed Polyurethane Foam Sealant: Sprayed Polyurethane Foam Sealant: Foamed-in-place, 1.5- to 2.0-lb/cu. ft. (24- to 32-kg/cu. m) density, with flame-spread index of 25 or less per ASTM E162, for filling of gaps at openings and penetrations.

N. Basis of Design; Tremco Inc., Flexible Low Expanding Foam (LEF)

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Surface Condition: Before applying air barrier materials, examine substrate and conditions to ensure substrates are fully cured, smooth, clean, dry, and free from high spots, depressions, loose and foreign particles and other deterrents to adhesion, and conditions comply with manufacturer's written recommendations.

B. Verify concrete and masonry surfaces are visibly dry, have cured for time period recommended by membrane air barrier manufacturer, and are free from release agents, curing agents, and other contaminates.

C. Test for capillary moisture by method recommended in writing by air barrier manufacturer..

D. Verify masonry joints are filled with mortar and struck flush.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INTERFACE WITH OTHER WORK

A. Commencement of Work: Commence work once air barrier substrates are adequately protected from weather and will remain protected during remainder of construction.

B. Sequencing of Work: Coordinate sequencing of air barrier work with work of other sections that form portions of building envelope air barrier to ensure that flashings and transition materials can be properly installed and inspected. Roofing systems shall be capped and sealed, or top of walls protected, in such a way as to eliminate the ability of water to saturate the wall or interior space, both before and after, air barrier system installation. Coordinate installation of EXOAIR® 230 with the roofing trade to ensure compatibility and continuity with the roofing system.

C. Subsequent Work: Coordinate air barrier work with work of other sections installed subsequent to air barrier to ensure complete inspection of installed air barrier and sealing of air barrier penetrations necessitated by subsequent work.

### 3.03 PREPARATION

A. Clean, prepare, and treat substrate in accordance with air barrier manufacturer's written instructions.

B. Mask adjacent finished surfaces.

C. Remove contaminants and film-forming coatings from substrates.

D. Remove projections and excess materials and fill voids with substrate patching material.

E. Prepare and treat joints and cracks in substrate per ASTM C1193 and membrane air barrier manufacturer's written instructions.

### 3.04 APPLICATION OF ACCESSORY MATERIALS

A. General: Install strips, transition strips, and accessory materials according to air-barrier manufacturer's written instructions. Install transition materials and other accessories to form connect and seal membrane air barrier material to adjacent components of building air barrier

system, including, but not limited to, roofing system air barrier, exterior fenestration systems, door framing, and other openings.

B. Primer: Apply primer to substrates when recommended by air barrier manufacturer at required rate for those substrates that will be receiving a modified bituminous self-adhered membrane. Reprime areas not covered within 24 hours.

C. Assembly Transitions: Connect and seal exterior wall air barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.

D. Opening Transitions: Fill gaps at perimeter of openings with foam sealant and apply approved transition or accessory material

E. Penetrations: Fill gaps at perimeter of penetrations with foam sealant and level with approved sealant. or seal transition strips around penetrating objects and terminate with approved sealant.

F. Joints: Bridge and cover isolation joints, expansion joints, and discontinuous joints between separate assemblies utilizing approved transition or accessory materials.

G. Changes in Plane: Apply approved sealant beads at corners and edges to form smooth transition.

H. Substrate Gaps: Cover gaps with stainless steel sheet mechanically attached to substrate and providing continuous support for air barrier.

I. Flashings: Seal top of through-wall flashings to membrane air barrier with a continuous bead of approved sealant recommended by air barrier manufacturer.

J. Seal punctures, voids, and seams. Patch with approved transition and accessory materials following air barrier manufacturer’s recommendations and extend repair beyond repaired areas to maintain continuity.

**3.05 FLUID AIR-BARRIER MEMBRANE INSTALLATION**

A. General: Apply fluid air-barrier material to form a seal with transition materials and accessories to achieve a continuous air barrier according to air-barrier manufacturer's written instructions. Apply fluid air-barrier material within manufacturer's recommended application temperature ranges.

B. Membrane Air Barrier: Apply fluid air barrier material in full contact with substrate to produce a continuous seal according to membrane air barrier manufacturers written instructions.

C. Vapor-Permeable Membrane Air Barrier: Total dry film thickness as recommended in writing by manufacturer to meet performance requirements, -in a range of 25 – 35 mils (1.0-mm) dry film thickness depending on substrate, applied in one or more equal coats, roller- or spray- applied.

D. Connect and seal exterior wall air-barrier membrane continuously to subsequently-installed roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, wall openings, and other construction used in exterior wall openings, using approved transitions and accessory materials.

E. Wall Openings: Apply approved sealant to adhere silicone extrusion to perimeter of windows, curtain walls, storefronts, doors, and louvers. Apply opening transition assembly according to air barrier transition manufacturer’s written instructions.

F. Seal punctures, voids, and seams. Patch with approved transition and accessory materials following air barrier manufacturer’s recommendations and extend repair beyond repaired areas to maintain continuity.

G. Do not cover air barrier until it has been tested and inspected by Owner's testing agency.

H. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

**3.06 CLEANING AND PROTECTING**

A. Clean spills, stains, and overspray resulting application utilizing cleaning agents recommended by manufacturers of affected construction. Remove masking materials.

B. Protect membrane air barrier from damage from subsequent work. Protect membrane materials from exposure to UV light for period in excess of that acceptable to membrane air barrier manufacturer; replace overexposed materials and retest.

**END OF SECTION**

# SECTION 074213
# METAL WALL PANELS

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Manufactured metal panels for exterior wall panels, with related flashings and accessory components.

### 1.02 RELATED REQUIREMENTS

A. Section 061000 - Rough Carpentry: Wall panel substrate.

B. Section 072100 - Thermal Insulation.

C. Section 072500 - Weather Barriers: Weather barrier under wall panels.

D. Section 079200 - Joint Sealants: Sealing joints between metal wall panel system and adjacent construction.

E. Section 092116 - Gypsum Board Assemblies: Wall panel substrate.

### 1.03 REFERENCE STANDARDS

A. 8 - test; 1.

B. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2026.

C. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.

D. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.

E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

F. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum; 2025.

### 1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data - Wall System: Manufacturer's data sheets on each product to be used, including:
   1. Physical characteristics of components shown on shop drawings.
   2. Storage and handling requirements and recommendations.
   3. Installation instructions and recommendations.

C. Shop Drawings: Indicate dimensions, layout, joints, construction details, support clips, and methods of anchorage.

D. Samples: Submit two samples of wall panel and soffit panel, 12 inches by 12 inches (305 mm by 305 mm) in size illustrating finish color, sheen, and texture.

E. Manufacturer's qualification statement.

F. Installer's qualification statement.

### 1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum ten years of documented experience.

B. Installer Qualifications: Company specializing in installing products specified in this section with minimum three years of documented experience.

### 1.06 MOCK-UPS

A. Construct mock-up, 8 feet (2.43 m) long by 4 feet (1.21 m) wide; include panel system, attachments to building frame, associated vapor retarder and air seal materials, weep drainage system, sealants and seals, and related insulation in mock-up.

B. Locate as directed by Architect.

C. Mock-up may remain as part of work.

### 1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.

B. Store prefinished material off the ground and protected from weather; prevent twisting, bending, or abrasion; provide ventilation; slope metal sheets to ensure proper drainage.

C. Prevent contact with materials that may cause discoloration or staining of products.

### 1.08 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Finish Warranty: Provide 30 year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with warrantor.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Metal Wall Panels - Concealed Fasteners:
   1. ATAS International, Inc; Versa-Seam: www.atas.com/#sle.

### 2.02 METAL WALL PANEL SYSTEM

A. Wall Panel System: Factory fabricated prefinished metal panel system, site assembled.
   1. Provide exterior wall panels and subgirt framing assembly.
   2. Design and size components to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of wall.
   3. Design Pressure: In accordance with applicable codes.
   4. Maximum Allowable Deflection of Panel: L/180 for length(L) of span.
   5. Movement: Accommodate movement within system without damage to components or deterioration of seals, movement between system and perimeter components when subject to seasonal temperature cycling; dynamic loading and release of loads; and deflection of structural support framing.
   6. Drainage: Provide positive drainage to exterior for moisture entering or condensation occurring within panel system.
   7. Panels to be tension leveled during the roll forming process.
   8. Fabrication: Formed true to shape, accurate in size, square, and free from distortion or defects; pieces of longest practical lengths.
   9. Corners: Factory-fabricated in one continuous piece with minimum 2-inch (51 mm) returns.

B. Exterior Wall Panels:
   1. Profile: Vertical; rainscreen style with a 1/2" reveal
   2. Side Seams: Continuous interlock, concealing all raw edges.
   3. Material: Precoated aluminum sheet, 18 gauge, 0.0403 inch (1.02 mm) minimum thickness.
   4. Panel Width: 12 inches (254 mm).
   5. Panel Depth: 1" (25.4 mm).
   6. Texture: Embossed
   7. With End Folds.
   8. Color: Woodland Series - Cedar #54.

C. Subgirt Framing Assembly:

D. Internal and External Corners: Same material, thickness, and finish as exterior sheets; profile to suit system; shop cut and factory mitered to required angles.

E. Expansion Joints: Same material, thickness and finish as exterior sheets; ___ gauge, ___ inch (___ mm) thick; manufacturer's standard brake formed type, of profile to suit system.

F. Trim: Same material, thickness and finish as exterior sheets; brake formed to required profiles.

G. Anchors: Galvanized steel.

**2.03 MATERIALS**

A. Precoated Aluminum Sheet: ASTM B209/B209M, 3105 alloy, O temper, with smooth surface texture; continuous-coil-coated on exposed surfaces with specified finish coating and on panel back with specified panel back coating.

**2.04 FINISHES**

A. Fluoropolymer Coil Coating System: Polyvinylidene fluoride (PVDF) multi-coat superior performing organic coatings system complying with AAMA 2605, including at least 70 percent PVDF resin, and at least 80 percent of coil coated metal surfaces having minimum total dry film thickness (DFT) of 0.9 mil, 0.0009 inch (0.023 mm); color and gloss as selected by Architect from manufacturer’s standard line.

**2.05 ACCESSORIES**

A. Cladding Support Clips:
   1. Thermally-broken clips that provide attachment support for girts, angles, channels, and other cladding support framing.

B. Sheathing Ventilation Shims:
   1. ASV spacer Shims - Polyoxymethylene (engineered thermoplastic) 3/8" stackable shims.

C. Miscellanious Sheet Metal Items:
   1. Provide factory formed flashings, gutters, downspouts, trim, moldings, closure strips, preformed crickets, caps, and equipment curbs of the same material, thickness, and finish as used for wall panels. Items completly concealed after installation may optionally be made of stainless steel.
   2. Fabricate trim and flashing components in mimimum 12'-0" lengths, or as dictated by project condiitions and approved by panel manufacturer.

D. Gaskets:
   1. Manufacturer's standard type suitable for use with system, permanently resilient; untraviolet and ozone resistant.

E. Profiled Rib Closures:
   1. Provide prefabricated, factory pre-notched colsures to match the panel profile close fitting components .032 Aluminum in the same color and finish as the panel system.

F. Sealants:
   1. Exposed Sealant:
      a. High performance Elastomeric; clear tri-polymer, as recommended by manufacturer.
   2. Concealed Sealant:
      a. high Performance Space Cubes to prevent bottoming out of sealant when fastners are installed non-curing butyl type.
   3. Seam Sealant:
      a. Factory Applied High Performance, high solid, non-skinning, non-drying formulated for roll forming application into concealed panel joints.

G. Fasteners: Provide as recommended by panel amnufacturer suitable for application meeting the following characteristics.
   1. Self-tapping and Self-drilling for metal to metal.
   2. Carbon Steel thread with organic long-life coating.

H. Internal and External Corners:
   1. Same material, thickness, and finish as extrerior sheets; profile to suit system; shop cut, and factory mitered to required angles.

I. Penetration Covers (Z Boxes) to be supplied by panel amufacturer, factory fabricated in same guage and finish as metal panels.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Verify that building framing members are ready to receive panels.

B. Verify water-resistive barrier (WRB) has been properly installed over substrate.

### 3.02 PREPARATION

A. Install subgirts perpendicular to panel length, securely fastened to substrates and shimmed and leveled to uniform plane, and spaced at intervals indicated.

B. Protect surrounding areas and adjacent surfaces from damage during execution of this work.

### 3.03 INSTALLATION

A. Install panels on walls in accordance with manufacturer's instructuions ans approved shop drawings.

B. Protect surfaces in contact with cementtitious materials and dissimilar metals with bitumous paint; allow time to properly dry prior to wall panel installation.

C. Provide expansion and control joints where indicated.

D. Use concealed fasteners unless otherwise indicated by Architect.

### 3.04 TOLERANCES

A. Offset From True Alignment Between Adjacent Members Abutting or In Line: 1/16 inch (1.6 mm), maximum.

B. Variation from Plane or Location As Indicated on Drawings: 1/4 inch (6.4 mm), maximum.

### 3.05 CLEANING

A. See Section 017000 - Execution and Closeout Requirements for additional requirements.

B. Remove site cuttings from finish surfaces.

C. Remove protective material from wall panel surfaces.

D. Clean and wash prefinished surfaces with mild soap and water; rinse with clean water.

E. Upon completion of installation, thoroughly clean prefinished aluminum surfaces in accordance with AAMA 609 & 610.

### 3.06 PROTECTION

A. Protect metal wall panels until completion of project.

B. Touch-up, repair, or replace damaged wall panels or accessories before Date of Substantial Completion.

**END OF SECTION**

**SECTION 074646**
**FIBER CEMENT SIDING – HARDIE ARCHITECTURAL PANEL**

## PART 1 – GENERAL

### 1.01 REFERENCE STANDARDS

A. 8 - test; 1.

B. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.

C. ASTM C1185 - Standard Test Methods for Sampling and Testing Fiber-Cement Flat Sheet, Roofing and Siding Shingles, and Clapboards; 2023.

D. ASTM C1186 - Standard Specification for Flat Fiber-Cement Sheets; 2026.

E. ASTM D3359 - Standard Test Methods for Rating Adhesion by Tape Test; 2023.

F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

G. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2026.

H. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C; 2026.

I. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2014 (Reapproved 2021).

### 1.02 1.1 SECTION INCLUDES

A. Fiber Cement Panel Siding.

B. Fiber Cement Architectural Panel Siding.

C. Trim, Fascia, Molding, and Accessories.

### 1.2 RELATED REQUIREMENTS

A. Section 06 10 00 – Rough Carpentry.

B. Section 07 21 00 – Thermal Insulation.

C. Section 07 27 26 – Fluid Applied Membrane Air Barrier.

D. Section 07 92 00 – Joint Sealants.

E. Section 09 91 13 – Exterior Painting.

### 1.3 REFERENCE STANDARDS

A. ASCE 7, Minimum Design Loads for Buildings and Other Structures, Current Edition.

B. ASTM C1185, Standard Test Methods for Sampling and Testing Fiber-Cement Flat Sheet, Roofing and siding Shingles, and Clapboards; 2023.

C. ASTM C1186., Standard Specification for Flat Fiber-Cement Sheets; 2022, with 2023 Editorial Revision.

D. ASTM D3359, Standard Test Methods for Rating Adhesion by Tape Test; 2023.

E. ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials; 2020.

F. ASTM E119, Standard Test Methods for Fire Tests of Building Construction and Materials; 2024.

G. ASTM E136, Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C; 2022.

H. ASTM E330/E330M, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2021.

I. ICC-ES Evaluation Reports ESR-1844, ESR-2290 and ESR-2273 (IBC, IRC, CBC, CRC); Current Editions.

**1.4 ADMINISTRATIVE REQUIREMENTS**

A. Pre-Installation Conference:
   1. A minimum of 2-weeks prior to the commencement of the Work of this section, conduct a preliminary pre-installation conference at project site.
   2. Meet with Owner, Architect, and Installer, and Subcontractors completing related work.
   3. Review the Following:
      a. Methods and procedures to complete the Work.
      b. Substrate and installation requirements.
      c. Temporary protection requirements.
      d. Repair procedures.
      e. Schedule.
      f. Other pertinent topics.
   4. Provide record of discussion with meeting minutes distributed to all attendees.

**1.5 SUBMITTALS**

A. See Section 01 30 00, Administrative Requirements.

B. Product Data:
   1. Manufacturer’s product data sheets.
   2. Manufacturer’s storage and handling requirements.
   3. Manufacturer’s preparation instructions.
   4. Manufacturer’s installation instructions.
   5. Manufacturer’s operation and maintenance instructions.

C. Shop Drawings:
   1. Provide detailed drawings showing dimensions, layout, joints, construction details, and attachments.
   2. Indicate atypical non-standard applications outside of manufacturer’s standard details and specifications.

D. Selection Samples:
   1. Provide two complete sets of color ships representing manufacturer’s full range of available colors and patterns for each finish product specified.

E. Verification Samples:
   1. Provide two samples, minimum 4-inch x 6-inch (100 mm x 150 mm) representing selected product, color, texture, and patterns for each finish product specified.

F. Installers qualification statement.

G. Warranty:
   1. Manufacturer’s sample warranty.
   2. Manufacturer’s executed written warranty, completed in Owner’s name and registered with manufacturer.

**1.6 QUALITY ASSURANCE**

A. Installer Qualifications: Company specializing in work specified in this section with a minimum of 3-years of experience with installation of products of this type.

B. Mock-up:
   1. Mock-Up: Build mock-up for evaluation of surface preparation techniques, installation workmanship, and to verify selections made from sample submittals to demonstrate aesthetic effects and set quality standards for fabrication and installation.

a. Minimum 48-inches wide x 60-inches high or similar area as fits the layout of the building exterior.
b. Include outside corner on one end of mockup and inside corner on the other end.
c. Finish areas designated by Architect.
d. Approval of mock-up does not constitute approval of deviations from the Contract Documents unless approved in writing.
e. Approved mock-up may not remain as a part of the completed work.

2. Provide a minimum of 7-days notification to Architect, Installer, and Manufacturer's Representative prior to application of mock-up for review.
3. Obtain approval of mock-up from Architect prior to commencement of Work.

**1.7 DELIVERY, STORAGE, AND HANDLING**

Deliver and store products in manufacturer's unopened packaging with labels intact until ready for installation.

Store siding flat on a smooth level surface and carry on its side.

Protect edges and corners from chipping.

Store materials under dry, waterproof, well-ventilated cover, elevated above grade, and kept dry prior to installation.

Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of the Authorities Having Jurisdiction.

Protect materials from damage, dust, or other detrimental conditions.

**1.8 FIELD CONDITIONS**

Maintain environmental conditions including temperature, humidity, and ventilation in accordance with the limits indicated in the manufacturer's written instructions.

Do not install products in conditions outside of the manufacturer's stated limits.

**1.9 WARRANTY**

Manufacturer's Limited, Non Pro-rated Product Warranty:
1. Plank, Soffit, and Trim: 30-year Warranty.
2. Color-Plus Finish: 15-year Warranty.
3. When installed and maintained in accordance with manufacturer's written requirements, warranty for 15-years from date of purchase covering peeling, cracking, and chipping.

Installers Warranty:
1. Provide 3-year installers warranty covering workmanship for work of this Section.

**PART 2 – PRODUCTS**

**2.1 MANUFACTURERS**

Basis-of-Design: James Hardie Building Products, Inc.; Hardie Panel and Hardie Architectural Panel; www.jameshardie.com.

Substitutions: In accordance with the requirements of Division 01, General Requirements.

**2.3 FIBER CEMENT – ARCHITECTURAL PANEL SIDING**

Fiber Cement Panel Siding:
1. Type A, Grade II, ASTM C1186.
2. Non-combustible Material, ASTM E136.
3. Flame Spread Index: 0, ASTM E84.
4. Smoke Developed Index: 0, ASTM E84.

Vertical Siding Panel – Architectural Collection - Type:
1. Thickness: 0.3125 inches.
2. Fine Sand:
   a. 4-feet (1219 mm) x 8-feet (2438 mm).

b. 4-feet (1219 mm) x 10-feet (3048 mm).
c. 4-feet (1219 mm) x 12-feet (3658 mm).

Color:
1. As selected by Architect from manufacturer's standard range.

Product:
1. Basis-of-Design: Hardie Architectural Panel Siding; www.jameshardie.com.
2. Substitutions: In accordance with the requirements of Division 01, General Requirements.

**2.7 ACCESSORIES**

HardieTrim Trim Boards; www.jameshardie.com.
1. Type A, Grade I, ASTM C1186..
2. Flame Spread Index: 0, ASTM E84.
3. Smoke Developed Index: <5, ASTM E84.
4. 4/4 Boards:
   a. 3-1/2 inch (89 mm) width.
   b. 5-1/2 inch (140 mm) width.
   c. 7-1/4 inch (184 mm) width.
   d. 9-1/4 inch (235 mm) width.
   e. 11-1/4 inch (286 mm) width.
5. 5/4 Boards:
   a. 3-1/2 inch (89 mm) width.
   b. 5-1/2 inch (140 mm) width.
   c. 7-1/4 inch (184 mm) width.
   d. 9-1/4 inch (235 mm) width.
   e. 11-1/4 inch (286 mm) width.
6. Color:
   a. As selected by Architect from manufacturer's standard range.
7. Texture:
   a. Smooth.
8. Length: 12-feet (3658 mm).
9. Thickness:
   a. 3/4-inch (19 mm) see drawings.
   b. 1-inch see drawings.

Seam Tape: HardieWrap; www.jameshardie.com.

Flashing:
1. HardieWrap Flashing Tape; www.jameshardie.com.
2. HardieWrap Flex Flashing Tape; www.jameshardie.com.

Fasteners:
1. Wood Framing Fasteners:
   a. 6d common corrosion resistant nails.
   b. 8d box ring common corrosion resistant nails.

Reveal Trim:
1. Aluminum Y trim Paintable

**2.8 FINISHES**

Factory Primer: Provide factory applied universal primer.
1. Primer: Factory primed by manufacturer.
2. Topcoat: Reference Section 09 90 00, Painting and Coating and project Finish Schedule.

Factory Finish: Reference project Finish Schedule.
1. As supplied by manufacturer.

2. Factory applied finish is finish applied by the same company and in the same facility that manufactures the siding substrate.
3. Require factory applied finish by fiber cement manufacturer applied in controlled environment within manufacturer's facility utilizing multi-coat, heat cured finish within one manufacturing process.
4. Each finish color to have documented color match to Delta E of 0.5 or better between product lines, manufacturing lots, or production runs as measured by photospectrometer and verified by third party.
5. Provide factory applied finish protection prior to transit to site. Remove finish protection after installation.
6. Accessories: Provide complete finishing system including pre-packaged touch-up kit provided by manufacturer.
7. Provide quantities as recommended by manufacturer.

## PART 3 – EXECUTION

### 3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. Examine substrate, clean and repair to eliminate conditions detrimental to installation.

C. Do not commence with the Work until unacceptable conditions are remedied.

D. Verify that weather barrier is installed over substrate and ready to receive the Work.

E. If framing preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation prior to commencement of Work.

### 3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using methods recommended by manufacturer’s written requirements.

C. Protect surrounding work areas and surface during installation.

D. Repair punctures or tears in weather barrier prior to installation of siding.

### 3.3 WEATHER BARRIER

A. See Section 07 27 26, Fluid Applied Membrane Air Barrier.

B. Ensure weather barrier is installed with penetration and junction flashing in accordance with manufacturer’s written requirements and the Authorities Having Jurisdiction.

### 3.4 INSTALLATION – PANEL SIDING

A. Install in strict accordance with manufacturer's written installation instructions at locations shown on Drawings.

B. General:
   1. Protect siding from Work of other trades.
   2. Surfaces to be dry prior to installation of weather barriers and siding.
   3. Reference trim details on Drawings.
   4. Touch-up cut edges prior to installation.

C. Flashing:
   1. Install above door and window trim and casings.
   2. Install above horizontal trim in field of siding.
   3. Install at transitions between materials.
   4. Install at base of wall to roof transition..

### 3.5 INSTALLATION OF SOFFIT AND VENTED PANELS

Install in strict accordance with manufacturer's written installation instructions at locations shown on Drawings.

Panels may be installed as soffit or ceiling over wood or steel framing.

20-gauge (33 mil) minimum to 16-gauge (54 mil) in compliance with the Authorities Having Jurisdiction.

Additional framing may be necessary to ensure proper fastening of siding.

**3.6 INSTALLATION OF TRIM BOARDS**

Install in strict accordance with manufacturer's written installation instructions at locations shown on Drawings.

Install flashing around all wall openings.

**3.7 FINISHING**

Finish in accordance with paint manufacturer’s written application instructions.

Finish unprimed siding with a minimum of one coat of manufacturer approved primer and one coat of 100 percent acrylic;latex exterior grade topcoat or two coats of manufacturer approved high quality alkali resistant 100 percent acrylic; latex exterior grade topcoat within 90-days of installation.

Finish factory primed siding with a minimum of one coat of manufacturer approved high quality 100 percent acrylic exterior grade paint within 180-days of installation.

**3.8 CLEANING**

See Section 01 70 00, Execution and Closeout Requirements.

Clean siding in accordance with manufacturer’s written instructions using materials and methods acceptable to manufacturer.

**3.9 PROTECTION**

Protect installed products until date of Substantial Completion.

Touch-up, repair or replace damaged areas prior to date of Substantial Completion.

**END OF SECTION**

**SECTION 075423**
**THERMOPLASTIC POLYOLEFIN (TPO) MEMBRANE ROOFING**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Adhered TPO membrane roofing system

B. Cover board.

C. Roof insulation.

### 1.02 RELATED SECTIONS

A. Division 05 Section Steel Decking for steel roof deck.

B. Division 06 Section Miscellaneous Rough Carpentry for wood nailers, curbs, and blocking.

C. Division 07 Section Sheet Metal Flashing and Trim for flashings and counter flashings.

### 1.03 REFERENCE STANDARDS

A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.

B. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2025.

C. ASTM D1079 - Standard Terminology Relating to Roofing and Waterproofing; 2026b.

D. CAN-ULC-S770 - Standard Test Method for Determination of Long-Term Thermal Resistance of Closed-Cell Thermal Insulating Foams; 2020 Reaffirmed.

E. test - sddds; sdds.

F. UL 790 - Standard for Standard Test Methods for Fire Tests of Roof Coverings; Current Edition, Including All Revisions.

G. Glossary of NRCA's The NRCA Roofing and Waterproofing Manual.

H. Roof Consultants Institute Glossary of Roofing Terms.

I. Single Ply Roofing Industry (SPRI)

J. International Building Code (IBC)

K. American Society of Civil Engineers (ASCE-7) Minimum Design Loads for Buildings & Other Structures

L. Sheet Metal Terminology and Techniques: SMACNA Architectural Sheet Metal Manual.

### 1.04 DESIGN CRITERIA

A. General: Installed roofing membrane systems shall remain watertight; and resist specified wind uplift pressures, thermally induced movement, and exposure to weather without failure.

B. Material Compatibility: Roofing materials shall be compatible with one another under conditions of service and application required, as demonstrated by roofing system manufacturer based on testing and field experience.

C. Installer shall comply with current code requirements based on authority having jurisdiction.

D. Wind Uplift Performance: Roofing system shall meet the intent of systems that have been successfully tested by a qualified testing and inspecting agency to resist wind uplift pressure calculated in accordance with ASCE 7.

E. Fire-Test-Response Characteristics: Provide roofing materials with the fire-test-response characteristics indicated as determined by testing identical products per UL 790 or another testing and inspecting agency acceptable to authorities having jurisdiction. Materials shall be identified with appropriate markings of applicable testing and inspecting agency.

**1.05 SUBMITTALS**

A. Product Data: Manufacturer’s data sheets for each product to be provided.

B. Detail Drawings: Provide roofing system plans, elevations, sections, details, and details of attachment to other Work, including:
   1. Base flashings and membrane terminations.
   2. Tapered insulation, including slopes.
   3. Crickets, saddles, and tapered edge strips, including slopes.
   4. Insulation fastening patterns.

C. Verification Samples: Provide for each product specified.

D. Installer Certificates: confirmation that installer is approved, authorized, or licensed by manufacturer to install roofing system.

E. Maintenance Data: Refer to Johns Manville's latest published documents on www.JM.com.

F. Guarantees: Provide manufacturer's current guarantee specimen.

G. Roofing sub-contractor shall provide a copy of the final System Assembly Letter issued by Johns Manville Roofing Systems indicating that the products and system to be installed shall be eligible to receive the specified manufacturer's guarantee when installed by a certified JM contractor in accordance with our application requirements, inspected and approved by a JM Technical Representative.

H. Prior to roofing system installation, roofing sub-contractor shall provide a copy of the Guarantee Application Confirmation document issued by Johns Manville Roofing Systems indicating that the project has been reviewed for eligibility to receive the specified guarantee and registered.

**1.06 QUALITY ASSURANCE**

A. Installer Qualifications: Qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product who is eligible to receive the specified manufacturer's guarantee.

B. Manufacturer Qualifications: Qualified domestic U.S. owned and based manufacturer that has UL listing or accredited testing agency listing for roofing system identical to that used for this project.

C. Source Limitations: Obtain all components from the single source roofing system manufacturer guaranteeing the roofing system. All products used in the system shall be labeled by the single source roofing system manufacturer issuing the guarantee.

D. Fire-Test-Response Characteristics: Roofing materials shall comply with the fire-test-response characteristics indicated as determined by testing identical products per test method below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Materials shall be identified with appropriate markings of applicable testing and inspecting agency.

**1.07 DELIVERY, STORAGE, AND HANDLING**

A. Deliver roofing materials in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storage.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

### 1.08 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when current and forecasted weather conditions permit roofing system to be installed in accordance with manufacturer's written instructions and guarantee requirements.

### 1.09 GUARANTEES

A. Provide manufacturer's system guarantee equal to Johns Manville's Peak Advantage No Dollar Limit Roofing System Guarantee.
   1. Single-source special guarantee includes roofing membrane, base flashings, roofing membrane accessories, roof insulation, fasteners, adhesives, cover board, walkway products, and other approved single-source components of roofing system marketed by the manufacturer.
   2. Guarantee Period: 30 years from date of Substantial Completion.
   3. Contractor is required to list 2WR of Georgia as the Specifier/Consultant of record in the appropriate fields (Specifier Account) when applying for the manufacturer's warranty.

B. Installer's Guarantee: Submit roofing Installer's guarantee, including all components of roofing system for the following guarantee period:

C. .

D. Existing Guarantees: Guarantees on existing building elements should not be affected by scope of work.
   1. Installer is responsible for coordinating with building owner's representative to verify compliance.

## PART 2 PRODUCTS

### 2.01 THERMOPLASTIC POLYOLEFIN ROOFING MEMBRANE- TPO

A. Fabric-Reinforced Thermoplastic Polyolefin Sheet: ASTM D 6878, uniform, flexible sheet formed from a thermoplastic polyolefin, internally fabric or scrim reinforced. Basis of design: JM TPO
   1. Membrane Thickness: 60 mils (1.524 mm)
   2. Exposed Face Color: White

### 2.02 AUXILIARY ROOFING MATERIALS

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.
   1. Liquid-type auxiliary materials shall meet VOC limits of authorities having jurisdiction.

B. Sheet Flashing: Manufacturer's internally reinforced or scrim reinforced. Basis of design: JM TPO 60 mil (1.524 mm)

C. Liquid Applied Flashing: Manufacturer's single ply liquid and fabric reinforced flashing system created with a fleece polyester scrim and a two-component polyurethane-based liquid applied flashing material, consisting of a liquid resin and a curing agent. Basis of design: JM SP Liquid Flashing Resin, JM SP Liquid Scrim

D. Liquid Applied Flashing Primer: Manufacturer's single ply liquid flashing primer. Basis of design: JM Liquid Applied Flashing Primers

E. Bonding Adhesive: Manufacturer’s standard solvent-based bonding adhesive for membrane. Basis of design: JM Membrane Bonding Adhesive (TPO & EPDM)
   1. Serviceable Installation Ambient Air Temperature: 25 F and rising

F. Flashing Adhesive: Manufacturer's standard solvent-based bonding adhesive for base flashings. Basis of design: JM Membrane Bonding Adhesive (TPO & EPDM)
   1. Serviceable Installation Ambient Air Temperature: 25 F and rising

G. Slip Sheet: Manufacturer’s recommended slip sheet, of type required for application.

H. Metal Termination Bars: Manufacturer’s standard predrilled stainless-steel or aluminum bars, with anchors. Basis of design: JM Termination Systems

I. Membrane Battens: Manufacturer's standard polymer or aluminum-zinc-alloy-coated steel sheet, pre-punched. Basis of design: JM Membrane Battens

J. Fasteners: Factory-coated steel fasteners and metal plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer. Basis of design: JM High Load Fasteners (15)

K. Miscellaneous Accessories: Provide all accessories to meet the roofing manufacturer's guarantee requirements.

**2.03 WALKWAYS AND SAFETY STRIPS**

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads sourced from membrane roofing system manufacturer. Basis of design: JM TPO Walkpad

B. Safety Strips, if required: Manufacturer's minimum 65 mils (1.651 mm) total thickness, comprise of 30 mil (0.762 mm) yellow non-reinforced TPO membrane laminated to 35 mil (0.889 mm) white cured seaming tape. Basis of design: JM Single Ply Safety Strip
   1. Exposed Face Color: Yellow

**2.04 COVER BOARD**

A. High-Density Polyisocyanurate: ASTM C1289, Type II, Class 4, Grade 1, High-density Polyisocyanurate technology bonded in-line to inorganic coated glass facers with greater than 80 lbs. of compressive strength. Basis of design: JM ProtectoR HD
   1. Thickness: ½ inch 0.5 inch (12.7 mm)
   2. R-value: 2.5

**2.05 ROOF INSULATION**

A. General: Preformed roof insulation boards that comply with requirements and referenced standards, selected from manufacturer's standard sizes and of thicknesses indicated.

B. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, Grade 2 20 psi (137.90 kPa) Basis of design: JM ENRGY 3
   1. Provide insulation package with minimum R Value: 25
   2. Provide insulation package in multiple layers when applicable.
   3. Minimum Long-Term Thermal Resistance (LTTR): 5.7 per inch.
      a. Determined in accordance with CAN-ULC-S770 at 75F (24C)

**2.06 TAPERED INSULATION**

A. Tapered Insulation: ASTM C1289, Type II, Class 1, Grade 2 20 psi (137.90 kPa), provide factory-tapered insulation boards with slopes as indicated on drawing. Basis of design: JM Tapered ENRGY 3

**2.07 INSULATION ACCESSORIES**

A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatible with membrane roofing.

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

C. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening roof insulation to substrate, and furnished by roofing system manufacturer. Basis of design: JM UltraFast Fasteners (12)

D. Urethane Adhesive: Manufacturer's two component polyurethane adhesive formulated to adhere insulation to substrate. Basis of design: JM QuickFoam Adhesive

E. Wood Nailer Strips: Comply with requirements in Division 06 Section Miscellaneous Rough Carpentry.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. General:
   1. Verify that roof openings and penetrations are in place and set and braced and that roof drains are securely clamped in place.
   2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.

B. Steel Decks:
   1. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 05 Section Steel Decking.
   2. Verify that decking is visibly dry and free of moisture.
   3. Verify that the decking is smooth and free of large cracks, holes or sharp changes in elevation of the surface.
   4. When applicable perform pull test with the specific fastener being used on the project to confirm the fastener resistance meets the requirements for that particular system.

C. Ensure general rigidity and proper slope for drainage.

D. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units more than 1/16 inch (1.59 mm) out of plane relative to adjoining deck.

E. Unacceptable panels should be brought to the attention of the General Contractor and Project Owner's Representative and shall be corrected prior to installation of roofing system.

### 3.02 INSULATION INSTALLATION

A. Coordinate installation of roof system components so insulation and cover board are not exposed to precipitation or left exposed at the end of the workday.

B. Comply with roofing system manufacturer's written instructions for installation of roof insulation and cover board.

C. Install tapered insulation under area of roofing to conform to slopes indicated.

D. Install insulation boards with long joints in a continuous straight line. Joints should be staggered between rows, abutting edges and ends per manufacturer's written instructions. Fill gaps exceeding 1/4 inch (6.35 mm) with like material.

E. Install 2 or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (152.4 mm) in each direction.

F. Trim surface of insulation boards where necessary at roof drains so completed surface is flush and does not restrict flow of water.

G. If required, install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.

H. Mechanically Fastened with Subsequent Layers Adhered Insulation: Secure first layer of insulation to deck using mechanical fasteners designed and sized for fastening specified board-type to deck type.
   1. Fasten first layer to resist uplift pressure at corners, perimeter, and field of roof.
   2. Install subsequent layers in a two-part urethane adhesive according to roofing system manufacturer's instruction.
   3. Install each layer to resist uplift pressure at corners, perimeter, and field of roof.

### 3.03 COVER BOARD INSTALLATION

A. Coordinate installing membrane roofing system components so cover board is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with membrane roofing system manufacturer's written instructions for installing roof cover board.

C. Install cover board with long joints in a continuous straight line. Joints should be staggered between rows, abutting edges and ends per manufacturer's written instructions. Fill gaps exceeding 1/4 inch (6.35 mm) with cover board.
   1. Cut and fit cover board within 1/4 inch (6.35 mm) of nailers, projections, and penetrations.

D. Trim surface of cover board where necessary at roof drains so completed surface is flush and does not restrict flow of water.
   1. If required, install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.

E. Adhered Cover Board: Adhere cover board to substrate as follows:
   1. Install in a two-part urethane adhesive according to roofing system manufacturer's instruction.
   2. Install to resist uplift pressure at corners, perimeter, and field of roof.

**3.04 ROOFING MEMBRANE INSTALLATION, GENERAL**

A. Install roofing membrane in accordance with roofing system manufacturer's written instructions, applicable recommendations of the roofing manufacturer and requirements in this Section.

B. Cooperate with testing and inspecting agencies engaged or required to perform services for installing roofing system.

C. Coordinate installing roofing system so insulation and other components of the roofing membrane system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is imminent.
   1. Provide tie-offs at end of each day's work to cover exposed roofing membrane sheets and insulation.
   2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
   3. Remove and discard temporary seals before beginning work on adjoining roofing.

**3.05 ADHERED ROOFING MEMBRANE INSTALLATION**

A. Install roofing membrane over area to receive roofing in accordance with membrane roofing system manufacturer's written instructions.
   1. Unroll roofing membrane and allow to relax before installing.
   2. Install sheet in accordance with roofing system manufacturer's written instructions.

B. Accurately align roofing membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

C. Bonding Adhesive: Apply solvent-based bonding adhesive to substrate and underside of roofing membrane at rate required by manufacturer. Follow all manufacturer recommendations for proper application of membrane. Do not apply bonding adhesive to splice area of roofing membrane.

D. Mechanically fasten roofing membrane securely at terminations, penetrations, and perimeter of roofing.

E. Apply roofing membrane with side laps shingled with slope of roof deck where possible.

F. Seams: Clean seam areas, overlap roofing membrane, and hot-air weld side and end laps of roofing membrane according to manufacturer's written instructions to ensure a watertight seam installation.
   1. Test lap edges with probe to verify seam weld continuity. Apply cut edge sealant to seal cut edges of roofing membrane.
   2. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
      a. Remove and repair any unsatisfactory sections before proceeding with installation.
   3. Repair tears, voids, and incorrectly lapped seams in roofing membrane that do not meet requirements.

G. Spread sealant or mastic bead over deck drain flange at deck drains and securely seal roofing membrane in place with clamping ring.

### 3.06 BASE FLASHING INSTALLATION

A. Install sheet flashings and preformed flashing accessories and adhere to substrates in accordance with membrane roofing system manufacturer's written instructions.

B. Apply solvent-based bonding adhesive at required rate and allow to partially dry. Do not apply bonding adhesive to seam area of flashing.

C. Apply single ply liquid applied flashing system per manufacturer's written instructions.

D. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

E. Clean seam areas and overlap and firmly roll sheet flashings into the adhesive. Weld side and end laps to ensure a watertight seam installation.

F. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

### 3.07 WALKWAY INSTALLATION

A. Flexible Walkways: Install walkway products in locations indicated. Heat weld and adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

### 3.08 FIELD QUALITY CONTROL

A. Owner or designated representative will provide on-site observation and inspection during installation.

B. Owner will engage a qualified testing agency to perform tests and inspections.

C. Final Roof Inspection: Arrange for roofing system manufacturer's technical representative to inspect roofing installation on completion and submit report to owner or designated representative.

D. Repair or remove and replace components of roofing system where test results or inspections indicate that they do not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

### 3.09 PROTECTION AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

**END OF SECTION**

# SECTION 076200
# SHEET METAL FLASHING AND TRIM

## PART 1 GENERAL

### 1.01 REFERENCE STANDARDS

A. ANSI/SPRI/FM 4435/ES-1 - Test Standard for Edge Systems Used with Low Slope Roofing Systems; 2022.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

D. ASTM A755/A755M - Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products; 2018 (Reapproved 2024).

E. ASTM B32 - Standard Specification for Solder Metal; 2020.

F. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products; 2025.

G. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018 (Reapproved 2024).

H. ASTM C1311 - Standard Specification for Solvent Release Sealants; 2022.

I. ASTM D1187/D1187M - Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal; 1997 (Reapproved 2024).

J. ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement; 2025.

K. ASTM F2329/F2329M - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners; 2015 (Reapproved 2023).

### 1.02 SUMMARY

A. Section Includes: Custom flashing and trim fabrications, made from the following:
   1. Sheet metal materials.
   2. Underlayment.
   3. Miscellaneous materials.

B. Related Requirements:
   1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
   2. Section 077100 "Roof Specialties" for manufactured copings, roof-edge specialties, roof-edge drainage systems, reglets, and counterflashings.

### 1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For sheet metal flashing and trim.
   1. Plans, elevations, sections, and attachment details.
   2. Fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
   3. Identification of material, thickness, weight, and finish for each item and location in Project.
   4. Details for forming, including profiles, shapes, seams, and dimensions.
   5. Details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
   6. Details of termination points and assemblies.
   7. Details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
   8. Details of roof-penetration flashing.

9. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashing.
10. Details of special conditions.

C. Samples: For each exposed product and for each color and texture specified, 12 inches long by actual width.

D. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

E. Samples for Verification: Actual sample of finished products for each type of exposed finish for sheet metal and other metal accessories.
1. Sheet Metal Flashing and Trim: Manufacturers' standard size. Include finished seam with required profile. Include fasteners, cleats, clips, closures, and other attachments.

**1.04 INFORMATIONAL SUBMITTALS**

A. Certificates: For each type of coping and roof edge flashing that is ANSI/SPRI/FM 4435/ES-1 tested.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Qualification Statements: For fabricator.

D. Sample warranties.

**1.05 QUALITY ASSURANCE**

A. Fabricator Qualifications: Entity that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

B. For roof edge flashings and copings that are ANSI/SPRI/FM 4435/ES-1 tested shop is to be listed as able to fabricate required details as tested and approved.

**1.06 DELIVERY, STORAGE, AND HANDLING**

A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.
1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
2. Protect stored sheet metal flashing and trim from contact with water.

B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

**1.07 COORDINATION**

A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.

**1.08 WARRANTY**

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
1. Finish Warranty Period: 20 years from date of Substantial Completion.

**PART 2 PRODUCTS**

**2.01 PERFORMANCE REQUIREMENTS**

A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, are to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim are not to rattle, leak, or loosen, and are to remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. SPRI Wind Design Standard: Manufacture and install roof edge flashings and copings tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressure:
   1. Design Pressure: 22.6 psf - 140.3 psf.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

## 2.02 SHEET METAL MATERIALS

A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with minimum ASTM A653/A653M, G90 coating designation Pre-painted by the coil-coating process to comply with ASTM A755/A755M.
   1. Surface: Smooth, flat.
   2. Exposed Coil-Coated Finish:
      a. Two-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions
   3. Color: As selected by Architect from manufacturer's full range.
   4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

C. Lead Sheet: ASTM B749 lead sheet.

## 2.03 UNDERLAYMENT

A. Self-Adhering, High-Temperature Sheet Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils thick, specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer when recommended by underlayment manufacturer.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Carlisle WIP Products; a brand of Carlisle Construction Materials
      b. Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)
      c. Owens Corning
      d. Polyglass U.S.A., Inc.

## 2.04 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
   1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.

2. Fasteners for Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.
3. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
4. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.

C. Solder:
1. For Zinc-Coated (Galvanized) Steel: ASTM B32, Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead.
2. For Stainless Steel: ASTM B32, Grade Sn60, with acid flux of type recommended by stainless steel sheet manufacturer.

D. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

E. Elastomeric Sealant: ASTM C920, elastomeric polyurethane silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

F. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

H. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.

I. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

J. Reglets: Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctions and with interlocking counterflashing on exterior face, of same metal as reglet.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Cheney Flashing Company
b. Fry Reglet Corporation
c. Heckmann Building Products, Inc.
d. Hohmann & Barnard, Inc
e. Metal-Era, Inc.
2. Material: Galvanized steel, 0.022 inch thick.
3. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
4. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
5. Accessories:
a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.

b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing's lower edge.

6. Finish: With manufacturer's standard color coating.

**2.05 FABRICATION, GENERAL**

A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.
   1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
   2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
   3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
   4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
   5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances:
   1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 ft. on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
   2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.

C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
   1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
   2. Use lapped expansion joints only where indicated on Drawings.

D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard and by FM Global Property Loss Prevention Data Sheet 1-49 for application, but not less than thickness of metal being secured.

G. Seams:
   1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
   2. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.

H. Do not use graphite pencils to mark metal surfaces.

**2.06 ROOF-DRAINAGE SHEET METAL FABRICATIONS**

A. Gutters:
   1. Fabricate to cross section required, with riveted and soldered joints, complete with end pieces, outlet tubes, and other special accessories as required.
   2. Fabricate in minimum 96-inch- long sections. Fabricate expansion joints and accessories from same metal as gutters unless otherwise indicated.
   3. Fabricate gutters with built-in expansion joints.
   4. Fabricate from the following materials:
      a. Stainless Steel: 0.0156 inch thick.

B. Downspouts: Fabricate round downspouts to dimensions indicated on Drawings, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors
   a. Aluminum-Zinc Alloy-Coated Steel: 0.040 inch thick.

C. Roof-Penetration Flashing: Fabricate from the following materials:
   1. Galvanized Steel: 0.028 inch thick.

### 2.07 WALL SHEET METAL FABRICATIONS

A. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch- long, but not exceeding 12 ft. long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of wall openings; and form with 2-inch- high, end dams. Fabricate from the following materials:
   1. Stainless Steel: 0.0156 inch thick.

B. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch- high, end dams. Fabricate from the following materials:
   1. Galvanized Steel: 0.022 inch thick.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrates, and other conditions affecting performance of the Work.
   1. Verify compliance with requirements for installation tolerances of substrates.
   2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
   3. Verify that air- or water-resistant barriers have been installed over substrate to prevent air infiltration or water penetration.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION OF UNDERLAYMENT

A. Self-Adhering, High-Temperature Sheet Underlayment:
   1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
   2. Prime substrate if recommended by underlayment manufacturer.
   3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
   4. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses.
   5. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller.
   6. Roll laps and edges with roller.
   7. Cover underlayment within 14 days.

### 3.03 INSTALLATION OF SHEET METAL FLASHING AND TRIM, GENERAL

A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.
   1. Install fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
   2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of sealant.
   3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
   4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
   5. Install continuous cleats with fasteners spaced not more than 12 inches o.c.

6. Space individual cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
8. Do not field cut sheet metal flashing and trim by torch.
9. Do not use graphite pencils to mark metal surfaces.

B. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.
1. Space movement joints at maximum of 10 ft. with no joints within 24 inches of corner or intersection.
2. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
3. Use lapped expansion joints only where indicated on Drawings.

C. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

D. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

E. Seal joints as required for watertight construction.
1. Use sealant-filled joints unless otherwise indicated.
a. Embed hooked flanges of joint members not less than 1 inch into sealant.
b. Form joints to completely conceal sealant.
c. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way.
d. Adjust setting proportionately for installation at higher ambient temperatures.
1) Do not install sealant-type joints at temperatures below 40 deg F.
2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

F. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter.
1. Pretin edges of sheets with solder to width of 1-1/2 inches; however, reduce pretinning where pretinned surface would show in completed Work.
2. Do not solder metallic-coated steel sheet.
3. Do not pretin zinc-tin alloy-coated copper.
4. Do not use torches for soldering.
5. Heat surfaces to receive solder, and flow solder into joint.
a. Fill joint completely.
b. Completely remove flux and spatter from exposed surfaces.

## 3.04 INSTALLATION OF ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Install sheet metal roof-drainage items to produce complete roof-drainage system in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.

B. Built-in Gutters:
1. Join sections with riveted and soldered joints.
2. Provide for thermal expansion.
3. Slope to downspouts.
4. Provide end closures and seal watertight with sealant.
5. Install underlayment layer in built-in gutter trough and extend to drip edge at eaves and under underlayment on roof sheathing.
a. Lap sides minimum of 2 inches over underlying course.
b. Lap ends minimum of 4 inches.
c. Stagger end laps between succeeding courses at least 72 inches.
d. Fasten with roofing nails.

6. Anchor and loosely lock back edge of gutter to continuous cleat.
7. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 18 inches apart.

C. Downspouts:
1. Join sections with 1-1/2-inch telescoping joints.
2. Provide hangers with fasteners designed to hold downspouts securely to walls.
3. Locate hangers at top and bottom and at approximately 60 inches o.c.
4. Provide elbows at base of downspout to direct water away from building.
5. Connect downspouts to underground drainage system.

**3.05 INSTALLATION OF WALL SHEET METAL FABRICATIONS**

A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

B. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings.

C. Reglets: Installation of reglets is specified in Section 042000 "Unit Masonry."

**3.06 INSTALLATION TOLERANCES**

A. Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 ft. on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

**3.07 CLEANING**

A. Clean and neutralize flux materials. Clean off excess solder.

B. Clean off excess sealants.

**3.08 PROTECTION**

A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.

C. Maintain sheet metal flashing and trim in clean condition during construction.

D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

**END OF SECTION**

# SECTION 077100
# ROOF SPECIALTIES

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Manufactured roof specialties, including copings, fascias, and gravel stops.

### 1.02 RELATED REQUIREMENTS

A. Section 077200 - Roof Accessories: Manufactured curbs.

### 1.03 REFERENCE STANDARDS

A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2026.

B. ANSI/SPRI/FM 4435/ES-1 - Test Standard for Edge Systems Used with Low Slope Roofing Systems; 2022.

C. NRCA (RM) - The NRCA Roofing Manual; 2026.

### 1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on shape of components, materials and finishes, anchor types and locations.

C. Shop Drawings: Indicate configuration and dimension of components, adjacent construction, required clearances and tolerances, and other affected work.

D. Samples: Submit two appropriately sized samples of coping and gravel stop.

E. Manufacturer's Installation Instructions: Indicate special procedures, fasteners, supporting members, and perimeter conditions requiring special attention.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Roof Edge Flashings and Copings:
   1. Architectural Products Co; _____: www.archprod.com/#sle.
   2. ATAS International, Inc; Rapid-Lok Fascia: www.atas.com/#sle.
   3. Metal-Era Inc; _____: www.metalera.com/#sle.

B. Counterflashings:
   1. ATAS International, Inc; ____: www.atas.com/#sle.
   2. Metal-Era Inc; _____: www.metalera.com/#sle.

### 2.02 COMPONENTS

A. Roof Edge Flashings: Factory fabricated to sizes required; corners mitered; concealed fasteners.
   1. Configuration: Fascia, cant, and edge securement for roof membrane.
   2. Pull-Off Resistance: Tested in accordance with ANSI/SPRI/FM 4435/ES-1 using test methods RE-1 and RE-2 to positive and negative design wind pressure as defined by applicable local building code.
   3. Exposed Face Height: As indicated on drawings.
   4. Material: Formed aluminum sheet, 0.050 inch (1.3 mm) thick, minimum.
   5. Finish: 70 percent polyvinylidene fluoride (PVDF).
   6. Color: As selected by Architect from manufacturer's standard range.
   7. Products:
      a. Hickman Edge Systems; Drip Edge Fascia: www.hickmanedgesystems.com/#sle.
      b. Metal-Era Inc; Anchor-Tite Drip Edge: www.metalera.com/#sle.

B. Copings: Factory fabricated to sizes required; corners mitered; concealed fasteners.
   1. Configuration: Concealed continuous hold down cleat at both legs; internal splice piece at joints of same material, thickness, and finish as cap; concealed stainless steel fasteners.
   2. Pull-Off Resistance: Tested in accordance with ANSI/SPRI/FM 4435/ES-1 using test method RE-3 to positive and negative design wind pressure as defined by applicable local building code.
   3. Wall Width: As indicated on drawings.
   4. Outside Face Height: As indicated on drawings.
   5. Inside Face Height: As indicated on drawings.
   6. Material: Formed aluminum sheet, 0.040 inch (1.01 mm) thick, minimum.
   7. Finish: 70 percent polyvinylidene fluoride.
   8. Color: As selected by Architect from manufacturer's standard range.
   9. Products:
      a. ATAS International, Inc; Rapid-Lok Coping: www.atas.com/#sle.
      b. Metal-Era Inc; Perma-Tite Coping: www.metalera.com/#sle.

C. Counterflashings: Factory fabricated and finished sheet metal that overlaps top edges of base flashing by at least 4 inches (102 mm), and designed to snap into through-wall flashing or reglets with lapped joints.
   1. Material: Formed aluminum sheet, 0.025 inch (0.64 mm) thick, minimum.
   2. Color: To be selected by Architect from manufacturer's standard range.
   3. Products:
      a. Hickman Edge Systems; Reglets: www.hickmanedgesystems.com/#sle.
      b. Metal-Era Inc; Counterflashing: www.metalera.com/#sle.

### 2.03 FINISHES

A. PVDF (Polyvinylidene Fluoride) Coating: Superior Performance Organic Finish, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system; color as selected from manufacturer's standard colors.

### 2.04 ACCESSORIES

A. Sealant for Joints in Linear Components: As recommended by component manufacturer.

B. Adhesive for Anchoring to Roof Membrane: Compatible with roof membrane and approved by roof membrane manufacturer.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Verify that deck, curbs, roof membrane, base flashing, and other items affecting work of this Section are in place and positioned correctly.

### 3.02 INSTALLATION

A. Install components in accordance with manufacturer's instructions and NRCA (RM) applicable requirements.

B. Seal joints within components when required by component manufacturer.

C. Anchor components securely.

D. Coordinate installation of components of this section with installation of roofing membrane and base flashings.

E. Coordinate installation of flashing flanges into reglets.

**END OF SECTION**

# SECTION 077200
# ROOF ACCESSORIES

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Roof curbs.

### 1.02 REFERENCE STANDARDS

A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

### 1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Shop Drawings: Submit detailed layout developed for this project and provide dimensioned location and number for each type of roof accessory.

### 1.04 DELIVERY, STORAGE, AND HANDLING

A. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.

B. Store products in manufacturer's unopened packaging until ready for installation.

C. Store products under cover and elevated above grade.

## PART 2 PRODUCTS

### 2.01 ROOF CURBS

A. Roof Curbs Manufacturers:
   1. AES Industries Inc: www.aescurb.com/#sle.
   2. LMCurbs; Roof Curbs: www.lmcurbs.com/#sle.
   3. MKT Metal Manufacturing: www.mktduct.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

B. Roof Curbs Mounting Assemblies: Factory fabricated hollow sheet metal construction, internally reinforced, and capable of supporting superimposed live and dead loads and designated equipment load with fully mitered and sealed corner joints welded or mechanically fastened, and integral counterflashing with top and edges formed to shed water.
   1. Roof Curb Mounting Substrate: Curb substrate consists of corrugated metal roof deck with insulation.
   2. Sheet Metal Material:
      a. Galvanized Steel: Hot-dip zinc coated steel sheet complying with ASTM A653/A653M, SS Grade 33 (230); G60 (Z180) coating designation; 18 gauge, 0.048 inch (1.21 mm) thick.

C. Curbs Adjacent to Roof Openings: Provide curb on each side of opening, with top of curb horizontal for equipment mounting.
   1. Provide preservative treated wood nailers along top of curb.
   2. Insulate inside curbs with 1-1/2 inch (38 mm) thick fiberglass insulation.
   3. Height Above Finished Roof Surface: 8 inches (203 mm), minimum.

**SECTION 079200**
**JOINT SEALANTS**

## PART 1 GENERAL

### 1.01 REFERENCE STANDARDS

A. ASTM C834 - Standard Specification for Latex Sealants; 2017 (Reapproved 2023).

B. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018 (Reapproved 2024).

C. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2025.

D. ASTM C1248 - Standard Test Method for Staining of Porous Substrate by Joint Sealants; 2022.

E. ASTM C1311 - Standard Specification for Solvent Release Sealants; 2022.

F. ASTM C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants; 2023.

### 1.02 SUMMARY

A. Section Includes:
   1. Silicone joint sealants.
   2. Nonstaining silicone joint sealants.
   3. Mildew-resistant joint sealants.
   4. Butyl joint sealants.
   5. Latex joint sealants.

### 1.03 ACTION SUBMITTALS

A. Product Data:

B. Samples for Initial Selection: Manufacturer's standard color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. 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.

### 1.04 INFORMATIONAL SUBMITTALS

A. Preconstruction Laboratory Test Schedule: Include the following information for each joint sealant and substrate material to be tested:
   1. Joint-sealant location and designation.
   2. Manufacturer and product name.
   3. Type of substrate material.
   4. Number of samples required.

B. Preconstruction Laboratory Test Reports: For each joint sealant and substrate material to be tested 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.

C. 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.

D. Sample warranties.

### 1.05 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:
   1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
   2. When joint substrates are wet.
   3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
   4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

### 1.06 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace 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 agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
   1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
   2. Disintegration of joint substrates from 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

### 2.01 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

### 2.02 SILICONE JOINT SEALANTS

A. Silicone, S, NS, 100/50, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.

B. Silicone, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. GE Construction Sealants; Momentive Performance Materials Inc.
      b. Pecora Corporation
      c. Sika Corporation - Building Components
      d. The Dow Chemical Company

C. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    a. GE Construction Sealants; Momentive Performance Materials Inc.
    b. Pecora Corporation
    c. Permathane; a Holcim brand
    d. Polymeric Systems, Inc.; PPG Industries, Inc.
    e. Sherwin-Williams Company (The)
    f. Sika Corporation - Building Components
    g. The Dow Chemical Company

D. Silicone, Acid Curing, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    a. Adfast
    b. Bostik; Arkema
    c. Everkem Diversified Products, Inc.
    d. Pecora Corporation
    e. Polymeric Systems, Inc.; PPG Industries, Inc.
    f. PPG Paints; PPG Industries, Inc.
    g. Premier Building Solutions
    h. Sika Corporation - Building Components
    i. The Dow Chemical Company

E. Silicone, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    a. Pecora Corporation
    b. The Dow Chemical Company

## 2.03 NONSTAINING SILICONE JOINT SEALANTS

A. Nonstaining Joint Sealants: No staining of substrates when tested in accordance with ASTM C1248.

B. Silicone, Nonstaining, S, NS, 100/50, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    a. Adfast
    b. Pecora Corporation
    c. Sika Corporation - Building Components
    d. Tremco Incorporated

C. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Adfast
b. GE Construction Sealants; Momentive Performance Materials Inc.
c. Pecora Corporation
d. Sika Corporation - Building Components
e. Soudal Accumetric
f. The Dow Chemical Company
g. Tremco Incorporated

D. Silicone, Nonstaining, S, NS, 100/50, T, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
a. The Dow Chemical Company

## 2.04 MILDEW-RESISTANT JOINT SEALANTS

A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Adfast
b. GE Construction Sealants; Momentive Performance Materials Inc.
c. Pecora Corporation
d. PPG Paints; PPG Industries, Inc.
e. Sika Corporation - Building Components
f. Soudal Accumetric
g. The Dow Chemical Company
h. Tremco Incorporated

## 2.05 BUTYL JOINT SEALANTS

A. Butyl-Rubber-Based Joint Sealants: ASTM C1311.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
a. Bostik; Arkema
b. Pecora Corporation

## 2.06 LATEX JOINT SEALANTS

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Pecora Corporation
b. Sherwin-Williams Company (The)
c. Tremco Incorporated

## 2.07 JOINT-SEALANT BACKING

A. Sealant Backing Material: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Construction Foam Products; a division of Nomaco, Inc.
b. Master Builders Solutions, brand of MBCC Group, a Sika company

B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

### 2.08 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
   a. Concrete.
   b. Masonry.
3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
   a. Metal.
   b. Glass.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. 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 or primer 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.

### 3.03 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of sealant backings.
   2. Do not stretch, twist, puncture, or tear sealant backings.
   3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants in accordance with requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   1. Remove excess sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
   3. Provide concave joint profile in accordance with Figure 8A in ASTM C1193 unless otherwise indicated.
   4. Provide recessed joint configuration of recess depth and at locations indicated on Drawings in accordance with Figure 8C in ASTM C1193.
      a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

### 3.04 CLEANING

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

### 3.05 PROTECTION

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

**END OF SECTION**

**SECTION 081113**
**HOLLOW METAL DOORS AND FRAMES**

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section Includes:
   1. Interior standard steel doors and frames.
   2. Exterior standard steel doors and frames.

B. Related Requirements:
   1. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.

### 1.02 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings in accordance with NAAMM-HMMA 803 or ANSI/SDI A250.8.

### 1.03 REFERENCE STANDARDS

A. 8 - test; 1.

B. ANSI/SDI A250.3 - Test Procedure and Acceptance Criteria for Factory Applied Finish Coatings for Steel Doors and Frames; 2025.

C. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors; 2026.

D. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames; 2024.

E. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100); 2023.

F. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames; 2025.

G. ANSI/SDI A250.11 - Recommended Erection Instructions for Steel Frames; 2022.

H. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

I. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

J. ASTM A879/A879M - Standard Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface; 2022.

K. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2026.

L. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2025.

M. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2024.

N. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C; 2026.

O. BHMA A156.115 - Hardware Preparation in Steel Doors and Frames; 2016.

P. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2025, with Amendment (2024).

Q. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives; 2025.

R. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2022.

S. NFPA 257 - Standard on Fire Test for Window and Glass Block Assemblies; 2022.

T. UL 9 - Standard for Fire Tests of Window Assemblies; Current Edition, Including All Revisions.

U. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

V. UL 1784 - Standard for Air Leakage Tests of Door Assemblies and Other Opening Protectives; Current Edition, Including All Revisions.

**1.04 COORDINATION**

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

**1.05 PREINSTALLATION MEETINGS**

A. Preinstallation Conference: Conduct conference at Project site.

**1.06 ACTION SUBMITTALS**

A. Product Data:
   1. Interior standard steel doors and frames.
   2. Exterior standard steel doors and frames.

B. Product Data Submittals: For each product.
   1. Include construction details, material descriptions, core descriptions, fire-resistance rating, and finishes.

C. 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 electrical raceway and preparation for electrified hardware, access control systems, and security systems.
   7. Details of anchorages, joints, field splices, and connections.
   8. Details of accessories.
   9. Details of moldings, removable stops, and glazing.

D. Product Schedule: For hollow-metal doors and frames, 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.

**1.07 INFORMATIONAL SUBMITTALS**

A. Product Test Reports: For each type of fire-rated hollow-metal door and frame assembly for tests performed by a qualified testing agency indicating compliance with performance requirements.

B. Oversize Construction Certification: For assemblies required to be fire-rated and exceeding limitations of labeled assemblies.

C. Field quality-control reports.

**1.08 DELIVERY, STORAGE, AND HANDLING**

A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use non vented plastic.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch- high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

## PART 2 PRODUCTS

### 2.01 HOLLOW METAL DOORS AND FRAMES

A. Manufacturers: Subject to compliance with requirements, products by one of the following
   1. Ceco Door; AADG, Inc.; ASSA ABLOY
   2. Curries, AADG, Inc.; ASSA ABLOY Group
   3. Mesker Door; Mesker Openings Group
   4. North American Door Corp
   5. Republic Doors and Frames; a Allegion brand
   6. Steelcraft; Allegion plc

### 2.02 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated on Drawings, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
   1. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.
   2. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

B. Fire-Rated, Borrowed-Lite Assemblies: Assemblies complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing in accordance with NFPA 257 or UL 9.

### 2.03 INTERIOR STANDARD STEEL DOORS AND FRAMES

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

B. Standard-Duty Doors and Frames: ANSI/SDI A250.8, Level 1; ANSI/SDI A250.4, Level C. At locations indicated in the Door and Frame Schedule on Drawings.
   1. Doors:
      a. Type: As indicated in the Door and Frame Schedule on Drawings.
      b. Thickness: 1-3/4 inches (44 mm).
      c. Face: Metallic-coated steel sheet, minimum thickness of 0.032 inch (0.81 mm).
      d. Edge Construction: Model 2, Seamless.
      e. Core: steel stiffener.
      f. Fire-Rated Core: Manufacturer's standard vertical steel stiffener, laminated mineral board core for fire-rated doors.
   2. Frames:
      a. Materials: Metallic-coated steel sheet, minimum thickness of 0.042 inch (1.07 mm).
      b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
      c. Construction: Full profile welded.
   3. Exposed Finish: Prime.

### 2.04 EXTERIOR STANDARD STEEL DOORS AND FRAMES

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

**2.05 HOLLOW-METAL PANELS**

A. Provide hollow-metal panels of same materials, construction, and finish as adjacent door assemblies.

**2.06 FRAME ANCHORS**

A. Jamb Anchors:
   1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
   2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches (609.6 mm) of frame height above 7 feet (213.36 cm).
   3. Post installed Expansion Anchor: Minimum 3/8-inch- diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at top of underlayment.

D. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
   1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized in accordance with ASTM A153/A153M, Class B.

**2.07 MATERIALS**

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.

D. Inserts, Bolts, and Fasteners: Hot-dip galvanized in accordance with ASTM A153/A153M.

E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

F. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

G. Glazing: Comply with requirements in Section 088000 "Glazing."

**2.08 FABRICATION**

A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch (19.05 mm) beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
   1. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

2. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
   a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
   b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
3. Terminated Stops (Hospital Stops): Terminate stops 6 inches (152.4 mm) above finish floor with a 4590-degree angle cut, and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.

C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping in accordance with ANSI/SDI A250.6, the Door Hardware Schedule on Drawings, and templates.
1. Reinforce doors and frames to receive non templated, mortised, and surface-mounted door hardware.
2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

D. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with mitered hairline joints.
1. Provide stops and moldings flush with face of door, and with beveled stops unless otherwise indicated.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (228.6 mm) o.c. and not more than 2 inches (50.8 mm) o.c. from each corner.

### 2.09 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

B. Factory Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, complying with ANSI/SDI A250.3.
1. Color and Gloss: As selected by Architect from manufacturer's full range

## PART 3 EXECUTION

### 3.01 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.

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

### 3.02 INSTALLATION

A. Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.

B. Hollow-Metal Frames: Comply with ANSI/SDI A250.11.
1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.

a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
b. Install frames with removable stops located on secure side of opening.

2. Fire-Rated Openings: Install frames in accordance with NFPA 80.
3. Floor Anchors: Secure with post installed expansion anchors.
   a. Floor anchors may be set with power-actuated fasteners instead of post installed expansion anchors if so indicated and approved on Shop Drawings.
4. Solidly pack mineral-fiber insulation inside frames.
5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
6. In-Place Concrete or Masonry Construction: Secure frames in place with post installed expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
7. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
   a. Squareness: Plus or minus 1/16 inch (1.59 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   b. Alignment: Plus or minus 1/16 inch (1.59 mm), measured at jambs on a horizontal line parallel to plane of wall.
   c. Twist: Plus or minus 1/16 inch (1.59 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
   d. Plumbness: Plus or minus 1/16 inch (1.59 mm), measured at jambs at floor.

C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8
2. Fire-Rated Doors: Install doors with clearances in accordance with NFPA 80.
3. Smoke-Control Doors: Install doors in accordance with NFPA 105.

D. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

**3.03 REPAIR**

A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint in accordance with manufacturer's written instructions.

C. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish in accordance with manufacturer's written instructions.

D. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

**END OF SECTION**

# SECTION 081213
# HOLLOW METAL FRAMES

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section Includes:
   1. Interior standard steel frames.
   2. Exterior standard steel frames.
   3. Borrowed lites.

B. Related Requirements:
   1. Section 081113 "Hollow Metal Doors and Frames" for hollow-metal doors and frames.

### 1.02 DEFINITIONS

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

### 1.03 REFERENCE STANDARDS

A. 8 - test; 1.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

D. ASTM A879/A879M - Standard Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface; 2022.

E. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2026.

F. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2025.

G. BHMA A156.115 - Hardware Preparation in Steel Doors and Frames; 2016.

H. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2025, with Amendment (2024).

I. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives; 2025.

J. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2022.

K. NFPA 257 - Standard on Fire Test for Window and Glass Block Assemblies; 2022.

L. UL 9 - Standard for Fire Tests of Window Assemblies; Current Edition, Including All Revisions.

M. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

N. UL 1784 - Standard for Air Leakage Tests of Door Assemblies and Other Opening Protectives; Current Edition, Including All Revisions.

### 1.04 COORDINATION

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

### 1.05 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

### 1.06 ACTION SUBMITTALS

A. Product Data:
   1. Interior standard steel frames.
   2. Exterior standard steel frames.

B. Product Data Submittals: For each product.
   1. Include construction details, material descriptions, fire-resistance ratings, and finishes.

C. Shop Drawings: Include the following:
   1. Elevations of each frame type.
   2. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
   3. Locations of reinforcement and preparations for hardware.
   4. Details of each different wall opening condition.
   5. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
   6. Details of anchorages, joints, field splices, and connections.
   7. Details of accessories.
   8. Details of moldings, removable stops, and glazing.

D. Product Schedule: For hollow-metal frames, 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.

### 1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use non vented plastic.
   1. Provide additional protection to prevent damage to factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal frames vertically under cover at Project site with head up. Place on minimum 4-inch- high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

## PART 2 PRODUCTS

### 2.01 HOLLOW METAL FRAMES

A. Manufacturers: Subject to compliance with requirements, products by one of the following
   1. Ceco Door; AADG, Inc.; ASSA ABLOY
   2. Curries, AADG, Inc.; ASSA ABLOY Group
   3. Mesker Door; Mesker Openings Group
   4. North American Door Corp
   5. Republic Doors and Frames; a Allegion brand
   6. Steelcraft; Allegion plc

### 2.02 PERFORMANCE REQUIREMENTS

A. Fire-Rated Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated on Drawings, based on testing at positive pressure according to NFPA 252 or UL 10C.
   1. Smoke- and Draft-Control Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

2. Oversize Fire-Rated Frames: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that frames comply with standard construction requirements for tested and labeled fire-rated assemblies except for size.

B. Fire-Rated, Borrowed-Lite Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

**2.03 STANDARD STEEL FRAMES**

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

B. Interior Standard Steel Frames: SDI A250.8. At locations indicated in the Door and Frame Schedule on Drawings.
1. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.35 mm)
2. Construction: Full profile welded.
3. Exposed Finish: Prime.

C. Exterior Standard Steel Frames: SDI A250.8. At locations indicated in the Door and Frame Schedule on Drawings.
1. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.35 mm), with minimum A60 coating.
2. Construction: Full profile welded.

**2.04 BORROWED LITES**

A. Fabricate of metallic-coated steel sheet, minimum thickness of 0.053 inch (1.35 mm).

B. Construction: Full profile welded.

C. Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each point, fabricated of metal of same or greater thickness as metal as frames.

D. Provide countersunk, flat-or oval- head exposed screws and bolts for exposed fasteners unless otherwise indicated.

**2.05 FRAME ANCHORS**

A. Jamb Anchors:
1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches (609.6 mm) of frame height above 7 feet (213.36 cm).
3. Post installed Expansion Anchor: Minimum 3/8-inch- diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at top of underlayment.

D. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized according to ASTM A153/A153M, Class B.

**2.06 MATERIALS**

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.

D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.

E. Glazing: Comply with requirements in Section 088000 "Glazing."

**2.07 FABRICATION**

A. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
   1. Sidelite and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding, or by rigid mechanical anchors.
   2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
   3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
      a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
      b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
   4. Terminated Stops: Terminate stops 6 inches (152.4 mm) above finish floor with a 90-degree angle cut, and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.

B. Hardware Preparation: Factory prepare hollow-metal frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule on Drawings, and templates.
   1. Reinforce frames to receive non templated, mortised, and surface-mounted door hardware.
   2. Comply with BHMA A156.115 for preparing hollow-metal frames for hardware.

C. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with mitered hairline joints.
   1. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
   2. Provide fixed frame moldings on outside of exterior and on secure side of interior frames. Provide loose stops and moldings on inside of hollow-metal frames.
   3. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
   4. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (228.6 mm) o.c. and not more than 2 inches (50.8 mm) o.c. from each corner.

**2.08 STEEL FINISHES**

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
   1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

B. Factory Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, complying with SDI A250.3.
   1. Color and Gloss: As selected by Architect from manufacturer's full range

## PART 3 EXECUTION

### 3.01 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.

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

### 3.02 INSTALLATION

A. General: Install hollow-metal frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions. Comply with SDI A250.11

B. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
   1. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
   2. Install frames with removable stops located on secure side of opening.

C. Fire-Rated Openings: Install frames according to NFPA 80.

D. Floor Anchors: Secure with post installed expansion anchors.
   1. Floor anchors may be set with power-actuated fasteners instead of post installed expansion anchors if so indicated and approved on Shop Drawings.

E. Solidly pack mineral-fiber insulation inside frames.

F. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.

G. In-Place Concrete or Masonry Construction: Secure frames in place with post installed expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

H. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
   1. Squareness: Plus or minus 1/16 inch (1.59 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   2. Alignment: Plus or minus 1/16 inch (1.59 mm), measured at jambs on a horizontal line parallel to plane of wall.
   3. Twist: Plus or minus 1/16 inch (1.59 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
   4. Plumbness: Plus or minus 1/16 inch (1.59 mm), measured at jambs at floor.

I. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

### 3.03 CLEANING AND TOUCHUP

A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

C. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.

D. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

**END OF SECTION**

# SECTION 081416
# FLUSH WOOD DOORS

## PART 1 GENERAL

### 1.01 REFERENCE STANDARDS

A. 01 - 1; 1.

B. 8 - test; 1.

C. ANSI - American National Standards Institute; N/A.

D. ANSI A208.1 - American National Standard for Particleboard; 2022.

E. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2025, with Amendment (2024).

F. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives; 2025.

G. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

H. UL 1784 - Standard for Air Leakage Tests of Door Assemblies and Other Opening Protectives; Current Edition, Including All Revisions.

I. WDMA I.S. 1A - Interior Architectural Wood Flush Doors; 2021, with Errata (2022).

### 1.02 SUMMARY

A. Section Includes:
   1. Solid-core five-ply flush wood veneer-faced doors and transom panels for transparent finish.

B. Related Requirements:
   1. Section 088000 "Glazing" for glass view panels in flush wood doors.
   2. 099300 "Staining and Transparent Finishing" for field finishing doors.

### 1.03 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

### 1.04 ACTION SUBMITTALS

A. Product Data:
   1. Solid-core five-ply flush wood veneer-faced doors and transom panels for transparent finish.

B. Product Data Submittals: For each product, including the following:
   1. Door core materials and construction.
   2. Door edge construction
   3. Door face type and characteristics.
   4. Door louvers.
   5. Door trim for openings.
   6. Door frame construction.
   7. Factory-machining criteria.

C. Shop Drawings: Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data; and the following:
   1. Door schedule indicating door and frame location, type, size, fire protection rating, and swing.
   2. Door elevations, dimension and locations of hardware, lite and louver cutouts, and glazing thicknesses.
   3. Details of frame for each frame type, including dimensions and profile.
   4. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
   5. Dimensions and locations of blocking for hardware attachment.

6. Dimensions and locations of mortises and holes for hardware.
7. Clearances and undercuts.
8. Requirements for veneer matching.
9. Doors to be factory finished and application requirements.
10. Apply AWI Quality Certification Program label to Shop Drawings.

**1.05 CLOSEOUT SUBMITTALS**

A. Special warranties.

**1.06 DELIVERY, STORAGE, AND HANDLING**

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Package doors individually in plastic bags or cardboard carton..

C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

**1.07 FIELD CONDITIONS**

A. Environmental Limitations:
   1. Do not deliver or install doors until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and HVAC system is operating and maintaining temperature and relative humidity at levels designed for building occupants for the remainder of construction period.
   2. Do not deliver or install doors until building is enclosed and weathertight, wet work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 25  percent during remainder of construction period.

**1.08 WARRANTY**

A. Special Warranty: Manufacturer agrees to repair or replace doors and frames that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Delamination of veneer.
      b. Warping (bow, cup, or twist) more than 1/4 inch (6.35 mm) in a 42-by-84-inch section.
      c. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
   2. Warranty also includes installation and finishing that may be required due to repair or replacement of defective doors and frames.
   3. Warranty Period for Solid-Core Interior Doors: Life of installation.

**PART 2 PRODUCTS**

**2.01 PERFORMANCE REQUIREMENTS**

A. Fire-Rated Wood Door and Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated on Drawings, based on testing at positive pressure in accordance with UL 10C.

B. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.

**2.02 FLUSH WOOD DOORS AND FRAMES, GENERAL**

A. Quality Standard: In addition to requirements specified, comply with ANSI/WDMA I.S. 1A.
   1. Provide labels, and, certificates from AWI certification program indicating that doors comply with requirements of grades specified.
      a. Contractor registers the Work under this Section with the AWI Quality Certification Program at www.awiqcp.org or by calling 855-345-0991.

2. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with the Contract Documents in addition to those of the referenced quality standard.

**2.03 SOLID-CORE FIVE-PLY FLUSH WOOD VENEER-FACED DOORS AND TRANSOM PANELS FOR TRANSPARENT FINISH**

A. Interior Doors, Solid-Core Five-Ply Veneer-Faced:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   a. Lambton Doors
   b. Masonite Architectural
   c. Oshkosh Door Company
   d. VT Industries, Inc.
2. Performance Grade: ANSI/WDMA I.S. 1A Extra Heavy
3. Performance Grade by Location:
   a. ANSI/WDMA I.S. 1A Extra Heavy Duty: where indicated on Drawings.
   b. ANSI/WDMA I.S. 1A Standard Duty: where indicated on Drawings.
4. ANSI/WDMA I.S. 1A Quality Grade: Premium..
5. Faces: Single-ply wood veneer not less than 1/50 inch (0.51 mm) thick.
   a. Species: Select white birch
   b. Cut: Rotary cut
   c. Match between Veneer Leaves: Book match.
   d. Assembly of Veneer Leaves on Door Faces: Center-balance match.
   e. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
   f. Room Match:
      1) Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by 10 feet (304.8 cm) or more.
      2) Provide door faces of compatible color and grain within each separate room or area of building.
6. Exposed Vertical and Top Edges: Same species as faces or a compatible species - Architectural Woodwork Standards edge Type A
   a. Fire-Rated Single Doors: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed vertical edges.
   b. Fire-Rated Pairs of Doors:
      1) Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
   c. Mineral-Core Doors: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
      1) Screw-Holding Capability: 550 lbf in accordance with WDMA T.M. 10.
7. Core for Non-Fire-Rated Doors:
   a. ANSI A208.1, Grade LD-1 particleboard.
      1) Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware:
         (a) 5-inch top-rail blocking, in doors indicated to have closers.
         (b) 5-inch bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armor plates.
         (c) 5-inch midrail blocking, in doors indicated to have exit devices.

2) Provide doors with glued-wood-stave, or, WDMA I.S. 10 structural-composite-lumber cores instead of particleboard cores for doors scheduled to receive exit devices in Section 087100 "Door Hardware.
b. Glued wood stave.
c. WDMA I.S. 10 structural composite lumber.
1) Screw Withdrawal, Door Face: 550 lbf.
2) Screw Withdrawal, Vertical Door Edge: 550 lbf.
d. Either glued wood stave or WDMA I.S. 10 structural composite lumber.
8. Core for Fire-Rated Doors: As required to achieve fire-protection rating indicated on Drawings.
a. Blocking for Mineral-Core Doors: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated on Drawings as needed to eliminate through-bolting hardware.
1) 5-inch top-rail blocking.
2) 5-inch bottom-rail blocking, in doors indicated to have protection plates.
3) 5-inch midrail blocking, in doors indicated to have armor plates.
4) 5-inch midrail blocking, in doors indicated to have exit devices.
9. Construction: Five plies, hot-pressed bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.

**2.04 FABRICATION**

A. Factory fit doors to suit frame-opening sizes indicated.
1. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
2. Comply with NFPA 80 requirements for fire-rated doors.

B. Factory machine doors for hardware that is not surface applied.
1. Locate hardware to comply with DHI-WDHS-3.
2. Comply with final hardware schedules, door frame Shop Drawings, ANSI/BHMA-156.115-W, and hardware templates.
3. Coordinate with hardware mortises in metal frames, to verify dimensions and alignment before factory machining.
4. For doors scheduled to receive electrified locksets, provide factory-installed raceway and wiring to accommodate specified hardware.
5. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

C. Transom and Side Panels:
1. Fabricate matching panels with same construction, exposed surfaces, and finish as specified for associated doors.
2. Finish bottom edges of transoms and top edges of rabbeted doors same as door stiles.
3. Provide factory-installed spring bolts for concealed attachment into jambs of metal door frames.

D. Openings: Factory cut and trim openings through doors.
1. Light Openings: Trim openings with moldings of material and profile indicated.
2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."
3. Louvers: Factory install louvers in prepared openings.

**PART 3 EXECUTION**

**3.01 EXAMINATION**

A. Examine doors and installed door frames, with Installer present, before hanging doors.
1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
2. Reject doors with defects.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.02 INSTALLATION**

A. Hardware: For installation, see Section 087100 "Door Hardware".

B. Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.

C. Install frames level, plumb, true, and straight.
   1. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches (2438.4 mm).
   2. Anchor frames to anchors or blocking built in or directly attached to substrates.
      a. Secure with countersunk, concealed fasteners and blind nailing.
      b. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork.
         1) For factory-finished items, use filler matching finish of items being installed.
   3. Install fire-rated doors and frames in accordance with NFPA 80.
   4. Install smoke- and draft-control doors in accordance with NFPA 105.

D. Job-Fitted Doors:
   1. Align and fit doors in frames with uniform clearances and bevels as indicated below.
      a. Do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors.
   2. Machine doors for hardware.
   3. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
   4. Clearances:
      a. Provide 1/8 inch at heads, jambs, and between pairs of doors.
      b. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering unless otherwise indicated on Drawings.
      c. Where threshold is shown or scheduled, provide 1/4 inch (6.35 mm) from bottom of door to top of threshold unless otherwise indicated.
      d. Comply with NFPA 80 for fire-rated doors.
   5. Bevel non-fire-rated doors 1/8 inch in 2 inches (50.8 mm) at lock and hinge edges.
   6. Bevel fire-rated doors 1/8 inch in 2 inches (50.8 mm) at lock edge; trim stiles and rails only to extent permitted by labeling agency.

E. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

F. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

**3.03 ADJUSTING**

A. Operation: Rehang or replace doors that do not swing or operate freely.

B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

**END OF SECTION**

# SECTION 083513
# ACCORDION FOLDING DOORS

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section Includes:
   1. Aluminum accordion folding doors.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.

### 1.02 REFERENCES

A. ASTM International - E336 - Standard Test Method for Measurement of Airborne Sound Attenuation Between Rooms in Buildings and E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements. (www.fscus.org)

### 1.03 SUBMITTALS

A. Submittals for Review:
   1. Shop Drawings: Indicate opening sizes, jamb, sill, and head conditions.
   2. Product Data: Manufacturer's descriptive literature for door units, and hardware.
   3. Samples:
      a. Color chips illustrating manufacturer's full range of available colors and finishes.

B. Closeout Submittals:
   1. Operation and Maintenance Data.

### 1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Primary products supplied by single manufacturer with minimum 5 years documented experience in fabrication of accordion folding wood doors.

B. Installer Qualifications: Minimum 2 years documented experience in work of this Section.

C. Regulatory Requirements: Comply with applicable accessibility code for door opening force.

### 1.05 DELIVERY, STORAGE AND HANDLING

A. Do not deliver doors until proper protection can be provided, and until needed for installation.

B. Store products in manufacturer's unopened packaging until ready for installation.

### 1.06 PROJECT CONDITIONS

A. Maintain temperature and humidity within manufacturer's recommended limits.

B. Do not install products under environmental conditions outside manufacturer's limits.

### 1.07 WARRANTIES

A. Provide manufacturer's standard limited warranty against manufacturing defects.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Contract Documents are based on products by Woodfold Mfg., Inc. (www.woodfold.com)

B. Substitutions: Under provisions of Division 01 .

### 2.02 ACCORDION FOLDING SECURITY DOORS

A. Source: Series 640 Alumifold door.

B. Components:
   1. Track: 1-1/8 x 1 inch aluminum, pre-punched for screw fasteners for surface mounting.
   2. Roller assembly: Nylon wheels on ball-bearing steel axles; riveted to hinge, dual trolley at lead post, single trolley at alternate panels, type for specified track.

3. Hinge assembly: 18 gauge steel, continuous pin, riveted to top and bottom of door panel, with automatic stop at full extension.
4. Panels: 0.08 inch thick solid aluminum, 4-1/4 inches wide.
5. Panel connectors: Continuous non-rigid vinyl, inserted into panel frame channel.
6. Lead post: Extruded aluminum, 3/4 x 2-3/4 inch cross section.
7. Intersecting jamb molding: Types for indicated configurations.
8. Handle: Rigid molded polyvinyl chloride.
9. Latching: Thumb turn one side with deadlatch.

C. Finishes:
1. Panels: Clear anodized aluminum, solid.
2. Steel: Manufacturer's standard finish, in color complementing panel finish.
3. Aluminum: Manufacturer's standard finish, in color complementing panel finish.

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. Install door assembly in accordance with manufacturer's instructions.

B. Anchor to adjacent construction without distortion or stress.

C. Fit and align door assembly including hardware, level and plumb, to provide smooth operation.

### 3.02 ADJUSTING

A. Adjust doors for smooth operation throughout full operating range.

**END OF SECTION**

**SECTION 083600**
**OVERHEAD DOORS**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Flush insulated steel sandwich sectional overhead door (Model 3220)

B. Electric Door Operators
   1. RELATED SECTIONS

C. 03 30 00 - Cast-In-Place Concrete.

D. 04 20 00 - Unit Masonry Assemblies.

E. 05 50 00 - Metal Fabrications.

F. 06 10 00 - Rough Carpentry.

G. 07 90 00 - Joint Seals.

H. 08 71 00 - Door Hardware and locks.

I. 09 90 00 - Paints and Coatings.

J. 11 15 00 - Parking Control Equipment: Remote door control.

K. 16 05 00 - Electrical service and connections for powered operators.
   1. REFERENCES

L. ASTM B 653/653M

M. ASTM B 209/209M

N. ASTM B221/221M

O. AAMA 2604

P. DASMA TDS-163

Q. ANSI/DASMA 102
   1. SUBMITTALS

R. Submit under provisions of Section 01 30 00 - Administrative Requirements.

S. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.
   4. Operation and maintenance data.
   5. Nameplate data and ratings for motors.

T. Shop Drawings: Include opening dimensions and required tolerances, connection details, anchorage spacing, hardware locations, and installation details.

U. Selection Samples: Upon request furnish color samples or 2’ X 2’ section sample.
   1. WIND PERFORMANCE REQUIREMENTS

V. Design doors to withstand positive and negative wind loads as calculated in accordance with applicable building code and detailed in structural documents.
   1. QUALITY ASSURANCE

W. Manufacturer Qualifications: Minimum ten years of documented experience.

X. Installer Qualifications: Minimum five years of documented experience, and authorized by the door manufacturer.
   1. WARRANTY

Y. Manufacturers Limited Warranty steel sectional overhead doors.

1. Standard finish warranty against cracking, checking, or peeling for 10 years. Custom color option Color Blast Finish limited warranty period for 5 years; Delamination warranty for 5 years; Parts and Hardware for 1 year. Extended 8-Year Hardware Warranty option.

### 1.02 REFERENCE STANDARDS

A. 01 - 1; 1.

B. 8 - test; 1.

C. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2026.

D. ANSI - American National Standards Institute; N/A.

E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

F. ASTM A924/A924M - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process; 2026.

G. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.

H. DASMA 102 - American National Standard Specifications for Sectional Doors; 2018.

I. NEMA ICS 1 - Industrial Control and Systems General Requirements; 2022.

J. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2008 (Reaffirmed 2020).

K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Acceptable Manufacturer: Clopay Corporation: 8585 Duke Blvd.; Mason, OH 45040; https://www.clopaydoor.com

B. Substitutions: Not permitted.

C. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.
   1. FLUSH STEEL DOORS, THERMALLY-BROKEN, POLYSTYRENE INSULATED

D. Door Construction:
   1. Panels: Sandwich construction of exterior and interior steel skins pressure bonded to an expanded core, with skins separated by a continuous silicone filling forming a thermal break.
   2. Steel Skins: Formed from roll formed commercial or drawing quality steel sheet, hot-dip galvanized per ASTM A924/A924M and ASTM A653/A653M, pre-painted with primer and baked-on polyester topcoat; sections formed to create weather tight tongue-in-groove meeting joint, unless otherwise specified.
   3. Reinforcing: Galvanized and primed steel reinforcement located under each hinge location, pre-punched for hinge attachment.

E. Heavy Duty Door: Clopay Model 3220.
   1. Style: Flush steel doors, thermally-broken, polystyrene insulated.
   2. Overall Panel Thickness: 2 inches (50.8 mm).
   3. Steel Skin Thickness: Minimum 20 gauge 0.034 inch (0.86 mm) exterior;
      a. minimum 27 gauge 0.016 inch (0.41 mm) interior.
   4. Stiles: Steel pre-painted end stiles, minimum 0.049 inch (1.24 mm) thick, engineered for easy hardware attachment through pre-punched holes.
   5. Astragal: U-shaped flexible PVC in retainer of full-length 0.055 inch (1.4 mm) rigid PVC.

6. Thermal Resistance (R-value): 9.1 degrees Fahrenheit (-12.72 degrees Celsius) hr sq ft/Btu (1.6 (K sq m)/W); calculated door section R-value in accordance with DASMA TDS-163.
7. U-Factor: 0.24
8. Air Infiltration: 0.34 cfm/ft2.
9. Windows: Polyurethane Insulated Full vision aluminum section.
    a. Glazing: 1/2 inch (12.7 mm) dual pane insulated glazing.
10. Finish: Flush stucco embossed texture, white interior, exterior as follows:
    a. Clopay ColorBlast®, a two part paint system utilizing Sherwin Williams® Solar reflective Polane Paint system. Sherwin Williams® color match color TBD.
11. Locking:
    a. Provide one inside slide lock.
12. Door Drop Safety Device: Provide brackets designed to stop the fall of the door should lift cables fail.
13. Weatherstripping: Provide complete perimeter seals.
14. Track:
    a. Provide track configuration to maximize headroom available per plans.
    b. 2 inches (50.8 mm) track designed for 2” diameter rollers. Vertical tracks minimum 0.061 inch (1.55 mm) galvanized steel. Horizontal tracks minimum 0.075 inch (1.9 mm) galvanized steel.
    c. 3 inches (76.2 mm) track designed for 3” diameter rollers. Vertical and horizontal tracks minimum 0.096 inch (2.44 mm) galvanized steel.
15. Spring Counterbalance: Torsion spring counterbalance mechanism sized to weight of the door, with high strength galvanized aircraft cable with minimum 7 to 1 safety factor.
    a. High Cycle Spring: 100,000 cycles.
    b. Maximum cycles on a single shaft.
16. ELECTRIC DOOR OPERATORS

F. General: Provide electric door operator provided by door manufacturer for door with operational life specified complete with electric motor and factory pre-wired motor controls, starter, gear-reduction unit, clutch, remote-control stations, control devices, integral gearing for locking door, and accessories required for proper operation. Comply with NFPA 70.
    1. Solenoid-operated brake.

G. Disconnect Device: Provide hand-operated disconnect or mechanism for emergency manual operation while disconnecting motor, without affecting timing of limit switch. Mount disconnect and operator so they are accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

H. Design operator so motor may be removed without disturbing limit switch adjustment and without affecting emergency auxiliary operator.

I. Provide control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V, AC or DC.

J. Electric Motors: Provide high-starting torque, reversible, continuous-duty, Class A insulated, electric motor, complying with NEMA MG 1, with overload protection, sized to start, accelerate, and operate door in either direction, from any position, at not less than 2/3 fps 0.22 yard (0.2 meter)/s) and not more than 1 fps (.03m/s), without exceeding nameplate ratings or considering service factor.
    1. Type: Mechanical.
    2. Type: Solid State.
    3. Type: Jackshaft.
    4. Type: Trolley.
    5. HP:
        a. 1/3 hp (246 W).
        b. 1/2 hp (373 W).

c. 3/4hp (559 W).
d. 1 hp (746 W).

6. Power Characteristics:
   a. 115 V.
   b. 220 V.
   c. 460 V.
   d. 1 phase.
   e. 3 phase.
7. Service Factor:
   a. NEMA MG 1.
   b. NEMA 4 watertight.
   c. NEMA 9 waterproof.
   d. NEMA 10 oil resistant.
   e. NEMA 12 explosion resistant.
8. Coordinate wiring requirements and electrical characteristics of motors with building electrical system.

K. Remote Control Station: Provide momentary contact, 3-button control station with push - button controls labeled "Open", "Close" and "Stop".

L. Remote Control Station: Provide continuous contact, 3-button control station with push - button controls labeled "Open", "Close" and "Stop".

M. Provide interior units, fully guarded, surface mounted, heavy-duty type, with general- purpose NEMA ICS 6 enclosure in one of the following types:
1. Enclosure Type: Type 1.
2. Enclosure Type: Type 4.
3. Enclosure Type: Type 12.

N. Obstruction Detection Device: Provide each motorized door with indicated external
1. automatic safety sensor able to protect full width of door opening. Activation of sensor immediately stops and reverses downward door travel.
2. Sensor Edge: Provide each motorized door with an automatic safety sensing edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor immediately stops and reverses downward door travel. Connect to control circuit using manufacturer's standard take-up reel or self- coiling cord. Sensing edge shall be operated by:
   a. Electric.
   b. Pneumatic.
   c. Electric Fail safe.
   d. Pneumatic Fail safe.
3. Photo-electric control: Provide each motorized door with a photo-electric device that will stop and reverse the downward door travel if the light beam is broken or blocked. Device shall be:
   a. NEMA Type 1.
   b. NEMA Type 4.

O. Limit Switches: Provide adjustable switches, interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.

P. Radio Controls: Provide 3 button radio transmitter to provide remote open, close, stop functionality.
1. Provide external antenna and coaxial wiring to receiver to enhance radio control reception.

Q. Provide auxiliary chain hoist: for emergency manual operation while disconnecting motor, without affecting timing of limit switch. Mount disconnect and operator so they are accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Examine wall and overhead areas, including opening framing and blocking, with installer present, for compliance with requirements for installation tolerances, clearances, and other conditions affecting performance of Work in this Section.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
   1. PREPARATION

C. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
   1. INSTALLATION

D. Install overhead doors and track in accordance with approved shop drawings and the manufacturer's printed instructions.
   1. PROTECTION

E. Protect installed products until completion of project.

F. Touch-up, repair or replace damaged products before Substantial Completion.

**END OF SECTION**

**SECTION 083613**
**SECTIONAL DOORS - FOUR FOLD**

**RELATED DOCUMENTS**

**1.01 REFERENCE STANDARDS**

A. 01 - 1; 1.

B. 8 - test; 1.

C. ASCE 7-16 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; 2016.

D. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2023.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. test - sddds; sdds.
   1. Drawings and general provisions of the contract, including supplementary conditions and DIVISION 1 specifications section, apply to this section.

**SUMMARY**

1. This section includes door engineering Four-Fold metal doors with surface mounted tube frames.
2. Operation of four-fold metal doors includes overhead mounted electro- mechanical operators.

**SUBMITTALS**

1. General: Submit each item in this article according to the conditions of the contract and division 1 specification sections.
2. Product data for each type of product specified consisting of manufacturer’s technical product data and installation instructions for each type of door required, including data substantiating that products comply with requirements.
3. Submittal drawings showing fabrication and installation of four-fold metal doors including plans, elevations, sections, details of components, hardware, operating mechanism, and attachments to the other units of work. include wiring diagrams for coordination with electrical trade.
4. Reference list including (5) successful installations of this type of door within the past two (2) years.

**QUALITY ASSURANCE**

1. Doors shall be designed to withstand external or internal horizontal wind loads of 120mph (3 second gust) per ASCE 7-16. the maximum allowable deflection shall not exceed 1/120 of the span. fiber stresses in main members shall be limited to 27,000 pounds per square inch. steel frames shall be designed in accordance with the AISC “steel construction manual”.
2. Door manufacturer shall have at least 10 years experience in manufacturing door type specified.

**DELIVERY, STORAGE AND HANDLING**

1. Store delivered materials and equipment in dry locations with adequate ventilation, free from dust and water, and so as to permit access for inspection and handling.
2. HANDLE MATERIALS CAREFULLY TO PREVENT DAMAGE.

**WARRANTY**

1. The door manufacturer shall provide a written standard limited warranty for material and workmanship.

**PART 2 - PRODUCTS**

**7.01 19.01 2.1 MANUFACTURERS**

A. A. Manufacturers: Four-Fold industrial metal doors manufactured by Door Engineering and Manufacturing, 101 Power Dr, Mankato, MN 56001, Bryan Wallace 770-380-0489 Factory (800)-959-1352 FF300 Series: Glazed

1. Alternate equal products by other manufacturers. must be approved by architect at least 2 weeks prior to bid date. doors shall be manufactured and assembled in the USA.
2. 20.01 MATERIALS
3. Steel tube: ASTM a513 and ASTM a500/a500m
4. Steel sheets: Steel sheets of commercial quality, complying with astm a1008 cold-rolled steel sheet.
5. Hardware: Manufacturer’s standard components.
6. Fasteners: zinc-coated steel.

**FOUR-FOLD DOORS**

1. Construction: Door framing shall be minimum 11-gauge structural steel tube with 16-gauge steel sheet on the exterior and interior faces. sheeting shall be formed on the vertical edges with no visible welds on the interior or exterior panel faces. all frames and framing members
2. shall be true to dimension and square in all directions, and no door shall be bowed, warped, or out of line, in the vertical or horizontal plane of the door opening by more than 1/8 inch 0.13 inch (3.18 mm) in 20 feet (609.6 cm). exposed welds and welds which interfere with the installation of various parts shall be ground smooth and flush.
3. Surface mounted tube frame: supply pre-hung tube frame system constructed of minimum ts6x4x3/16”, designed to anchor to masonry wall construction or weld to steel structure. all hinges, track supports, and operator supports shall be factory attached.
4. Factory finish: Door panels and tube frames shall be finished with manufacturer’s standard ppg spectracron epoxy primer and polyurethane top coat. customer to select from manufacturer’s standard color chart or furnish sample to match.
5. 28.01 Operator and operating hardware shall be powder-coated manufacturer’s standard gray.
6. Hardware: Hardware shall include guide tracks and brackets, trolleys, center guides, not less than three pairs of jamb and fold hinges per opening, and all bolts, nuts, fasteners, etc. necessary for complete installation and operation.

**8.02 ALL HARDWARE, INCLUDING HINGES AND TROLLEYS, SHALL BE BOLTED TO THE PANEL FOR EASY REMOVAL FOR SERVICE OR PANEL REPLACEMENT.**

**8.03 DOORS UP TO 16’ WIDE AND UNDER 30PSF WIND LOAD SHALL REQUIRE NO FLOOR MOUNTED SUPPORTS, GUIDES OR TRACKS.**

**8.04 TOP TRACKS SHALL BE ADJUSTABLE ON THE END TRACK HANGERS TO ALLOW FOR ADJUSTMENT OF THE DOOR PANELS IN THE OPEN POSITION AND EASILY REPLACEABLE WITHOUT REMOVAL OF THE DOOR FRAMING OR OPERATORS.**

1. Hinges: Jamb hinges shall be dual shear and have two thrust bearings and two needle bearings. fold hinges shall be stainless steel and be dual shear with two thrust bearings. all bearings shall be completely concealed within the hinge barrel and include grease zerks. all hinge pins shall be minimum ¾” diameter hardened steel.
2. Hinge guards: Provide plastic guards at jamb hinges to prevent access through hinge space.
3. Weatherstripping: Material shall be adjustable and readily replaceable and provide a substantially weather-tight installation. weatherstripping at center shall be 1/16” epdm and include no exposed fasteners on the exterior side of the panel. weatherstripping at sill shall include two 1/16” epdm sweeps with an aluminum retainer. the retainer shall be attached to the door with adhesive.
4. Perimeter weatherstripping: Provide full perimeter jamb and head weatherstripping.

5. Vision panels: Provide 1” insulated, tempered, vision panels of the size, shape and location as noted on the drawings.
   a. OPERATOR
6. Each four-fold door shall be operated by an overhead mounted electro- mechanical drive unit designed for high cycle operation. operator consists of an electric motor, gear reducer, and rotating drive arm. the door shall be operated with connecting rods attached to the rotating drive arm on the operator and to control arms attached to the jamb door section and to the door lintel. the connecting rods shall be positive drive, always keeping the door under firm control. the connecting rods shall be fitted with spherical bearings and control arms shall be equipped with oil impregnated bronze bearings on polished shafts.
7. Operator shall be instantly reversible, open and close rapidly and start and stop gradually. operator shall be adjustable to allow door to fully clear the opening. operator shall automatically lock the door in the closed position. operator shall be equipped with disengaging mechanism to convert to manual operation.
8. Electric motor shall be of sufficient size to operate doors under normal operating conditions at no more than 75 percent of rated capacity. the motor shall be wound for three phase 208/230/480 vac, 60 hertz operation.
9. Electric controls: controls shall be furnished by the door manufacturer and shall be complete for each door and built in accordance with the latest nema standards. incoming electrical shall be: 208vac single phase.

**8.05 CONTROL PANEL ASSEMBLIES SHALL BE UL LISTED AS PER NFPA 70.**

**8.06 CONTROLS SHALL INCLUDE A PROGRAMMABLE LOGIC CONTROLLER WITH DIGITAL MESSAGE DISPLAY. CONTROLLER SHALL INCLUDE PROGRAMMABLE CLOSE TIMERS AND PROGRAMMABLE INPUTS/OUTPUTS.**

**8.07 CONTROLS SHALL INCLUDE A VARIABLE FREQUENCY DRIVE WITH INDEPENDENT ADJUSTMENT OF THE OPENING AND CLOSING SPEEDS.**

**8.08 ENCLOSURES SHALL BE NEMA 4 WITH DISCONNECT SWITCH.**

**8.09 PUSHBUTTONS (INTERIOR) FOR EACH DOOR SHALL HAVE ONE (1) MOMENTARY PRESSURE THREE-BUTTON PUSH- BUTTON STATION MARKED “OPEN”,“CLOSE” AND “STOP”. PUSH BUTTON ENCLOSURE SHALL BE NEMA 4.**

**8.10 LIMIT SWITCHES SHALL BE PROVIDED TO STOP THE TRAVEL OF THE DOOR IN ITS FULLY OPEN OR FULLY CLOSED POSITION.**

**8.11 SAFETY EDGES: PROVIDE MONITORED ELECTRIC SAFETY EDGES ON LEADING EDGE OF ALL DOORS TO REVERSE DOOR UPON CONTACT WITH OBSTRUCTION.**

**8.12 PHOTO EYES: PROVIDE (1) EXTERIOR, JAMB MOUNTED, LIGHT CURTAIN TYPE PHOTO EYES, NEMA 4 RATED. PHOTO EYE SHALL COVER FROM FLOOR LEVEL TO 72” ABOVE FLOOR.**

**8.13 PRESENCE SENSOR: PROVIDE (1) INTERIOR, OVERHEAD MOUNTED, PRESENCE SENSOR BEA IS40P OR EQUAL.**

**8.14 RADIO CONTROLS: PROVIDE ONE (1) RADIO RECEIVER AND (1) SINGLE BUTTON REMOTES PER DOOR. REMOTES TO OPEN AND CLOSE DOORS WITH SINGLE BUTTON. SUPPLIED BY DOOR INSTALLER. PROVIDE EXTENDED RANGE ANTENNA OR BOOSTER DUE TO BUILDING DESIGN.**

**8.15 WIRING: DOOR MANUFACTURER SHALL SUPPLY CONTROLS AND COMPONENTS ONLY. ELECTRICAL CONTRACTOR SHALL INSTALL CONTROLS AND FURNISH AND INSTALL CONDUITS AND WIRING FOR JOBSITE POWER AND CONTROL WIRING.**

**PART 3 - EXECUTION**

**9.01 40.01 3.1 INSTALLATION**

1. Install four-fold metal doors in strict accordance with the approved drawings by qualified door erection crews. all door openings shall be completely prepared by the general contractor prior to the installation of the doors. permanent or temporary electric wiring

shall be brought to the door opening before installation is started and shall be completed so as not to delay the inspection test.

2. Doors shall be set plumb, level, and square, and with all parts properly fastened and mounted. all moving parts shall be tested and adjusted and left in good operating condition.
3. 3.2 ADJUSTING AND CLEANING
4. Inspection of the doors and a complete operating test will be made by the installer in the presence of the general contractor or architect as soon as the erection is complete. any defects noted shall be corrected. after door approval in the above test, the general contractor must assume the responsibility for any damage or rough handling of the doors during construction until the building is turned over to the owner and final inspection is made.
5. Clean surfaces and repaint abraded or damaged finished surfaces to match factory-applied finish.

**END OF SECTION**

# SECTION 084313
# ALUMINUM-FRAMED STOREFRONTS

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Aluminum-framed storefront, with vision glass.

### 1.02 RELATED REQUIREMENTS

A. Section 072500 - Weather Barriers: Sealing framing to water-resistive barrier installed on adjacent construction.

B. Section 079200 - Joint Sealants: Sealing joints between frames and adjacent construction.

C. Section 088000 - Glazing: Glass and glazing accessories.

### 1.03 REFERENCE STANDARDS

A. AAMA 503 - Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems; 2024.

B. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum; 2025.

C. AAMA 611 - Specification for Anodized Architectural Aluminum; 2026.

D. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site; 2026.

E. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.

F. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.

G. ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2026.

H. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2014 (Reapproved 2021).

I. ASTM E1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference; 2015 (Reapproved 2023).

### 1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordinate with installation of other components that comprise the exterior enclosure.

### 1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, and internal drainage details.

C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, expansion and contraction joint location and details, and field welding required.

D. Samples for initial selection:
   1. Provide samples for units with factory-applied color finishes.

E. Samples for Verification:
   1. Provide a veriofication smaple for aluminum-framed storefront system and required components.

F. Design Data: Provide framing member structural and physical characteristics, engineering calculations, and dimensional limitations.

G. Manufacturer's qualification statement.

H. Specimen warranty.

**1.06 QUALITY ASSURANCE**

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with minimum 3 years of documented experience.

B. Installer Qualifications: Company specializing in performing work of type specified, with minimum 3 years of documented experience.

**1.07 DELIVERY, STORAGE, AND HANDLING**

A. Handle products of this section in accordance with AAMA CW-10.

B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

**1.08 FIELD CONDITIONS**

A. Do not install sealants when ambient temperature is less than 40 degrees F (5 degrees C). Maintain this minimum temperature during and 48 hours after installation.

**1.09 WARRANTY**

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Correct defective Work within a two year period after Date of Substantial Completion.

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS**

A. Aluminum-Framed Storefronts:
   1. Kawneer North America; Trifab 451T: www.kawneer.com/#sle.
   2. Oldcastle BuildingEnvelope: www.oldcastlebe.com/#sle.
   3. YKK AP America, Inc: www.ykkap.com/commercial/#sle.

**2.02 BASIS OF DESIGN -- FRAMING FOR INSULATING GLAZING**

A. Center-Set Style, Thermally-Broken:
   1. Basis of Design: Kawneer Company, Inc; Trifab VersaGlaze 451T.
   2. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep (51 mm wide by 114 mm deep).

**2.03 ALUMINUM-FRAMED STOREFRONT**

A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
   1. Finish: Class I color anodized.
      a. Factory finish all surfaces that will be exposed in completed assemblies.
   2. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.
   3. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
   4. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
   5. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F (95 degrees C) over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.
   6. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.

7. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.

B. Performance Requirements
   1. Wind Loads: Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330/E330M, using loads 1.5 times the design wind loads and 10 second duration of maximum load.
      a. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.
   2. Air Leakage: 0.06 cfm/sq ft (0.3 L/sec sq m) maximum leakage of storefront wall area when tested in accordance with ASTM E283/E283M at 1.57 psf (75 Pa) pressure difference.

**2.04 COMPONENTS**

A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
   1. Glazing Stops: Flush.

B. Glazing: See Section 088000.

**2.05 MATERIALS**

A. Extruded Aluminum: ASTM B221 (ASTM B221M).

B. Fasteners: Stainless steel.

C. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.

D. Glazing Accessories: See Section 088000.

**2.06 FINISHES**

A. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils (0.018 mm) thick.

**PART 3 EXECUTION**

**3.01 EXAMINATION**

A. Verify dimensions, tolerances, and method of attachment with other work.

B. Verify that storefront wall openings and adjoining water-resistive and/or air barrier seal materials are ready to receive work of this section.

**3.02 INSTALLATION**

A. Install wall system in accordance with manufacturer's instructions.

B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.

C. Provide alignment attachments and shims to permanently fasten system to building structure.

D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.

E. Provide thermal isolation where components penetrate or disrupt building insulation.

F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.

G. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.

H. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

I. Install glass and infill panels using glazing method required to achieve performance criteria; see Section 088000.

J. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

**3.03 TOLERANCES**

A. Maximum Variation from Plumb: 0.06 inch per 3 feet (1.5 mm per m) non-cumulative or 0.06 inch per 10 feet (1.5 mm per 3 m), whichever is less.

B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch (0.8 mm).

**3.04 CLEANING**

A. Remove protective material from pre-finished aluminum surfaces.

B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths, and take care to remove dirt from corners and to wipe surfaces clean.

C. Upon completion of installation, thoroughly clean aluminum surfaces in accordance with AAMA 609 & 610.

**3.05 PROTECTION**

A. Protect installed products from damage until Date of Substantial Completion.

**END OF SECTION**

**SECTION 085113**
**ALUMINUM WINDOWS**

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section Includes: Kawneer Aluminum Windows including perimeter trims, stools, accessories, shims and anchors, and perimeter sealing of window units.
   1. Types of Aluminum windows include.
      a. Kawneer Series 8225TL Thermal Windows.
      b. Fixed and Project-Out.
      c. 2-1/4" (57.2mm) frame depth, with 0.125" (3.2mm) wall thickness.
      d. AW-PG90-AP

### 1.02 DEFINITIONS

A. For fenestration industry standard terminology and definitions refer to American Architectural manufacturers Association (AAMA) - AAMA Glossary (AMMA AG).

### 1.03 REFERENCE STANDARDS

A. AAMA 611 - Specification for Anodized Architectural Aluminum; 2026.

B. AAMA 901 - Specification for Rotary & Linear Operators in Window Applications; 2024.

C. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections; 2009.

D. AAMA/WDMA/CSA 101/I.S.2/A440 - North American Fenestration Standard/Specification for Windows, Doors, and Skylights; 2026.

E. ASTM C1036 - Standard Specification for Flat Glass; 2025.

F. ASTM E1886 - Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials; 2019.

G. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes; 2026.

H. ASTM E2112 - Standard Practice for Installation of Exterior Windows, Doors and Skylights; 2023.

I. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation; 2019.

J. NFRC 100 - Procedure for Determining Fenestration Product U-factors; 2023.

### 1.04 COORDINATION

A. Finish Matching: Coordinate all exposed exterior aluminum components and trim to ensure uniform and consistent color and appearance. Use products specified in this Section as a benchmark. Architect's decision will be final as to whether a proposed product matches.

### 1.05 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   2. Review and discuss finishing of aluminum windows that is required to be coordinated with finishing of other aluminum work for color and finish matching.
   3. Review, discuss, and coordinate interrelationship of aluminum windows with other exterior wall components. Include provisions for anchoring, flashing, weeping, sealing perimeters, and protecting finishes.
   4. Review and discuss sequence of work required to construct a watertight and weathertight exterior building envelope.

5. Inspect and discuss condition of substrate and other preparatory work performed by other trades.

### 1.06 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes.

B. Shop Drawings:
   1. Plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish:
   1. Exposed Aluminum Finishes: Manufacturers' standard size.
   2. Exposed Hardware: Full-size units.

E. Product Schedule: For aluminum windows. Use same designations indicated on Drawings.

### 1.07 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For manufacturer and Installer.

B. Sample warranties.

### 1.08 CLOSEOUT SUBMITTALS

A. Warranty Documentation:
   1. Manufacturers' special warranties.

### 1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver aluminum windows to Project site in original, unopened packages and store them in accordance with manufacturer's written instructions. Protect aluminum windows against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Handle aluminum windows in a manner that prevents damage before, during, and after installation.

### 1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install aluminum windows outside of limits recommended in writing by manufacturer.

### 1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Failure to meet performance requirements.
      b. Structural failures, including excessive deflection, water leakage, condensation, and air infiltration.
      c. Faulty operation of movable sash and hardware.
      d. Deterioration of materials and finishes beyond normal weathering.
      e. Failure of insulating glass.
   2. Warranty Period:
      a. Window: Two years from date of Substantial Completion.
      b. Glazing Units: Five years from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.01 SOURCE LIMITATIONS

A. Obtain aluminum windows from single source from single manufacturer.

## 2.02 PERFORMANCE REQUIREMENTS

A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
   1. Window Certification: FGIA certified with label attached to each window.

B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:
   1. Minimum Performance Class: and Grade AW -PG100-FW and AW-PG90-AP.

C. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:
   1. Thermal Transmittance (U-factor): As determined in accordance with NFRC 100:
      a. Fixed Windows: Not more than.34 Btu/sq. ft. x h x deg F.
      b. Operable Windows: Not more than 0.54 Btu/sq. ft. x h x deg F.
   2. Condensation-Resistance Factor (CRF): Provide aluminum windows tested for thermal performance in accordance with AAMA 1503, showing a CRF of 57 for Fixed windows and 55 for Project-Out.

D. Thermal Movements: Provide aluminum windows, including anchorage, which allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change: 120 deg F ambient; 180 deg F material surface.

E. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone 1 for basic protection.
   1. Large-Missile Test: For glazing located within 30 feet (914.4 cm) of grade.
   2. Small-Missile Test: For glazing located more than 30 feet (914.4 cm) above grade.

## 2.03 ALUMINUM WINDOWS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Kawneer Model 8225TL - Fixed and Out-Swing or comparable product by one of the following:
   1. EFCO Corporation
   2. Kawneer Company, Inc.; Arconic Corporation
   3. OldCastle BuildingEnvelope (OBE)
   4. Winco Window Company, Inc.

B. Provide manufacturer's standard aluminum window assemblies consisting of frames, sashes, glass, hardware, fasteners, and all components and accessories as required for a complete installation.

C. Operating Types: Provide the following operating types in locations indicated on Drawings:
   1. Casement: Outswing..
   2. Fixed.

D. Frames and Sashes: Aluminum extrusions of alloy, temper, and strength complying with AAMA/WDMA/CSA 101/I.S.2/A440.
   1. Thermally Broken Construction: Fabricate frames, sashes, and muntins 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.

E. Glass: Clear annealed glass, ASTM C1036, Type 1, Class 1, q3.
   1. Kind: Fully tempered where indicated on Drawings.

F. Insulating-Glass Units: ASTM E2190.
   1. Glass: ASTM C1036, Type 1, Class 1, q3.
      a. Tint: Clear.
      b. Kind: Fully tempered where indicated on Drawings.

2. Lites: Two.
3. Filling: Fill space between glass lites with air.
4. Low-E Coating: Pyrolytic on second surface.

G. Glazing System: Manufacturer's standard factory-glazing system that produces weathertight seal.

H. Hardware, General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock windows, and sized to accommodate sash weight and dimensions.
1. Exposed Hardware Color and Finish: As selected by Architect from manufacturer's full range.

I. Window Hardware: Casement and projected.
1. Gear-Type Rotary Operators: Complying with AAMA 901 when tested in accordance with ASTM E405, Method A. Provide operators that function without requiring the removal of interior screens or using screen wickets.
a. Type and Style: As selected by Architect from manufacturer's full range of types and styles.
2. Hinges: Non-friction type, not less than two per sash.
3. Lock: Lever handle and cam-action lock with keeper.
4. Limit Devices: Concealed support arms with adjustable, limited, hold-open limit devices designed to restrict sash opening.
a. Limit clear opening to 4 inches for ventilation; with custodial key release.
5. Pole Operators: Tubular-shaped anodized aluminum; with rubber-capped lower end and standard push-pull hook at top to match hardware design; of sufficient length to operate window without reaching more than 60 inches above floor; one pole operator and pole hanger per room that has operable windows more than 72 inches above floor.

J. Weather Stripping: Provide manufacturer's standard full-perimeter weather stripping for each operable sash unless otherwise indicated.

K. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.
1. Exposed Fasteners: Avoid exposed fasteners to greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

L. Mullions: Provide manufacturer's standard combination and reinforcing mullions and cover plates matching window units, complete with anchors for support to structure. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections. Provide reinforcing mullions and cover plates capable of withstanding design wind loads of window units.

## 2.04 ACCESSORIES

A. Subsills: Thermally broken, extruded-aluminum subsills in configurations indicated on Drawings.

B. Interior Trim: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.

C. Panning Trim: Profiles in sizes and configurations indicated on Drawings.

D. Nail Fins: Manufacturer's standard mounting flanges with holes pre-punched for mechanical fasteners.

## 2.05 FABRICATION

A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.

B. Glaze aluminum windows in the factory.

C. Weather strip each operable sash to provide weathertight installation.

D. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.

E. Provide water-shed members above side-hinged sashes and similar lines of natural water penetration.

F. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

### 2.06 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA AMP 500 "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

### 2.07 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0 inch (0.02 mm) or thicker.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.

C. Examine wall flashings, vapor retarders, air and weather barriers, and other built-in components to ensure weathertight window installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION

A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.

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 to produce weathertight construction.

C. Mullions: Install combination and reinforcing mullions for combination assemblies in accordance with manufacturer's written instructions.

D. Install windows and components to drain water passing joints and condensation to the exterior.

E. Separate aluminum from sources of corrosion or electrolytic action at points of contact with other materials.

### 3.03 ADJUSTING

A. Adjust operating sashes and hardware for a tight fit at contact points and weather stripping for smooth operation and weathertight closure.

### 3.04 CLEANING AND PROTECTION

A. Clean exposed surfaces immediately after installing windows using manufacturer's written instructions. Avoid damaging finishes. Remove excess sealants, glazing materials, dirt, and other substances.

B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

C. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately in accordance with manufacturer's written instructions.

**END OF SECTION**

**SECTION 087100**
**DOOR HARDWARE**

## PART 1 GENERAL

### 1.01 REFERENCE STANDARDS

A. ANSI - American National Standards Institute; N/A.

B. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100); 2023.

C. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2026.

D. BHMA A156.1 - Standard for Butts and Hinges; 2025.

E. BHMA A156.2 - Bored and Preassembled Locks and Latches; 2022.

F. BHMA A156.3 - Exit Devices; 2025.

G. BHMA A156.4 - Door Closers and Pivots; 2024.

H. BHMA A156.5 - Cylinders and Input Devices for Locks; 2020.

I. BHMA A156.13 - Mortise Locks and Latches; 2022.

J. BHMA A156.26 - Standard for Continuous Hinges; 2025.

K. BHMA A156.28 - Standard for Recommended Practices for Mechanical Keying Systems; 2023.

L. BHMA A156.31 - Electric Strikes and Frame Mounted Actuators; 2024.

M. ISO 9000 - Quality Management — Fundamentals and Vocabulary; 2026.

N. NFPA - National Fire Protection Association; 2024.

O. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

P. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2025, with Amendment (2024).

Q. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

R. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives; 2025.

S. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2022.

T. UL 10B - Standard for Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

U. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

V. UL 305 - Standard for Panic Hardware; Current Edition, Including All Revisions.

W. UL 1784 - Standard for Air Leakage Tests of Door Assemblies and Other Opening Protectives; Current Edition, Including All Revisions.

X. WDMA I.S. 1A - Interior Architectural Wood Flush Doors; 2021, with Errata (2022).

### 1.02 SUMMARY

A. Section includes:
   1. Mechanical and electrified door hardware
   2. Electronic access control system components

B. Section excludes:
   1. Windows
   2. Cabinets (casework), including locks in cabinets
   3. Signage
   4. Toilet accessories
   5. Overhead doors

C. Related Sections:

1. Division 01 "General Requirements" sections for Allowances, Alternates, Owner Furnished Contractor Installed, Project Management and Coordination.
2. Division 06 Section "Rough Carpentry"
3. Division 06 Section "Finish Carpentry"
4. Division 07 Section "Joint Sealants" for sealant requirements applicable to threshold installation specified in this section.
5. Division 08 Sections:
    a. "Metal Doors and Frames"
    b. "Flush Wood Doors"
    c. "Aluminum-Framed Entrances and Storefronts"
    d. "Special Function Doors"
    e. "Entrances"
6. Division 26 "Electrical" sections for connections to electrical power system and for low-voltage wiring.
7. Division 28 "Electronic Safety and Security" sections for coordination with other components of electronic access control system and fire alarm system.

**1.03 REFERENCES**

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

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

C. NFPA – National Fire Protection Association
1. NFPA 70 – National Electric Code
2. NFPA 80 – Standard for Fire Doors and Other Opening Protectives
3. NFPA 101 – Life Safety Code
4. NFPA 105 – Smoke and Draft Control Door Assemblies
5. NFPA 252 – Fire Tests of Door Assemblies

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

**1.04 SUBMITTALS**

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

B. Action Submittals:

1. Product Data: Submit technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
2. Riser and Wiring Diagrams: After final approval of hardware schedule, submit details of electrified door hardware, indicating:
    a. Wiring Diagrams: For power, signal, and control wiring and including:
        1) Details of interface of electrified door hardware and building safety and security systems.
        2) Schematic diagram of systems that interface with electrified door hardware.
        3) Point-to-point wiring.
        4) Risers.
3. Samples for Verification: If requested by Architect, submit production sample of requested door hardware unit in finish indicated and tagged with full description for coordination with schedule.
    a. Samples will be returned to supplier. Units that are acceptable to Architect may, after final check of operations, be incorporated into Work, within limitations of key coordination requirements.
4. Door Hardware Schedule:
    a. Submit concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate fabrication of other work critical in Project construction schedule.
    b. Submit under direct supervision of a Door Hardware Institute (DHI) certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule published by DHI.
    c. Indicate complete designations of each item required for each opening, include:
        1) Door Index: door number, heading number, and Architect's hardware set number.
        2) Quantity, type, style, function, size, and finish of each hardware item.
        3) Name and manufacturer of each item.
        4) Fastenings and other pertinent information.
        5) Location of each hardware set cross-referenced to indications on Drawings.
        6) Explanation of all abbreviations, symbols, and codes contained in schedule.
        7) Mounting locations for hardware.
        8) Door and frame sizes and materials.
        9) Degree of door swing and handing.
        10) Operational Description of openings with electrified hardware covering egress, ingress (access), and fire/smoke alarm connections.
5. Key Schedule:
    a. After Keying Conference, provide keying schedule that includes levels of keying, explanations of key system's function, key symbols used, and door numbers controlled.
    b. Use ANSI/BHMA A156.28 "Recommended Practices for Keying Systems" as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
    c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
    d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.
    e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion. Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.

f. Prepare key schedule by or under supervision of supplier, detailing Owner's final keying instructions for locks.

C. Informational Submittals:
1. Provide Qualification Data for Supplier, Installer and Architectural Hardware Consultant.
2. Provide Product Data:
a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
b. Include warranties for specified door hardware.

D. Closeout Submittals:
1. Operations and Maintenance Data: Provide in accordance with Division 01 and include:
a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
b. Catalog pages for each product.
c. Final approved hardware schedule edited to reflect conditions as installed.
d. Final keying schedule
e. Copy of warranties including appropriate reference numbers for manufacturers to identify project.
f. As-installed wiring diagrams for each opening connected to power, both low voltage and 110 volts.

E. Inspection and Testing:
1. Submit written reports to the Owner and Authority Having Jurisdiction (AHJ) of the results of functional testing and inspection for:
a. Fire door assemblies, in compliance with NFPA 80.
b. Required egress door assemblies, in compliance with NFPA 101.

**1.05 QUALITY ASSURANCE**

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

B. Certifications:
1. Fire-Rated Door Openings:
a. Provide door hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction.

b. Provide only items of door hardware that are listed products tested by UL LLC, Intertek Testing Services, or other testing and inspecting organizations acceptable to authorities having jurisdiction for use on types and sizes of doors indicated, based on testing at positive pressure and according to NFPA 252 or UL 10C and in compliance with requirements of fire-rated door and door frame labels.

2. Smoke and Draft Control Door Assemblies:
   a. Provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105
   b. Comply with the maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at tested pressure differential of 0.3-inch wg (75 Pa) of water.
3. Electrified Door Hardware
   a. Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction.
4. Accessibility Requirements:
   a. Comply with governing accessibility regulations cited in "REFERENCES" article 087100, 1.02.D3 herein for door hardware on doors in an accessible route. This project must comply with all Federal Americans with Disability Act regulations and all Local Accessibility Regulations.

C. Pre-Installation Meetings
1. Keying Conference
   a. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including:
      1) Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
      2) Preliminary key system schematic diagram.
      3) Requirements for key control system.
      4) Requirements for access control.
      5) Address for delivery of keys.
2. Pre-installation Conference
   a. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   b. Inspect and discuss preparatory work performed by other trades.
   c. Inspect and discuss electrical roughing-in for electrified door hardware.
   d. Review sequence of operation for each type of electrified door hardware.
   e. Review required testing, inspecting, and certifying procedures.
   f. Review questions or concerns related to proper installation and adjustment of door hardware.
3. Electrified Hardware Coordination Conference:
   a. Prior to ordering electrified hardware, schedule and hold meeting to coordinate door hardware with security, electrical, doors and frames, and other related suppliers.

## 1.06 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site. Promptly replace products damaged during shipping

B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package. Deliver each article of hardware in manufacturer's original packaging.

C. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.

D. Provide secure lock-up for door hardware delivered to Project. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.

E. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.

F. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

**1.07 COORDINATION**

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

B. Installation Templates: Distribute for doors, frames, and other work specified to be factory or shop prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

C. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

D. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

**1.08 WARRANTY**

A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within published warranty period.
   1. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.
   2. Warranty Period: Beginning from date of Substantial Completion, for durations indicated in manufacturer's published listings.
      a. Mechanical Warranty
         1) Locks
            (a) Schlage L Series: 10 years
            (b) Schlage ND Series: 10 years
         2) Exit Devices
            (a) Von Duprin: 10 years
         3) Closers
            (a) LCN 4000 Series: 30 years
      b. Electrical Warranty
         1) Locks
            (a) Schlage: 3 years
         2) Exit Devices
            (a) Von Duprin: 3 years

**1.09 MAINTENANCE**

A. Furnish complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.

B. Turn over unused materials to Owner for maintenance purposes.

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS**

A. The Owner requires use of certain products for their unique characteristics and project suitability to ensure continuity of existing and future performance and maintenance standards. After investigating available product offerings, the Awarding Authority has elected to prepare proprietary specifications. These products are specified with the notation: "No Substitute."
   1. Where "No Substitute" is noted, submittals and substitution requests for other products will not be considered.

B. Approval of alternate manufacturers and/or products other than those listed as "Scheduled Manufacturer" or "Acceptable Manufacturers" in the individual article for the product category are only to be considered by official substitution request in accordance with section 01 25 00.

C. Approval of products from manufacturers indicated in "Acceptable Manufacturers" is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer's product.

D. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect's approval.

**2.02 MATERIALS**

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

B. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.
   1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.

C. Cable and Connectors:
   1. Where scheduled in the hardware sets, provide each item of electrified hardware and wire harnesses with number and gage of wires enough to accommodate electric function of specified hardware.
   2. Provide Molex connectors that plug directly into connectors from harnesses, electric locking and power transfer devices.
   3. Provide through-door wire harness for each electrified locking device installed in a door and wire harness for each electrified hinge, electrified continuous hinge, electrified pivot, and electric power transfer for connection to power supplies.

**2.03 HINGES**

A. Manufacturers and Products:
   1. Scheduled Manufacturer and Product:
      a. Ives 5BB series
   2. Acceptable Manufacturers and Products:
      a. Hager BB1191/1279 series
      b. Best FBB series

B. Requirements:
   1. Provide hinges conforming to ANSI/BHMA A156.1.
   2. Provide five knuckle, ball bearing hinges.
   3. 1-3/4 inch (44 mm) thick doors, up to and including 36 inches (914 mm) wide:
      a. Exterior: Standard weight, bronze or stainless steel, 4-1/2 inches (114 mm) high
      b. Interior: Standard weight, steel, 4-1/2 inches (114 mm) high
   4. 1-3/4 inch (44 mm) thick doors over 36 inches (914 mm) wide:
      a. Exterior: Heavy weight, bronze/stainless steel, 5 inches (127 mm) high
      b. Interior: Heavy weight, steel, 5 inches (127 mm) high
   5. 2 inches or thicker doors:
      a. Exterior: Heavy weight, bronze or stainless steel, 5 inches (127 mm) high
      b. Interior: Heavy weight, steel, 5 inches (127 mm) high
   6. Adjust hinge width for door, frame, and wall conditions to allow proper degree of opening.

7. Provide three hinges per door leaf for doors 90 inches (2286 mm) or less in height, and one additional hinge for each 30 inches (762 mm) of additional door height.
8. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
    a. Steel Hinges: Steel pins
    b. Non-Ferrous Hinges: Stainless steel pins
    c. Out-Swinging Exterior Doors: Non-removable pins
    d. Out-Swinging Interior Lockable Doors: Non-removable pins
    e. Interior Non-lockable Doors: Non-rising pins
9. Provide hinges with electrified options as scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware. Locate electric hinge at second hinge from bottom or nearest to electrified locking component. Provide mortar guard for each electrified hinge specified.

**2.04 CONTINUOUS HINGES**

A. Manufacturers:
    1. Scheduled Manufacturer:
        a. Ives
    2. Acceptable Manufacturers:
        a. Select
        b. ABH

B. Requirements:
    1. Provide aluminum geared continuous hinges conforming to ANSI/BHMA A156.26, Grade 1.
    2. Provide aluminum geared continuous hinges, where specified in the hardware sets, fabricated from 6063-T6 aluminum.
    3. Provide split nylon bearings at each hinge knuckle for quiet, smooth, self-lubricating operation.
    4. Provide hinges capable of supporting door weights up to 450 pounds, and successfully tested for 1,500,000 cycles.
    5. On fire-rated doors, provide aluminum geared continuous hinges classified for use on rated doors by testing agency acceptable to authority having jurisdiction.
    6. Provide aluminum geared continuous hinges with electrified option scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware.
    7. Provide hinges 1 inch (25 mm) shorter in length than nominal height of door, unless otherwise noted or door details require shorter length and with symmetrical hole pattern.

**2.05 ELECTRIC POWER TRANSFER**

A. Manufacturers:
    1. Scheduled Manufacturer and Product:
        a. Von Duprin EPT-10
    2. Acceptable Manufacturers and Products:
        a. No Substitute

B. Requirements:
    1. Provide power transfer with electrified options as scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware.
    2. Locate electric power transfer per manufacturer's template and UL requirements, unless interference with operation of door or other hardware items.

**2.06 FLUSH BOLTS**

A. Manufacturers:
    1. Scheduled Manufacturer:
        a. Ives

2. Acceptable Manufacturers:
   a. DCI
   b. Trimco

B. Requirements:
1. Provide automatic, constant latching, and manual flush bolts with forged bronze or stainless-steel face plates, extruded brass levers, and with wrought brass guides and strikes. Provide 12 inch (305 mm) steel or brass rods at doors up to 90 inches (2286 mm) in height. For doors over 90 inches (2286 mm) in height increase top rods by 6 inches (152 mm) for each additional 6 inches (152 mm) of door height. Provide dust-proof strikes at each bottom flush bolt.

**2.07 MORTISE LOCKS**

A. Manufacturers and Products:
1. Scheduled Manufacturer and Product:
   a. Schlage L9000 series
2. Acceptable Manufacturers and Products:
   a. Accurate 9000/9100 series
   b. Best 45H series

B. Requirements:
1. Provide mortise locks conforming to ANSI/BHMA A156.13 Series 1000, Grade 1, and UL Listed for 3-hour fire doors.
2. Indicators: Where specified, provide indicator window measuring a minimum 2-inch x 1/2 inch with 180-degree visibility. Provide messages color-coded with full text and/or symbols, as scheduled, for easy visibility.
3. Provide locks manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance.
4. Provide lock case that is multi-function and field reversible for handing without opening case. Cylinders: Refer to “KEYING” article, herein.
5. Provide locks with standard 2-3/4 inches (70 mm) backset with full 3/4 inch (19 mm) throw stainless steel mechanical anti-friction latchbolt. Provide deadbolt with full 1-inch (25 mm) throw, constructed of stainless steel.
6. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
7. Provide electrified options as scheduled in the hardware sets. Where scheduled, provide switches and sensors integrated into the locks and latches. Provide motor based electrified and motor based latch retraction locksets that comply with the following requirements:
   a. Universal input voltage – single chassis accepts 12 or 24VDC to allow for changes in the field without changing lock chassis.
   b. Fail Safe/Fail Secure – changing mode between electrically locked (fail safe) and electrically unlocked (fail secure) is field selectable without opening the lock case
   c. Low maximum current draw – maximum 0.4 amps (Lever control) and maximum 2.0 amps (Latch retraction) to allow for multiple locks on a single power supply.
   d. Low holding current (Lever control or latch retraction) – maximum 0.01 amps to produce minimal heat, eliminate “hot levers” in electrically locked applications and motorized latch retraction applications, and to provide reliable operation in wood doors that provide minimal ventilation and air flow.
   e. Connections – provide quick-connect Molex system standard.
8. (OPTION Key Override) Provide locks with a key override feature built into the chassis that allows the outside key to retract the deadbolt and/or latchbolt, overriding the inside thumbturn when it is being held in the locked position - where the XL13-439 option is specified in the hardware sets.
9. Lever Trim: Solid brass, bronze, or stainless steel, cast or forged in design specified, with wrought roses and external lever spring cages. Provide thru-bolted levers with 2-piece spindles.

a. Lever Design: 03A.

## 2.08 CYLINDRICAL LOCKS – GRADE 1

A. Manufacturers and Products:
   1. Scheduled Manufacturer and Product:
      a. Schlage ND series
   2. Acceptable Manufacturers and Products:
      a. Best 9K3
      b. Sargent 11-Line

B. Requirements:
   1. Provide cylindrical locks conforming to ANSI/BHMA A156.2 Series 4000, Grade 1, and UL Listed for 3-hour fire doors.
   2. Indicators: Where specified, provide escutcheon with lock status indicator window on top of lockset rose:
      a. Escutcheon height (including rose) 6.05 inches high by 3.68 inches wide.
      b. Indicator window measuring a minimum 3.52-inch by .60 inch with 1.92 square-inches of front facing viewing area and 180-degree visibility with a total of .236 square-inches of total viewable area.
      c. Provide snap-in serviceable window to prevent tampering. Lock must function if indicator is compromised.
      d. Provide messages color-coded with full text and symbol, as scheduled, for easy visibility.
      e. Unlocked and Unoccupied message will display on white background, and Locked and Occupied message will display on red background.
   3. Cylinders: Refer to "KEYING" article, herein.
   4. Provide locks with standard 2-3/4 inches (70 mm) backset, unless noted otherwise, with 1/2-inch latch throw. Provide proper latch throw for UL listing at pairs.
   5. Provide locksets with separate anti-rotation thru-bolts, and no exposed screws.
   6. Provide independently operating levers with two external return spring cassettes mounted under roses to prevent lever sag.
   7. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
   8. Provide electrified options as scheduled in the hardware sets.
   9. Lever Trim: Solid cast levers without plastic inserts and wrought roses on both sides.
      a. Lever Design: TLR.

## 2.09 EXIT DEVICES

A. Manufacturers and Products:
   1. Scheduled Manufacturer and Product:
      a. Von Duprin 99/33A series
   2. Acceptable Manufacturers and Products:
      a. No Substitute

B. Requirements:
   1. Provide exit devices tested to ANSI/BHMA A156.3 Grade 1 and UL listed for Panic Exit or Fire Exit Hardware.
   2. Cylinders: Refer to "KEYING" article, herein.
   3. Provide grooved touchpad type exit devices, fabricated from brass, bronze, stainless steel, or aluminum, plated to standard architectural finishes to match the balance of door hardware.
   4. Touchpad must extend a minimum of one-half of the door width. No plastic inserts are allowed in touchpads.
   5. Provide exit devices with a deadlatching feature for security and for future addition of alarm kits and/or other electrified requirements.

6. Provide exit devices at pool gates with weather-resistant components that can withstand harsh conditions of various climates and corrosive cleaners used in outdoor pool environments.
7. Provide flush end caps for exit devices.
8. Provide exit devices with manufacturers' approved strikes.
9. Provide exit devices cut to the door width and height. Install exit devices at a height recommended by the exit device manufacturer, allowable by governing building codes, and approved by the Architect.
10. Mount the mechanism case flush on the face of the doors or provide spacers to fill gaps behind the devices. Where glass trim or molding projects off the face of the door, provide glass bead kits.
11. Provide cylinder or hex-key dogging as specified at non-fire-rated openings.
12. Provide factory-drilled weep holes for exit devices used in full exterior applications, highly corrosive areas, and where noted in hardware sets.
13. Provide electrified options as scheduled.
14. Top latch mounting: double- or single-tab mount for steel doors, face mount for aluminum doors, eliminating the requirement of tabs, and double tab mount for wood doors.
15. Accessibility: Require not more than 5 lb. to retract the latchbolt, per CBC 2019 11B-404.2.7 and 11B-309.4.
    a. Mechanical method: Von Duprin AX feature, where touchpad directly retracts the latchbolt with 5 lb. or less of force. Provide testing lab certification confirming that the mechanical device is independent third-party tested to meet this 5 lb. requirement.
    b. Electrical method: Von Duprin's RX-QEL feature, where lightly pressing the touchpad with 5 lb. or less of force closes an electric switch, activating quiet electric latch retraction.
16. Provide exit devices with optional trim designs to match other lever and pull designs used on the project.
    a. Provide levers that return to within 1/2 inch (13 mm) of the door face.

**2.10 CYLINDERS**

A. Manufacturers and Products:
   1. Scheduled Manufacturer and Product:
      a. Schlage Everest 29 T
   2. Acceptable Manufacturers and Products:
      a. No Substitute

B. Requirements:
   1. Provide cylinders/cores compliant with ANSI/BHMA A156.5; latest revision; cylinder face finished to match lockset; manufacturer's series as indicated. Refer to "KEYING" article, herein.
   2. Provide cylinders in the below-listed configuration(s), distributed throughout the Project as indicated.
      a. Patented Restricted: cylinder with interchangeable core with patented, restricted keyway.
   3. Patent Protection: Cylinders/cores requiring use of restricted, patented keys, patent protected.
   4. Nickel silver bottom pins.

**2.11 KEYING**

A. Scheduled System:
   1. New factory registered system:
      a. Provide a factory registered keying system, complying with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.

B. Requirements:
   1. Construction Keying:

a. Replaceable Construction Cores.
1) Provide temporary construction cores replaceable by permanent cores, furnished in accordance with the following requirements.
(a) 3 construction control keys
(b) 12 construction change (day) keys.
2) Owner or Owner's Representative will replace temporary construction cores with permanent cores.

2. Permanent Keying:
a. Provide permanent cylinders/cores keyed by the manufacturer according to the following key system.
1) Master Keying system as directed by the Owner.
b. Forward bitting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements will be cause for replacement of cylinders/cores involved at no additional cost to Owner.
c. Provide keys with the following features:
1) Material: Nickel silver; minimum thickness of .107-inch (2.3mm)
2) Patent Protection: Keys and blanks protected by one or more utility patent(s).
3) Geographically Exclusive: Where High Security or Security cylinders/cores are indicated, provide nationwide, geographically exclusive key system complying with the following restrictions.
d. Identification:
1) Mark permanent cylinders/cores and keys with applicable blind code for identification. Do not provide blind code marks with actual key cuts.
2) Identification stamping provisions must be approved by the Architect and Owner.
3) Stamp cylinders/cores and keys with Owner's unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with "DO NOT DUPLICATE" along with the "PATENTED" or patent number to enforce the patent protection.
4) Failure to comply with stamping requirements will be cause for replacement of keys involved at no additional cost to Owner.
5) Forward permanent cylinders/cores to Owner, separately from keys, by means as directed by Owner.
e. Quantity: Furnish in the following quantities.
1) Permanent Control Keys: 3.
2) Master Keys: 6.
3) Change (Day) Keys: 3 per cylinder/core that is keyed differently
4) Key Blanks: Quantity as determined in the keying meeting.

## 2.12 KEY CONTROL SYSTEM

A. Manufacturers:
1. Scheduled Manufacturer:
a. Telkee
2. Acceptable Manufacturers:
a. HPC
b. Lund

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

## 2.13 DOOR CLOSERS

A. Manufacturers and Products:
   1. Scheduled Manufacturer and Product:
      a. LCN 4040XP series
   2. Acceptable Manufacturers and Products:
      a. Norton 9500 series
      b. Sargent 281 series

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

## 2.14 DOOR CLOSERS

A. Manufacturers and Products:
   1. Scheduled Manufacturer and Product:
      a. LCN 4010/4110/4020 series
   2. Acceptable Manufacturers and Products:
      a. Norton 9500 series
      b. Sargent 281 series

B. Requirements:
   1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. Certify surface mounted mechanical closers to meet fifteen million (15,000,000) full load cycles. ISO 9000 certify closers. Stamp units with date of manufacture code.
   2. Provide door closers with fully hydraulic, full rack and pinion action with high strength cast iron cylinder, and full complement bearings at shaft.
   3. Cylinder Body: 1-1/2-inch (38 mm) diameter with 11/16-inch (17 mm) diameter double heat-treated pinion journal.

4. Hydraulic Fluid: Fireproof, passing requirements of UL 10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck.
7. Provide closers with solid forged steel main arms and factory assembled heavy-duty forged forearms for parallel arm closers. When closers are parallel arm mounted, provide closers which mount within 6-inch (152 mm) top rail without use of mounting plate so that closer is not visible through vision panel from pull side.
8. Pressure Relief Valve (PRV) Technology: Not permitted.
9. Finish for Closer Cylinders, Arms, Adapter Plates, and Metal Covers: Powder coating finish which has been certified to exceed 100 hours salt spray testing as described in ANSI/BHMA Standard A156.4 and ASTM B117, or has special rust inhibitor (SRI).
10. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

## 2.15 DOOR TRIM

A. Manufacturers:
   1. Scheduled Manufacturer:
      a. Ives
   2. Acceptable Manufacturers:
      a. Burns
      b. Trimco

B. Requirements:
   1. Provide push plates, push bars, pull plates, pulls, and hands-free reversible door pulls with diameter and length as scheduled.

## 2.16 PROTECTION PLATES

A. Manufacturers:
   1. Scheduled Manufacturer:
      a. Ives
   2. Acceptable Manufacturers:
      a. Burns
      b. Trimco

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

## 2.17 OVERHEAD STOPS AND OVERHEAD STOP/HOLDERS

A. Manufacturers:
   1. Scheduled Manufacturers:
      a. Glynn-Johnson
   2. Acceptable Manufacturers:
      a. Rixson
      b. ABH

B. Requirements:
   1. Provide overhead stop at any door where conditions do not allow for a wall stop or floor stop presents tripping hazard.

## 2.18 DOOR STOPS AND HOLDERS

A. Manufacturers:
   1. Scheduled Manufacturer:
      a. Ives
   2. Acceptable Manufacturers:
      a. Burns
      b. Trimco

B. Provide door stops at each door leaf:
   1. Provide wall stops wherever possible. Provide concave type where lockset has a push button of thumbturn.
   2. Where a wall stop cannot be used, provide universal floor stops.
   3. Where wall or floor stop cannot be used, provide overhead stop.
   4. Provide roller bumper where doors open into each other and overhead stop cannot be used.

## 2.19 SILENCERS

A. Manufacturers:
   1. Scheduled Manufacturer:
      a. Ives
   2. Acceptable Manufacturers:
      a. Burns
      b. Trimco

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

## 2.20 THRESHOLDS, SEALS, DOOR SWEEPS, AUTOMATIC DOOR BOTTOMS, AND GASKETING

A. Scheduled Manufacturer:
   1. Zero International

B. Acceptable Manufacturers:
   1. National Guard
   2. Reese

C. Seals and Gasketing: Provide continuous gasketing on exterior openings, to the head and jambs, forming a continuous seal between the door and the frame. Provide smoke, light, or sound gasketing on interior doors where indicated.
   1. Provide self-tapping fasteners for aluminum extruded gasketing being applied to hollow metal frames.
      a. Provide non-corrosive fasteners for all exterior applications.
      b. Provide security fasteners where indicated.
   2. Provide neoprene, EPDM, silicone, or nylon brush inserts as specified in hardware sets. Provide non brush inserts of solid or sponge cell, as specified in hardware sets. Vinyl inserts are not allowed except where specified in hardware sets.

D. Smoke Labeled Gasketing: At all smoke labeled openings, provide smoke listed perimeter gasketing assemblies complying with NFPA 105 listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for smoke control ratings indicated based on testing according to UL 1784.

E. Fire Listed Gasketing: Assemblies complying with NFPA 80 that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction for fire ratings indicated based on testing according to UL 10C.

1. Where frame-applied intumescent seals are required by the manufacturer, provide gaskets that comply with UL 10C Standard for Positive Pressure Fire Tests of Door Assemblies and UBC 7-2, Fire Tests of Door Assemblies.

F. Sound-Rated Gasketing: Provide acoustic gasketing to meet Sound Transmission Class (STC) rating required.

G. Meeting-Stile Gasketing: Provide meeting-stile gasketing that fastens to the meeting stiles forming a continuous seal when doors are closed.

H. Door Sweeps or Shoes: Apply to the bottom of the door to close the gap between the door bottom and finished floor or saddle threshold.
1. Provide solid neoprene, EPDM, silicone, or nylon brush type of seal as specified in hardware sets. Vinyl inserts are not allowed except where specified in hardware sets.

I. Automatic Door Bottoms:
1. Provide closed cell sponge, bulb neoprene. or EPDM type of seal as specified in hardware sets.
2. Door bottom to be mortised, semi mortised, or surface mount as with a minimum thickness as specified in hardware sets.

J. Rain Drips:
1. Provide overhead rain drips for out-swinging hollow metal doors that are not covered against 45 degree blowing rain. Aluminum extrusion to be a minimum of .088 inches thick and extend 2.50 inches from the face of the frame, in anodized finish to match door.
2. Door sweeps or shoes with integral rain drip must meet ADA requirements

K. Thresholds: Provide threshold units not less than 4 inches wide, formed to accommodate change in floor elevation where indicated, and fabricated to accommodate door hardware and fit door frames.
1. Threshold extrusion to be a minimum thickness as specified in hardware sets.

## 2.21 DOOR POSITION SWITCHES

A. Manufacturers:
1. Scheduled Manufacturer:
a. Schlage
2. Acceptable Manufacturers:
a. GE-Interlogix
b. Sentrol

B. Requirements:
1. Provide recessed or surface mounted type door position switches as specified.
2. Coordinate door and frame preparations with door and frame suppliers. If switches are being used with magnetic locking device, provide minimum of 4 inches (102 mm) between switch and magnetic locking device.

## 2.22 COAT HOOKS

A. Manufacturers:
1. Scheduled Manufacturer:
a. Ives
2. Acceptable Manufacturers:
a. Burns
b. Trimco

B. Provide coat hooks as specified.

## 2.23 FINISHES

A. FINISH: BHMA 626/652 (US26D); EXCEPT:
1. Hinges at Exterior Doors: BHMA 630 (US32D)
2. Aluminum Geared Continuous Hinges: BHMA 628 (US28)

3. Push Plates, Pulls, and Push Bars: BHMA 630 (US32D)
4. Protection Plates: BHMA 630 (US32D)
5. Overhead Stops and Holders: BHMA 630 (US32D)
6. Door Closers: Powder Coat to Match
7. Wall Stops: BHMA 630 (US32D)
8. Latch Protectors: BHMA 630 (US32D)
9. Weatherstripping: Clear Anodized Aluminum
10. Thresholds: Mill Finish Aluminum

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance. Verify doors, frames, and walls have been properly reinforced for hardware installation.

B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

C. Submit a list of deficiencies in writing and proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION

A. Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.
   1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
   2. Custom Steel Doors and Frames: HMMA 831.
   3. Interior Architectural Wood Flush Doors: ANSI/WDMA I.S. 1A
   4. Installation Guide for Doors and Hardware: DHI TDH-007-20
   5. 2022 California Building Code, Section 1010.1.9.2 and 11B-404.2.7.

B. Install door hardware in accordance with NFPA 80, NFPA 101 and provide post-install inspection, testing as specified in section 1.03.E unless otherwise required to comply with governing regulations.

C. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.

D. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.

E. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.

F. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

G. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.

H. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated.

I. Lock Cylinders:
   1. Install construction cores to secure building and areas during construction period.
   2. Replace construction cores with permanent cores as indicated in keying section.
   3. Furnish permanent cores to Owner for installation.

J. Lead Protection: Lead wrap hardware penetrating lead-lined doors. Line levers and roses with lead. Apply kick and armor plates on lead-lined doors with adhesive as recommended by manufacturer.

K. Wiring: Coordinate with Division 26, ELECTRICAL and Division 28 ELECTRONIC SAFETY AND SECURITY sections for:
   1. Conduit, junction boxes and wire pulls.
   2. Connections to and from power supplies to electrified hardware.
   3. Connections to fire/smoke alarm system and smoke evacuation system.
   4. Connection of wire to door position switches and wire runs to central room or area, as directed by Architect.
   5. Connections to panel interface modules, controllers, and gateways.
   6. Testing and labeling wires with Architect's opening number.

L. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.

M. Continuous Hinges: Re-locate the door and frame fire rating labels where they will remain visible so that the hinge does not cover the label once installed.

N. Door Closers: Mount closers/operators on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Mount closers/operators so they are not visible in corridors, lobbies and other public spaces unless approved by Architect.

O. Overhead Stops/Holders: Mount overhead stops/holders on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.

P. Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings or in equipment room, or alternate location as directed by Architect.

Q. Thresholds:
   1. Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."
   2. Aluminum thresholds to be cut-in, and scribed around mullions, frame members, and stops. Do not butt to thresholds. Provide a continuous surface across full width of opening from jamb to jamb.
   3. Where aluminum panic-type (rabbeted) thresholds with neoprene inserts are specified, undercut doors as required to properly mate with seal in threshold.

R. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they may impede traffic or present tripping hazard.

S. Perimeter Gasketing:
   1. Apply to head and jamb, forming seal between door and frame.
   2. Install gasketing in a manner eliminating need to cut any seal to install surface mounted hardware. Install compatible mounting bracket for surface mounted hardware unless minimum 1/4 inch thick solid aluminum seals are provided for mounting of surface applied hardware.

T. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

U. Door Bottoms and Sweeps: Apply to bottom of door, forming seal with threshold when door is closed.

**3.03 ADJUSTING**

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
   1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

B. Occupancy Adjustment: Approximately three to six months after date of Substantial Completion, examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors and door hardware.

### 3.04 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items per manufacturer's instructions to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

### 3.05 DOOR HARDWARE SCHEDULE

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

B. Discrepancies, conflicting hardware, and missing items are to be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application.

C. Hardware items are referenced in the following hardware schedule. Refer to the above specifications for special features, options, cylinders/keying, and other requirements.

D. Hardware Sets:

| Abbreviation | Name |
|---|---|
| GLY | Glynn-Johnson Corp |
| IVE | H.B. Ives |
| LCN | LCN Commercial Division |
| SCE | Schlage Electronic Security |
| SCH | Schlage Lock Company |
| VON | Von Duprin |
| ZER | Zero International Inc |

**154731 OPT0491892 VERSION 2**

**LEGEND:**

**□LINK TO CATALOG CUT SHEET**

**~ELECTRIFIED OPENING**

**HARDWARE GROUP NO. 01 - IN - 50**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 104 | 106 | 107 | 108 | 109 | 109A |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 | □ | | 652 | IVE |
| 1 | EA | ENTRANCE/OFFICE LOCK | ND50TD TLR | □ | | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 X S125 KEYWAY | □ | | 626 | SCH |
| 1 | EA | WALL STOP | WS406/407CCV | □ | | 630 | IVE |
| 3 | EA | SILENCER | SR64 | □ | | GRY | IVE |

**HARDWARE GROUP NO. 02 - IN - 70/AP**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 124 | | | | | |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 | □ | | 652 | IVE |
| 1 | EA | CLASSROOM LOCK | ND70TD TLR | □ | | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 X S125 KEYWAY | □ | | 626 | SCH |
| 1 | EA | SURFACE CLOSER | 4011T | □ | | 689 | LCN |
| 1 | EA | ARMOR PLATE | 8402 34" X 2" LDW B-CS UL | □ | | 630 | IVE |
| 1 | EA | WALL STOP | WS406/407CCV | □ | | 630 | IVE |
| 3 | EA | SILENCER | SR64 | □ | | GRY | IVE |

**HARDWARE GROUP NO. 03 - IN - 40I/SRI**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 115 | 117 | | | | |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 | □ | | 630 | IVE |
| 1 | EA | PRIVACY LOCK W/ OUTSIDE INDICATOR | ND40S TLR OS-LOC | □ | | 626 | SCH |
| 1 | EA | OH STOP | 90S | □ | | 630 | GLY |
| 1 | EA | SURFACE CLOSER | 4011TSRI TBWMS | □ | | 689 | LCN |
| 1 | EA | KICK PLATE | 8400 10" X 2" LDW B-CS | □ | | 630 | IVE |
| 1 | EA | MOP PLATE | 8400 6" X 1" LDW B-CS | □ | | 630 | IVE |
| 1 | EA | GASKETING | 488SBK PSA | □ | | BK | ZER |
| 1 | EA | COAT AND HAT HOOK | 571 | □ | | 626 | IVE |

**HARDWARE GROUP NO. 04 - IN - 40I/SRI/WS**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 134 | | | | | |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 | □ | | 630 | IVE |
| 1 | EA | PRIVACY LOCK W/ OUTSIDE INDICATOR | ND40S TLR OS-LOC | □ | | 626 | SCH |
| 1 | EA | SURFACE CLOSER | 4011TSRI TBWMS | □ | | 689 | LCN |
| 1 | EA | KICK PLATE | 8400 10" X 2" LDW B-CS | □ | | 630 | IVE |
| 1 | EA | MOP PLATE | 8400 6" X 1" LDW B-CS | □ | | 630 | IVE |
| 1 | EA | WALL STOP | WS406/407CCV | □ | | 630 | IVE |
| 1 | EA | GASKETING | 488SBK PSA | □ | | BK | ZER |
| 1 | EA | COAT AND HAT HOOK | 571 | □ | | 626 | IVE |

**HARDWARE GROUP NO. 05 - IN - 40I/WS**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 102 | 104A | | | | |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 | □ | | 630 | IVE |
| 1 | EA | PRIVACY LOCK W/ OUTSIDE INDICATOR | ND40S TLR OS-LOC | □ | | 626 | SCH |
| 1 | EA | SURFACE CLOSER | 4011T | □ | | 689 | LCN |
| 1 | EA | KICK PLATE | 8400 10" X 2" LDW B-CS | □ | | 630 | IVE |
| 1 | EA | MOP PLATE | 8400 6" X 1" LDW B-CS | □ | | 630 | IVE |
| 1 | EA | WALL STOP | WS406/407CCV | □ | | 630 | IVE |
| 1 | EA | GASKETING | 488SBK PSA | □ | | BK | ZER |
| 1 | EA | COAT AND HAT HOOK | 571 | □ | | 626 | IVE |

**HARDWARE GROUP NO. 06**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 129B | 129C | 129D | 129E | 129G | 129H |
| 129J | 129K | 130B | | | |

**PROVIDE EACH RU DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 1 | EA | ROLL UP DOOR | PROVIDED BY OTHERS | | | | |

**HARDWARE GROUP NO. 07 - IN - 70/KP**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 128 | 133 | | | | |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 | □ | | 652 | IVE |
| 1 | EA | CLASSROOM LOCK | ND70TD TLR | □ | | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 X S125 KEYWAY | □ | | 626 | SCH |
| 1 | EA | SURFACE CLOSER | 4011T | □ | | 689 | LCN |
| 1 | EA | KICK PLATE | 8400 10" X 2" LDW B-CS | □ | | 630 | IVE |
| 1 | EA | WALL STOP | WS406/407CCV | □ | | 630 | IVE |
| 3 | EA | GASKETING | 488SBK PSA | □ | | BK | ZER |

**HARDWARE GROUP NO. 08 - IN - 80/ CR/OH**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 119 | | | | | |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 | □ | | 652 | IVE |
| 1 | EA | POWER TRANSFER | EPT10 | □ | ~ | 689 | VON |
| 1 | EA | EU STOREROOM LOCK | ND80TDEU TLR RX CON 12V/24V DC | □ | ~ | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 X S125 KEYWAY | □ | | 626 | SCH |
| 1 | EA | OH STOP | 90S | □ | | 630 | GLY |
| 1 | EA | SURFACE CLOSER | 4011 | □ | | 689 | LCN |
| 1 | EA | KICK PLATE | 8400 10" X 2" LDW B-CS | □ | | 630 | IVE |
| 3 | EA | SILENCER | SR64 | □ | | GRY | IVE |
| 1 | EA | WIRE HARNESS | CON-XXY (LOCK/EXIT TO HINGE | | ~ | | SCH |

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| | | | JAMB) | | | | |
| 1 | SET | CARD READER/ KEYPAD | PROVIDED BY SECURITY VENDOR | | | | |
| 1 | EA | DOOR CONTACT | 679-05HM/WD AS REQ. | □ | ~ | BLK | SCE |
| 1 | EA | POWER SUPPLY | BY SECURITY CONTRACTOR | | | | |
| 1 | EA | WIRING | WIRING DIAGRAMS AS REQUIRED | | | | |

**FREE EGRESS AT ALL TIMES. AUTHORIZED CREDENTIAL MOMENTARILY RELEASES OUTSIDE LEVER, ALLOWING ENTRY. RX SWITCH MONITORS AUTHORIZED EGRESS. DOOR CONTACT MONITORS WHEN DOOR OPENS AND CLOSES. FAIL SECURE.**

**HARDWARE GROUP NO. 09 - O - WT/70**

**FOR USE ON DOOR #(S):**

| 101B | | | | | |
|---|---|---|---|---|---|

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1WT 4.5 X 5 | □ | | 652 | IVE |
| 1 | EA | CLASSROOM LOCK | ND70TD TLR | □ | | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 X S125 KEYWAY | □ | | 626 | SCH |
| 1 | EA | SURFACE CLOSER | 4111 EDA | □ | | 689 | LCN |
| 1 | EA | KICK PLATE | 8400 10" X 2" LDW B-CS | □ | | 630 | IVE |
| 1 | EA | WALL STOP | WS406/407CCV | □ | | 630 | IVE |
| 1 | EA | GASKETING | 188SBK PSA | □ | | BK | ZER |

**HARDWARE GROUP NO. 011 - IN - 70**

**FOR USE ON DOOR #(S):**

| 101 | 101A | | | | |
|---|---|---|---|---|---|

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 | □ | | 652 | IVE |
| 1 | EA | CLASSROOM LOCK | ND70TD TLR | □ | | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 X S125 KEYWAY | □ | | 626 | SCH |

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 1 | EA | SURFACE CLOSER | 4011T | □ | | 689 | LCN |
| 1 | EA | WALL STOP | WS406/407CCV | □ | | 630 | IVE |
| 3 | EA | SILENCER | SR64 | □ | | GRY | IVE |

**HARDWARE GROUP NO. 012 - O - 10**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 103A | | | | | |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 | □ | | 652 | IVE |
| 1 | EA | PASSAGE SET | ND10S TLR | □ | | 626 | SCH |
| 1 | EA | SURFACE CLOSER | 4111 SCUSH | □ | | 689 | LCN |
| 1 | EA | WALL STOP | WS406/407CCV | □ | | 630 | IVE |
| 3 | EA | SILENCER | SR64 | □ | | GRY | IVE |

**HARDWARE GROUP NO. 013 - IN - 80**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 119A | 124A | | | | |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 | □ | | 652 | IVE |
| 1 | EA | STOREROOM LOCK | ND80TD TLR | □ | | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 X S125 KEYWAY | □ | | 626 | SCH |
| 1 | EA | WALL STOP | WS406/407CCV | □ | | 630 | IVE |
| 3 | EA | SILENCER | SR64 | □ | | GRY | IVE |

**HARDWARE GROUP NO. 014 - EXT - O - 80**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 119B | 130A | | | | |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 NRP | □ | | 630 | IVE |
| 1 | EA | STOREROOM LOCK | L9080T 03A | □ | | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 X S125 | □ | | 626 | SCH |

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| | | | KEYWAY | | | | |
| 1 | EA | SURFACE CLOSER | 4040XP SCUSH | □ | | 689 | LCN |
| 1 | EA | RAIN DRIP | 142AA | □ | | AA | ZER |
| 1 | EA | WEATHER STRIP | 8303AA | □ | | AA | ZER |
| 1 | EA | DOOR SWEEP | 39A | □ | | A | ZER |
| 1 | EA | THRESHOLD | 545A | □ | | A | ZER |

**HARDWARE GROUP NO. 015 - EXT - O - CR**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 123 | 129L | | | | |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 NRP | □ | | 630 | IVE |
| 1 | EA | POWER TRANSFER | EPT10 | □ | ~ | 689 | VON |
| 1 | EA | EU MORTISE LOCK | L9092TEU 03A RX CON 12/24 VDC | □ | ~ | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 X S125 KEYWAY | □ | | 626 | SCH |
| 1 | EA | SURFACE CLOSER | 4040XP SCUSH | □ | | 689 | LCN |
| 1 | EA | WEATHER STRIP | 8303AA | □ | | AA | ZER |
| 1 | EA | DOOR SWEEP | 39A | □ | | A | ZER |
| 1 | EA | THRESHOLD | 545A | □ | | A | ZER |
| 1 | EA | WIRE HARNESS | CON-XXY (LOCK/EXIT TO HINGE JAMB) | | ~ | | SCH |
| 1 | SET | CARD READER/ KEYPAD | PROVIDED BY SECURITY VENDOR | | | | |
| 1 | EA | DOOR CONTACT | 679-05HM/WD AS REQ. | □ | ~ | BLK | SCE |
| 1 | EA | POWER SUPPLY | BY SECURITY CONTRACTOR | | | | |
| 1 | EA | WIRING | WIRING DIAGRAMS AS | | | | |

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| | | | REQUIRED | | | | |

**FREE EGRESS AT ALL TIMES. AUTHORIZED CREDENTIAL MOMENTARILY RELEASES OUTSIDE LEVER, ALLOWING ENTRY. RX SWITCH MONITORS AUTHORIZED EGRESS. DOOR CONTACT MONITORS WHEN DOOR OPENS AND CLOSES. FAIL SECURE.**

**HARDWARE GROUP NO. 016 - O - L**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 121 | | | | | |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 | □ | | 652 | IVE |
| 1 | EA | PANIC HARDWARE | 99-L-03 | □ | | 626 | VON |
| 1 | EA | FSIC CORE | 23-030 EV29 X S125 KEYWAY | □ | | 626 | SCH |
| 1 | EA | SURFACE CLOSER | 4111 SCUSH | □ | | 689 | LCN |
| 1 | EA | WALL STOP | WS406/407CCV | □ | | 630 | IVE |
| 3 | EA | SILENCER | SR64 | □ | | GRY | IVE |

**HARDWARE GROUP NO. 017 - EXT - O - CR/NL**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 122 | 129A | | | | |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 NRP | □ | | 630 | IVE |
| 1 | EA | ELEC PANIC HARDWARE | RX-QEL-99-NL-CON 24 VDC | □ | ~ | 626 | VON |
| 1 | EA | RIM CYLINDER FSIC | 20-057 X S125 KEYWAY | □ | | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 X S125 KEYWAY | □ | | 626 | SCH |
| 1 | EA | SURFACE CLOSER | 4040XP SCUSH | □ | | 689 | LCN |
| 1 | EA | WEATHER STRIP | 8303AA | □ | | AA | ZER |
| 1 | EA | DOOR SWEEP | 39A | □ | | A | ZER |
| 1 | EA | THRESHOLD | 545A | □ | | A | ZER |
| 1 | EA | WIRE HARNESS | CON-XXY (LOCK/EXIT | | ~ | | SCH |

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| | | | TO HINGE JAMB) | | | | |
| 1 | | CREDENTIAL READER | BY SECURITY INTEGRATOR | | | | |
| 1 | EA | DOOR CONTACT | 679-05HM/WD AS REQ. | □ | ~ | BLK | SCE |
| 1 | EA | POWER SUPPLY | BY SECURITY CONTRACTOR | | | | |
| 1 | EA | WIRING | WIRING DIAGRAMS AS REQUIRED | | | | |

**FREE EGRESS AT ALL TIMES. AUTHORIZED CREDENTIAL MOMENTARILY RETRACTS LATCHBOLT IN QEL, ALLOWING ENTRY. RX SWITCH MONITORS AUTHORIZED EGRESS. DOOR CONTACT MONITORS WHEN DOOR OPENS AND CLOSES. FAIL SECURE.**

**HARDWARE GROUP NO. 018 - IN - 70/OH**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 122A | 122B | 122C | | | |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 | □ | | 652 | IVE |
| 1 | EA | CLASSROOM LOCK | ND70TD TLR | □ | | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 X S125 KEYWAY | □ | | 626 | SCH |
| 1 | EA | OH STOP | 90S | □ | | 630 | GLY |
| 3 | EA | SILENCER | SR64 | □ | | GRY | IVE |

**HARDWARE GROUP NO. 019 - EXT - O - EO**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 129F | | | | | |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 NRP | □ | | 630 | IVE |
| 1 | EA | PANIC HARDWARE | 99-EO | □ | | 626 | VON |
| 1 | EA | SURFACE CLOSER | 4040XP SCUSH | □ | | 689 | LCN |
| 1 | EA | RAIN DRIP | 142AA | □ | | AA | ZER |

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 1 | EA | WEATHER STRIP | 8303AA | □ | | AA | ZER |
| 1 | EA | DOOR SWEEP | 39A | □ | | A | ZER |
| 1 | EA | THRESHOLD | 545A | □ | | A | ZER |

**HARDWARE GROUP NO. 020 - O - LBE**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 111 | | | | | |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1HW 4.5 X 4.5 | □ | | 652 | IVE |
| 1 | EA | PANIC HARDWARE | 99-L-BE-03-SNB | □ | | 626 | VON |
| 1 | EA | SURFACE CLOSER | 4111 SCUSH | □ | | 689 | LCN |
| 1 | EA | KICK PLATE | 8400 10" X 2" LDW B-CS | □ | | 630 | IVE |
| 1 | EA | GASKETING | 488SBK PSA | □ | | BK | ZER |

**HARDWARE GROUP NO. 021 - EXT - O - L**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 127 | | | | | |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 1 | EA | CONT. HINGE | 040XY | □ | | US28 | IVE |
| 1 | EA | PANIC HARDWARE | 99-L-03 | □ | | 626 | VON |
| 1 | EA | FSIC CORE | 23-030 EV29 X S125 KEYWAY | □ | | 626 | SCH |
| 1 | EA | SURFACE CLOSER | 4111 EDA | □ | | 689 | LCN |
| 1 | EA | WALL STOP | WS406/407CCV | □ | | 630 | IVE |
| 1 | EA | GASKETING | 188SBK PSA | □ | | BK | ZER |

**HARDWARE GROUP NO. 022 - IN - 80/CL**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 113 | 130 | 131 | 132 | | |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 | □ | | 652 | IVE |
| 1 | EA | STOREROOM LOCK | ND80TD TLR | □ | | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 X S125 KEYWAY | □ | | 626 | SCH |
| 1 | EA | SURFACE CLOSER | 4011T | □ | | 689 | LCN |
| 1 | EA | KICK PLATE | 8400 10" X 2" LDW B-CS | □ | | 630 | IVE |
| 1 | EA | WALL STOP | WS406/407CCV | □ | | 630 | IVE |
| 3 | EA | SILENCER | SR64 | □ | | GRY | IVE |

**HARDWARE GROUP NO. 023**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 105 | | | | | |

**PROVIDE EACH CO DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 1 | EA | CASED OPENING | CASED OPENING | | | | |

**HARDWARE GROUP NO. 025 - IN - 40/ADB**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 110 | 112 | 114 | 116 | 118 | 120 |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 | □ | | 652 | IVE |
| 1 | EA | PRIVACY LOCK | ND40S TLR | □ | | 626 | SCH |
| 1 | EA | SURFACE CLOSER | 4011T | □ | | 689 | LCN |
| 1 | EA | WALL STOP | WS406/407CCV | □ | | 630 | IVE |
| 1 | SET | PERIMETER SOUND SEAL | 870AA-S | □ | | AA | ZER |
| 1 | EA | MORTISED AUTO DR BOTTOM | 369AA | □ | | AA | ZER |
| 1 | EA | THRESHOLD | 63A-223 | □ | | A | ZER |
| 1 | EA | COAT AND HAT HOOK | 571 | □ | | 626 | IVE |

**HARDWARE GROUP NO. 026 - EXT - IN - 80**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 125 | | | | | |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 NRP | □ | | 630 | IVE |
| 1 | EA | STOREROOM LOCK | L9080T 03A | □ | | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 X S125 KEYWAY | □ | | 626 | SCH |
| 1 | EA | SURFACE CLOSER | 4040XP | □ | | 689 | LCN |
| 1 | EA | KICK PLATE | 8400 10" X 2" LDW B-CS | □ | | 630 | IVE |
| 1 | EA | WALL STOP | WS406/407CCV | □ | | 630 | IVE |
| 1 | EA | RAIN DRIP | 142AA | □ | | AA | ZER |
| 1 | EA | WEATHER STRIP | 8303AA | □ | | AA | ZER |
| 1 | EA | DOOR SWEEP | 39A | □ | | A | ZER |
| 1 | EA | THRESHOLD | 545A | □ | | A | ZER |

**HARDWARE GROUP NO. 027 - EXT - IN - 80/OH**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 126A | | | | | |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 NRP | □ | | 630 | IVE |
| 1 | EA | STOREROOM LOCK | L9080T 03A | □ | | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 X S125 KEYWAY | □ | | 626 | SCH |
| 1 | EA | OH STOP | 90S | □ | | 630 | GLY |
| 1 | EA | SURFACE CLOSER | 4040XP | □ | | 689 | LCN |
| 1 | EA | KICK PLATE | 8400 10" X 2" LDW B-CS | □ | | 630 | IVE |
| 1 | EA | RAIN DRIP | 142AA | □ | | AA | ZER |
| 1 | EA | WEATHER STRIP | 8303AA | □ | | AA | ZER |
| 1 | EA | DOOR SWEEP | 39A | □ | | A | ZER |
| 1 | EA | THRESHOLD | 545A | □ | | A | ZER |

**HARDWARE GROUP NO. 028 - EXT - O - CR/NLOP**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 100 | | | | | |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 NRP | □ | | 630 | IVE |
| 1 | EA | ELEC PANIC HARDWARE | RX-QEL-99-NL-OP-110MD-CON 24 VDC | □ | ~ | 626 | VON |
| 1 | EA | RIM CYLINDER FSIC | 20-057 X S125 KEYWAY | □ | | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 X S125 KEYWAY | □ | | 626 | SCH |
| 1 | EA | 90 DEG OFFSET PULL | 8190EZHD 10" O | □ | | 630-316 | IVE |
| 1 | EA | SURFACE CLOSER | 4040XP SCUSH | □ | | 689 | LCN |
| 1 | EA | WEATHER STRIP | 8303AA | □ | | AA | ZER |
| 1 | EA | DOOR SWEEP | 39A | □ | | A | ZER |
| 1 | EA | THRESHOLD | 545A | □ | | A | ZER |
| 1 | EA | WIRE HARNESS | CON-XXY (LOCK/EXIT TO HINGE JAMB) | | ~ | | SCH |
| 1 | | CREDENTIAL READER | BY SECURITY INTEGRATOR | | | | |
| 1 | EA | DOOR CONTACT | 679-05HM/WD AS REQ. | □ | ~ | BLK | SCE |
| 1 | EA | POWER SUPPLY | BY SECURITY CONTRACTOR | | | | |
| 1 | EA | WIRING | WIRING DIAGRAMS AS REQUIRED | | | | |

**FREE EGRESS AT ALL TIMES. AUTHORIZED CREDENTIAL MOMENTARILY RETRACTS LATCHBOLT IN QEL, ALLOWING ENTRY. RX SWITCH MONITORS AUTHORIZED EGRESS. DOOR CONTACT MONITORS WHEN DOOR OPENS AND CLOSES. FAIL SECURE.**

**HARDWARE GROUP NO. 029 - O - CH/70**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 128A | | | | | |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | CONT. HINGE | 040XY | □ | | US28 | IVE |
| 1 | EA | CLASSROOM LOCK | ND70TD TLR | □ | | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 X S125 KEYWAY | □ | | 626 | SCH |
| 1 | EA | SURFACE CLOSER | 4111 EDA | □ | | 689 | LCN |
| 1 | EA | KICK PLATE | 8400 10" X 2" LDW B-CS | □ | | 630 | IVE |
| 1 | EA | WALL STOP | WS406/407CCV | □ | | 630 | IVE |
| 1 | EA | GASKETING | 188SBK PSA | □ | | BK | ZER |

**HARDWARE GROUP NO. 030 - IN - 80/CL/488**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 126 | | | | | |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 | □ | | 652 | IVE |
| 1 | EA | STOREROOM LOCK | ND80TD TLR | □ | | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 X S125 KEYWAY | □ | | 626 | SCH |
| 1 | EA | SURFACE CLOSER | 4011T | □ | | 689 | LCN |
| 1 | EA | KICK PLATE | 8400 10" X 2" LDW B-CS | □ | | 630 | IVE |
| 1 | EA | WALL STOP | WS406/407CCV | □ | | 630 | IVE |
| 3 | EA | GASKETING | 488SBK PSA | □ | | BK | ZER |

**HARDWARE GROUP NO. 031 - O - LBE**

**FOR USE ON DOOR #(S):**

| | | | | | |
|---|---|---|---|---|---|
| 103 | | | | | |

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

| QTY | | DESCRIPTION | CATALOG NUMBER | | | FINISH | MFR |
|---|---|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 | □ | | 652 | IVE |
| 1 | EA | PANIC HARDWARE | 99-L-BE-03-SNB | □ | | 626 | VON |
| 1 | EA | SURFACE CLOSER | 4111 EDA | □ | | 689 | LCN |
| 1 | EA | WALL STOP | WS406/407CCV | □ | | 630 | IVE |
| 3 | EA | SILENCER | SR64 | □ | | GRY | IVE |

**END OF HARDWARE SECTION 087100**

**END OF SECTION**

# SECTION 088000
# GLAZING

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section Includes:
   1. Glass products.
   2. Insulating glass.
   3. Glazing tapes.
   4. Miscellaneous glazing materials.

### 1.02 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters in accordance with ASTM C1036.

C. IBC: International Building Code.

D. Interspace: Space between lites of an insulating-glass unit.

### 1.03 REFERENCE STANDARDS

A. 8 - test; 1.

B. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials; Current Edition.

C. ASTM C1021 - Standard Practice for Laboratories Engaged in Testing of Building Sealants; 2008 (Reapproved 2023).

D. ASTM C1036 - Standard Specification for Flat Glass; 2025.

E. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2025.

F. ASTM C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants; 2023.

G. ASTM C1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass; 2021a.

H. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings; 2024.

I. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation; 2019.

J. NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence; 2023.

K. NFRC 300 - Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems; 2026.

L. test - sddds; sdds.

### 1.04 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances to achieve proper safety margins for glazing retention under each design load case, load case combination, and service condition.

### 1.05 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   2. Review temporary protection requirements for glazing during and after installation.

### 1.06 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches (304.8 mm) square.
   1. Coated glass.

C. Glazing Accessory Samples: For sealants, in 12-inch lengths. Install sealant Samples between two strips of material representative in color of adjoining framing system.

D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

E. Delegated Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by qualified professional engineer responsible for their preparation.

### 1.07 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturers of fabricated glass units.

B. Product Certificates: For glass.

C. Product Test Reports: For Coated glass and insulating for tests performed by a qualified testing agency.
   1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.

D. Preconstruction adhesion and compatibility test report.

E. Sample Warranties: For special warranties.

### 1.08 QUALITY ASSURANCE

A. Installer Qualifications: A qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AG&M) contractors and who employs glazing technicians certified under the Architectural Glass and Metal Technician (AGMT) certification program.

B. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

C. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.

D. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.
   1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

### 1.09 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials in accordance with manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

### 1.10 FIELD CONDITIONS

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

### 1.11 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
   1. Warranty Period: 10 years from date of Substantial Completion.

B. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is obstruction of vision by dust, moisture, or film on interior surfaces of glass.
   1. Warranty Period: 10 years from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazing.

C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined in accordance with the IBC and ASTM E1300:
   1. Design Wind Pressures: As indicated on Drawings.
      a. Wind Design Data: As indicated on Drawings.
      b. Basic Wind Speed: 110 mph.
      c. Importance Factor: 1.0.
      d. Exposure Category: B.
   2. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch (25.4 mm), whichever is less.

D. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

E. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
   1. For monolithic-glass lites, properties are based on units with lites 0.24 inch (6 mm) thick.
   2. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
   3. U-Factors: Comply with the requirements of the 2015 IECC and Georgia Amendments for Climate Zone 3.
   4. SHGC and Visible Transmittance: Center-of-glazing values, in accordance with NFRC 200 and based on most current non-beta version of LBL's WINDOW computer program. Comply with the requirements of the 2015 IECC and Georgia amendments for Climate zone 3.
   5. Visible Reflectance: Center-of-glazing values, in accordance with NFRC 300.

### 2.02 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than thickness indicated.
   1. Minimum Glass Thickness for Exterior Lites: 0.24 inch (6 mm).
   2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.

## 2.03 GLASS PRODUCTS

A. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. AGC Glass Company North America, Inc.
      b. Cardinal Glass Industries, Inc.
      c. Guardian Glass LLC
      d. Pilkington North America; NSG Group

B. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
   1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

C. Reflective- and Low-E-Coated Vision Glass: ASTM C1376.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Cardinal Glass Industries, Inc.
      b. Guardian Glass LLC
      c. Pilkington North America; NSG Group

D. Reflective- and Low-E-Coated Spandrel Glass: ASTM C1376, Kind CS.

## 2.04 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified in accordance with ASTM E2190.
   1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
   2. Desiccant: Molecular sieve or silica gel, or a blend of both.

## 2.05 GLAZING SEALANTS

A. General:
   1. Compatibility: Compatible with one another and with other materials they 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 of industry colors.

### 2.06 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; 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; and complying with ASTM C1281 and AAMA 800 for products indicated below:
   1. AAMA 804.3 tape, where indicated.
   2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
   3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
   1. AAMA 810.1, Type 1, for glazing applications in which tape acts as primary sealant.
   2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

### 2.07 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, recommended in writing by 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:
   1. Neoprene with Shore A durometer hardness of 85, plus or minus 5.

D. Spacers:
   1. Neoprene blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks:
   1. Neoprene with Shore A durometer hardness per manufacturer's written instructions.

F. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

### 2.08 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit 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.
   1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
      a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

C. Grind smooth and polish exposed glass edges and corners.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Examine framing, glazing channels, and stops, 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 systems.
   3. Minimum required face and edge clearances.

4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.02 PREPARATION**

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

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

**3.03 GLAZING, GENERAL**

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. 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.

E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

F. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).
   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- 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.

G. 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 in accordance with requirements in referenced glazing publications.

H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended in writing by gasket manufacturer.

**3.04 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, then to jambs. Cover horizontal framing joints by applying tapes to jambs, 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 right before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

**3.05 GASKET GLAZING (DRY)**

A. Cut compression gaskets to 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. Installation with Drive-in Wedge Gaskets: 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 in writing by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

**3.06 CLEANING AND PROTECTION**

A. Immediately after installation, remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. 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.
   1. If, despite such protection, contaminating substances do contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

D. Wash glass on both exposed surfaces 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.

**3.07 MONOLITHIC GLASS SCHEDULE**

A. Clear Glass Type : Fully tempered float glass.
   1. Minimum Thickness: 0.24 inch (6 mm).
   2. Safety glazing required.

**3.08 INSULATING GLASS SCHEDULE**

A. Low-E-Coated, Clear Insulating Glass Type :
   1. Overall Unit Thickness: 1 inch (25.4 mm).
   2. Minimum Thickness of Each Glass Lite: 0.24 inch (6 mm).
   3. Outdoor Lite: Fully tempered float glass.
   4. Interspace Content: Argon.

5. Indoor Lite: Fully tempered float glass.
6. Low-E Coating: Sputtered on second surface.
7. Winter Nighttime U-Factor. Comply with 2015 IEC and Georgia Amendments for Climate Zone 3.
8. Summer Daytime U-Factor: Comply with 2015 IECC and Georgia amendments for climate Zone 3.
9. Visible Light Transmittance: Comply with 2015 IECC and Georgia Amendments for climate Zone 3.
10. SGHC: Comply with 2015 IECC and Georgia Amendments for Climate Zone 3.
11. Safety glazing required.

**END OF SECTION**

# SECTION 088300
# MIRRORS

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Tempered safety glass mirrors.

### 1.02 REFERENCE STANDARDS

A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials; Current Edition.

B. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2025.

C. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2025.

D. GANA (GM) - GANA Glazing Manual; 2022.

E. GANA (SM) - GANA Sealant Manual; 2008.

### 1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data on Mirror Types: Submit structural, physical and environmental characteristics, size limitations, and special handling and installation requirements.

C. Certificate: Certify mirrors meet or exceed specified requirements.

D. Manufacturer's qualification statement.

E. Executed warranty.

### 1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with minimum 3 years of documented experience.

### 1.05 DELIVERY, STORAGE, AND HANDLING

A. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.

B. Transport, receive, and store mirrors in accordance with manufacturer's recommendations.

### 1.06 FIELD CONDITIONS

A. Do not install mirrors when ambient temperature is less than 50 degrees F (10 degrees C).

### 1.07 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Mirrors:
   1. Binswanger Glass: binswangerglass.com/#sle.
   2. Dreamwalls by Gardner Glass Products; Laminated Mirrors: www.dreamwalls.com/#sle.
   3. Lenoir Mirror Company: www.lenoirmirror.com/#sle.
   4. Trulite Glass & Aluminum Solutions, LLC: www.trulite.com/#sle.
   5. Gardner Walker Glass; Walker Glass Mirrors: www.walkerglass.com/#sle.

### 2.02 MIRROR MATERIALS

A. Mirror Design Criteria: Select materials and provide supports as required to limit mirror material deflection to 1/200, or to the flexure limit of glass, with full recovery of glazing materials, whichever is less.

B. Mirror Glass: Clear, tempered safety glass; ASTM C1048, with copper and silver coatings, and protective overcoating.

1. Thickness: 1/4 inch (6 mm).
2. Edges: Pencil Polished.
3. Size: 96 inches (2438 mm) wide by 72 inches (1828.8 mm) high, nominal mounted 12" above floor.

**2.03 ACCESSORIES**

A. Mirror Adhesive: Silicone pre-polymer based, chemically compatible with mirror coating and wall substrate.
   1. Application Temperature: Minus 35 to 140 degrees F (Minus 37 to 60 degrees C) at contact surfaces.

B. Channel Frame: One piece, channel frame, stainless steel, Type 430, satin finish, 1/2 inch by 1/2 inch by 3/8 inch deep (12 mm by 12 mm by 10 mm deep) with 90-degree mitered corners.

**2.04 SOURCE QUALITY CONTROL**

A. See Section 014000 - Quality Requirements for additional requirements.

B. Fabricate mirrors in accordance with manufacturer's recommendations, GANA (GM), and GANA (SM).

**PART 3 EXECUTION**

**3.01 EXAMINATION**

A. Verify openings for mirrored glazing are sized within tolerance of manufacturer's instructions.

B. Verify surfaces of mirror frames or recesses are clean, free of obstructions, and ready for installation of mirrors.

C. Notify Architect in writing of conditions detrimental to completion of work. Do not proceed with installation until detrimental conditions are corrected.

**3.02 PREPARATION**

A. Clean contact surfaces with solvent and wipe dry.

B. Seal porous mirror frames or recesses with substrate-compatible primer or sealer. Prime surfaces scheduled to receive sealant.

C. Prepare installation in accordance with ASTM C1193 for solvent release sealants, and install sealant in accordance with manufacturer's instructions.

**3.03 INSTALLATION**

A. Install mirrors in accordance with manufacturer's recommendations, GANA (GM), and GANA (SM).

B. Set mirrors plumb and level and free of optical distortion.

C. Set mirrors with edge clearance free of surrounding construction, including countertops or backsplashes.

D. Adhesive Installation of Frameless Mirrors: Set mirrors in place with adhesive, applied in accordance with adhesive manufacturer's instructions.

**3.04 CLEANING**

A. See Section 017000 - Execution and Closeout Requirements for additional requirements.

B. Remove nonpermanent labels after work is complete.

**3.05 PROTECTION**

A. Protect installed mirrors from subsequent construction operations.

B. Remove and replace mirrors damaged during construction period prior to mm-dd-yyyy.

**END OF SECTION**

**SECTION 090561**
**COMMON WORK RESULTS FOR FLOORING PREPARATION**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. This section applies to floors identified in Contract Documents that are receiving the following types of floor coverings:
   1. Resilient tile and sheet.
   2. Carpet tile.
   3. Thin-set ceramic tile and stone tile.

B. Removal of existing floor coverings.

C. Preparation of existing concrete floor slabs for installation of floor coverings.

D. Testing of concrete floor slabs for moisture and alkalinity (pH).

E. Remediation of concrete floor slabs due to unsatisfactory moisture or alkalinity (pH) conditions.
   1. Contractor shall perform all specified remediation of concrete floor slabs. If such remediation is indicated by testing agency's report and is due to a condition not under Contractor's control or could not have been predicted by examination prior to entering into the contract, a contract modification will be issued.

F. Patching compound.

G. Remedial floor coatings.

### 1.02 RELATED REQUIREMENTS

A. Section 014000 - Quality Requirements: Additional requirements relating to testing agencies and testing.

B. Section 017419 - Construction Waste Management and Disposal: Handling of existing floor coverings removed.

### 1.03 REFERENCE STANDARDS

A. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 50 mm [2 in.] Cube Specimens); 2024.

B. ASTM C472 - Standard Test Methods for Physical Testing of Gypsum, Gypsum Plasters, and Gypsum Concrete; 2020.

C. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride; 2023.

D. ASTM F3010 - Standard Practice for Two-Component Resin Based Membrane-Forming Moisture Mitigation Systems for Use Under Resilient Floor Coverings; 2024.

E. ASTM F3513 - Standard Practice for Single Component, Fluid-Applied Membrane-Forming Moisture Mitigation Systems for Use Under Resilient Floor Coverings; 2024.

F. RFCI (RWP) - Recommended Work Practices for Removal of Resilient Floor Coverings; 2018.

G. test - sddds; sdds.

### 1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordinate scheduling of cleaning and testing, so that preliminary cleaning has been completed for at least 24 hours prior to testing.

### 1.05 SUBMITTALS

A. Visual Observation Report: For existing floor coverings to be removed.

B. Floor Covering and Adhesive Manufacturers' Product Literature: For each specific combination of substrate, floor covering, and adhesive to be used; showing:
   1. Moisture and alkalinity (pH) limits and test methods.
   2. Manufacturer's required bond/compatibility test procedure.

C. Testing Agency's Report:
   1. Description of areas tested; include floor plans and photographs if helpful.
   2. Summary of conditions encountered.
   3. Moisture and alkalinity (pH) test reports.
   4. Copies of specified test methods.
   5. Recommendations for remediation of unsatisfactory surfaces.
   6. Submit report not more than two business days after conclusion of testing.

D. Adhesive Bond and Compatibility Test Report.

E. Copy of RFCI (RWP).

**1.06 QUALITY ASSURANCE**

A. Contractor may perform adhesive and bond test with Contractor's own personnel or hire a testing agency.

B. Contractor's Responsibility Relating to Independent Agency Testing:
   1. Provide access for and cooperate with testing agency.
   2. Confirm date of start of testing at least 10 days prior to actual start.
   3. Allow at least 4 business days on site for testing agency activities.
   4. Achieve and maintain specified ambient conditions.

**PART 2 PRODUCTS**

**2.01 MATERIALS**

A. Patching Compound: Floor covering manufacturer's recommended product, suitable for conditions, and compatible with adhesive and floor covering. In the absence of any recommendation from flooring manufacturer, provide a product with the following characteristics:
   1. Cementitious moisture-, mildew-, and alkali-resistant compound, compatible with floor, floor covering, and floor covering adhesive, and capable of being feathered to nothing at edges.
   2. Compressive Strength: 3000 psi (20684.28 kPa), minimum, after 28 days, when tested in accordance with ASTM C109/C109M or ASTM C472, whichever is appropriate.

B. Alternate Flooring Adhesive: Floor covering manufacturer's recommended product, suitable for the moisture and pH conditions present; low-VOC. In the absence of any recommendation from flooring manufacturer, provide a product recommended by adhesive manufacturer as suitable for substrate and floor covering and for conditions present.

C. Remedial Floor Coating, Two-Component: Single-layer coating resistant to water vapor transmission meeting flooring manufacturer's emission limits, resistant to alkalinity (pH) level found, and suitable for flooring adhesion without further treatment.
   1. Material: Comply with ASTM F3010.
   2. Thickness: As required for application and in accordance with manufacturer's installation instructions.
   3. Products:
      a. Custom Building Products; TechMVC Moisture Vapor and Alkalinity Barrier: www.custombuildingproducts.com/#sle.
      b. H.B. Fuller Construction Products, Inc; TEC LiquiDam: www.tecspecialty.com/#sle.
      c. LATICRETE International, Inc; LATICRETE VAPOR BAN E: www.laticrete.com/#sle.
      d. Mapei Corporation; Planiseal VS: www.mapei.com/#sle.
      e. Sika Corporation; Sikafloor Moisture Tolerance Epoxy Primer: www.sikafloorusa.com/#sle.

D. Remedial Floor Coating, Single Component: Single-layer coating resistant to water vapor transmission meeting flooring manufacturer's emission limits, resistant to alkalinity (pH) level found, and suitable for flooring adhesion without further treatment.
   1. Material: Comply with ASTM F3513.

2. Thickness: As required for application and in accordance with manufacturer's installation instructions.
3. Products:
   a. H.B. Fuller Construction Products, Inc; TEC LiquiDam EZ: www.tecspecialty.com/#sle.

## PART 3 EXECUTION

### 3.01 CONCRETE SLAB PREPARATION

A. Perform following operations in the order indicated:
   1. Existing concrete slabs (on-grade and elevated) with existing floor coverings:
      a. Visual observation of existing floor covering, for adhesion, water damage, alkaline deposits, and other defects.
      b. Removal of existing floor covering.
   2. Preliminary cleaning.
   3. Moisture vapor emission tests; 3 tests in the first 1000 sq feet (1.07643 sq cm) and one test in each additional 1000 sq feet (1.07643 sq cm), unless otherwise indicated or required by flooring manufacturer.
   4. Internal relative humidity tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
   5. Alkalinity (pH) tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
   6. Specified remediation, if required.
   7. Patching, smoothing, and leveling, as required.
   8. Other preparation specified.
   9. Adhesive bond and compatibility test.
   10. Protection.

B. Remediations:
   1. Active Water Leaks or Continuing Moisture Migration to Surface of Slab: Correct this condition before doing any other remediation; re-test after correction.
   2. Excessive Moisture Emission or Relative Humidity: If an adhesive that is resistant to the level of moisture present is available and acceptable to flooring manufacturer, use that adhesive for installation of the flooring; if not, apply remedial floor coating or remedial sheet membrane over entire suspect floor area.
   3. Excessive Alkalinity (pH): If remedial floor coating is necessary to address excessive moisture, no additional remediation is required; if not, if an adhesive that is resistant to the level present is available and acceptable to the flooring manufacturer, use that adhesive for installation of the flooring; otherwise, apply a skim coat of specified patching compound over entire suspect floor area.

### 3.02 REMOVAL OF EXISTING FLOOR COVERINGS

A. Comply with local, State, and federal regulations and recommendations of RFCI (RWP), as applicable to floor covering being removed.

B. Dispose of removed materials in accordance with local, State, and federal regulations and as specified.

### 3.03 PRELIMINARY CLEANING

A. Clean floors of dust, solvents, paint, wax, oil, grease, asphalt, residual adhesive, adhesive removers, film-forming curing compounds, sealing compounds, alkaline salts, excessive laitance, mold, mildew, and other materials that might prevent adhesive bond.

B. Do not use solvents or other chemicals for cleaning.

### 3.04 MOISTURE VAPOR EMISSION TESTING

A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.

B. Where this specification conflicts with the referenced test method, comply with the requirements of this section.

C. Test in accordance with ASTM F1869 and as follows.

D. Plastic sheet test and mat bond test may not be substituted for the specified ASTM test method, as those methods do not quantify the moisture content sufficiently.

E. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if test values exceed 3 pounds per 1000 sq feet (1.07643 sq cm) per 24 hours.

F. Report: Report the information required by the test method.

**3.05 ALKALINITY TESTING**

A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.

B. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if alkalinity (pH) test value is over 10.

**3.06 PREPARATION**

A. See individual floor covering section(s) for additional requirements.

B. Comply with requirements and recommendations of floor covering manufacturer.

C. Fill and smooth surface cracks, grooves, depressions, control joints and other non-moving joints, and other irregularities with patching compound.

D. Do not fill expansion joints, isolation joints, or other moving joints.

**3.07 ADHESIVE BOND AND COMPATIBILITY TESTING**

A. Comply with requirements and recommendations of floor covering manufacturer.

**3.08 APPLICATION OF REMEDIAL FLOOR COATING**

A. Comply with requirements and recommendations of coating manufacturer.

**3.09 APPLICATION OF REMEDIAL FLOOR TREATMENT**

A. Comply with requirements and recommendations of treatment manufacturer.

**3.10 PROTECTION**

A. Cover prepared floors with building paper or other durable covering.

**END OF SECTION**

# SECTION 092116
# GYPSUM BOARD ASSEMBLIES - USG

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Performance criteria for gypsum board assemblies.

B. Metal stud wall framing.

C. Metal grid or channel ceiling framing.

D. Gypsum wallboard.

E. Gypsum sheathing.

F. Joint treatment and accessories.

### 1.02 RELATED REQUIREMENTS

A. Section 061000 - Rough Carpentry: Building framing and sheathing.

B. Section 061000 - Rough Carpentry: Wood blocking product and execution requirements.

C. Section 072500 - Weather Barriers: Water-resistive barrier over sheathing.

D. Section 079200 - Joint Sealants: Sealing acoustical gaps in construction other than gypsum board or plaster work.

E. Section 092216 - Non-Structural Metal Framing.

F. Section 313116 - Termite Control: Field-applied termiticide and mildewcide for metal framing.

### 1.03 REFERENCE STANDARDS

A. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2017 (Reapproved 2022).

B. ASTM C514 - Standard Specification for Nails for the Application of Gypsum Board; 2004 (Reapproved 2020).

C. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.

D. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2025.

E. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2022.

F. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2022.

G. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base; 2019.

H. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2024.

I. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2024.

J. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.

K. ASTM E413 - Classification for Rating Sound Insulation; 2022.

L. GA-216 - Application and Finishing of Gypsum Panel Products; 2024.

### 1.04 SUBMITTALS

A. See Section #013300 Submittals for submittal proceedures.

B. Shop Drawings: Indicate special details associated with fireproofing and acoustic seals.

C. Product Data: Include data on gypsum board, glass mat faced gypsum board, sheathing, accessories, and joint finishing system.

D. Product Data: Include manufacturer's data on partition head to structure connectors, showing compliance with requirements.

**1.05 QUALITY ASSURANCE**

A. Copies of Documents at Site: Maintain at the project site a copy of each referenced document that prescribes execution requirements.

**PART 2 PRODUCTS**

**2.01 GYPSUM BOARD ASSEMBLIES**

A. Provide completed assemblies complying with ASTM C840 and GA-216.

B. Interior Partitions, Indicated as Acoustic: Provide completed assemblies with the following characteristics:
   1. Sound Transmission Loss Values: STC of 45-49, calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

**2.02 ACOUSTICAL GYPSUM BOARD CEILING ASSEMBLIES**

A. Acoustical Ceiling Assembly Type ACA-1:
   1. Ensemble Direct Mount Ceiling System.

**2.03 BOARD MATERIALS**

A. Manufacturers - Gypsum-Based Board:
   1. USG Corporation: www.usg.com/#sle.

B. Gypsum Board: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
   1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
   2. Thickness:
      a. Vertical Surfaces: As indicated on drawings.
      b. Ceilings: 5/8 inch (16 mm).
   3. Paper-Faced Regular Board Products:
   4. Paper-Faced Fire-Resistant Board Products:
      a. USG Corporation; USG Sheetrock Brand Firecode SCX Panels 5/8 inch: www.usg.com/#sle.
   5. Moisture- and Mold-Resistant Paper-Faced Board Products:
      a. USG Sheetrock Brand Mold Tough Firecode SCX Panels 5/8 inch: www.usg.com/#sle.

C. Ceiling Board: Special sag resistant gypsum ceiling board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
   1. Application: Ceilings, unless otherwise indicated.
   2. Thickness: 5/8 inch (16 mm).
   3. Edges: Tapered.

D. Exterior Sheathing Board: See Section 061000.

**2.04 GYPSUM WALLBOARD ACCESSORIES**

A. Water-Resistive Barrier: See Section 072500.

B. Beads, Joint Accessories, and Other Trim: ASTM C1047, rigid plastic, galvanized steel, or rolled zinc, unless otherwise indicated.
   1. Corner Beads: Low profile, for 90 degree outside corners.

C. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
   1. Fiberglass Tape: 2 inch (50 mm) wide, coated glass fiber tape for joints and corners, except as otherwise indicated.

2. Paper Tape: 2 inch (50 mm) wide, creased paper tape for joints and corners, except as otherwise indicated.
3. Joint Compound: Setting type, field-mixed.

D. Drywall Ceiling Installation Accessories: Products recommended by gypsum board manufacturer.
1. Drywall Grid Locking Channels: Manufacturer's standard channels with an engineered locking pocket for connecting tees to the perimeter of ceiling, without using fasteners.

E. Fasteners and Adhesives: Products recommended by gypsum board manufacturer.
1. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inches (0.84 mm) in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion-resistant.
2. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch (0.84 to 2.84 mm) in Thickness: ASTM C954; steel drill screws, corrosion-resistant.
3. Nails for Attachment to Wood Members: ASTM C514.
4. Anchorage to Substrate: Tie wire, nails, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Verify that project conditions are appropriate for work of this section to commence.

### 3.02 FRAMING INSTALLATION

A. Metal Framing: Install in accordance with ASTM C754 and manufacturer's instructions.

B. Suspended Ceilings and Soffits: Space framing and furring members as indicated.
1. Level ceiling system to a tolerance of 1/1200.
2. Laterally brace entire suspension system.

C. Studs: Space studs at 16 inches on center (at 406 mm on center).
1. Extend partition framing to structure where indicated and to ceiling in other locations.
2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.

D. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.

E. Blocking: Install wood blocking for support of:
1. Framed openings.
2. Wall-mounted cabinets.
3. Plumbing fixtures.
4. Toilet accessories.
5. Wall-mounted door hardware.

### 3.03 ACOUSTIC ACCESSORIES INSTALLATION

A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.

B. Acoustic Sealant: Install in accordance with manufacturer's instructions.

### 3.04 BOARD INSTALLATION

A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.

B. Single-Layer Nonrated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.

C. Exposed Gypsum Board in Interior Wet Areas: Seal joints, cut edges, and holes with water-resistant sealant.

D. Installation on Wood Framing: For rated assemblies, comply with requirements of listing authority. For nonrated assemblies, install as follows:
   1. Single-Layer Applications: Screw attachment.

**3.05 INSTALLATION OF TRIM AND ACCESSORIES**

A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.
   1. Not more than 30 feet (9 meters) apart on walls and ceilings over 50 feet (15 meters) long.

B. Corner Beads: Install at external corners, using longest practical lengths.

C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials.

**3.06 JOINT TREATMENT**

A. Paper Faced Gypsum Board: Use paper joint tape, embed with drying type joint compound and finish with drying type joint compound.

B. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
   1. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
   2. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
   3. Level 1: Fire-resistance-rated wall areas above finished ceilings, whether or not accessible in the completed construction.

C. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
   1. Feather coats of joint compound so that camber is maximum 1/32 inch (0.8 mm).

**3.07 TOLERANCES**

A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet (3 mm in 3 m) in any direction.

**END OF SECTION**

**SECTION 093000**
**TILING**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Tile for floor applications.

B. Tile for wall applications.

C. Tile for shower receptors.

D. Coated glass mat backer board as tile substrate.

E. Ceramic accessories.

F. Ceramic trim.

G. Non-ceramic trim.

### 1.02 RELATED REQUIREMENTS

A. Section 090561 - Common Work Results for Flooring Preparation: Concrete slab moisture and alkalinity testing and remediation procedures.

### 1.03 REFERENCE STANDARDS

A. ANSI A108.19 - American National Standard Specifications for Interior Installation of Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs by the Thin-Bed Method Bonded with Modified Dry-Set Cement Mortar or Improved Modified Dry-Set Cement Mortar; 2020.

B. ANSI A108/A118/A136 - American National Standard Specifications for the Installation of Ceramic Tile (Compendium); 2024.

C. ANSI A118.1 - American National Standard Specifications for Dry-Set Cement Mortar; 2023.

D. ANSI A118.3 - American National Standard Specifications for Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy and Water Cleanable Tile-Setting Epoxy Adhesive; 2021.

E. ANSI A118.4 - American National Standard Specifications for Modified Dry-Set Cement Mortar; 2023.

F. ANSI A118.6 - American National Standard Specifications for Standard Cement Grouts for Tile Installation; 2019.

G. ANSI A118.7 - American National Standard Specifications for High Performance Cement Grouts for Tile Installation; 2019.

H. ANSI A118.10 - American National Standard Specifications for Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation; 2023.

I. ANSI A118.12 - American National Standard Specifications for Crack Isolation Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation; 2014 (Reaffirmed 2024).

J. ANSI A137.1 - American National Standard Specifications for Ceramic Tile; 2022.

K. ANSI A326.3 - American National Standard Test Method for Measuring Dynamic Coefficient of Friction of Hard Surface Flooring Materials; 2021.

L. ASTM C373 - Standard Test Methods for Determination of Water Absorption and Associated Properties by Vacuum Method for Pressed Ceramic Tiles and Glass Tiles and Boil Method for Extruded Ceramic Tiles and Non-tile Fired Ceramic Whiteware Products; 2018 (Reapproved 2023).

M. ASTM C1178/C1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel; 2024.

N. TCNA (HB-GP) - Handbook for Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs Installation; 2025-2026.

O. TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation; 2026.

**1.04 SUBMITTALS**

A. Ssee Section #013300 - Submittal proceedures for submittal proceedures.

B. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.

C. Installer's qualification statement.

D. Maintenance Data: Include recommended cleaning methods, cleaning materials, and stain removal methods.

**1.05 QUALITY ASSURANCE**

A. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum five years of documented experience.

B. Installer Qualifications:
   1. Company specializing in performing tile installation, with minimum of five years of documented experience.

**1.06 DELIVERY, STORAGE, AND HANDLING**

A. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.

B. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

**1.07 FIELD CONDITIONS**

A. Do not install solvent-based products in an unventilated environment.

B. Maintain ambient and substrate temperature above 50 degrees F (10 degrees C) and below 100 degrees F (38 degrees C) during installation and curing of setting materials.

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS**

A. Tile:
   1. Trinity Tile: www.trinitytile.com.

B. Setting Materials:
   1. LATICRETE International, Inc: www.laticrete.com/#sle.
   2. Mapei Corporation: www.mapei.com/#sle.
   3. Schluter-Systems: www.schluter.com/#sle.
   4. Source Limitations: Furnish products produced by single manufacturer and obtained from single supplier.

C. Grout:
   1. Custom Building Products: www.custombuildingproducts.com/#sle.
   2. LATICRETE International, Inc: www.laticrete.com/#sle.
   3. Mapei Corporation: www.mapei.com/#sle.
   4. Source Limitations: Furnish products produced by single manufacturer and obtained from single supplier.

**2.02 PERFORMANCE REQUIREMENTS**

A. Floor Tile: Provide tile for flooring applications with minimum wet Dynamic Coefficient of Friction (DCOF) of 0.42 when tested in accordance with ANSI A326.3.

**2.03 TILE**

A. Porcelain Tile: ANSI A137.1 standard grade.
   1. Moisture Absorption: 0 to 0.5 percent as tested in accordance with ASTM C373.
   2. Size: Varies see finish plan schedule.
   3. Thickness: Varies see finish plan sschedule.

4. Edges: Square.
5. Color: As indicated on drawings.
6. Trim Units: Matching bullnose, cove base, and cove shapes in sizes coordinated with field tile.
7. Products:
   a. Trinity Tile: www.Trinity Tile.com.

**2.04 TRIM AND ACCESSORIES**

A. Ceramic Accessories: Glazed finish, same color and finish as adjacent field tile; same manufacturer as tile.

B. Pre-Formed Accessories To Be Covered with Tile: High density expanded polystyrene with ANSI A118.10 waterproofing finish or membrane.
   1. Products:
      a. Schluter-Systems; KERDI: www.schluter.com/#sle.

C. Ceramic Trim: Matching bullnose, double bullnose, cove base, and cove ceramic shapes in sizes coordinated with field tile.
   1. Manufacturers: Same as for tile.

D. Non-Ceramic Trim: Brushed stainless steel, style and dimensions to suit application, set with tile mortar or adhesive.
   1. Applications:
      a. Inside and outside wall corners.
      b. Floor-to-wall joints.
   2. Products:
      a. Schluter-Systems; Rondec: www.schluter.com/#sle.
      b. SChluter-Systems; Dilex:www.schluter.com.

**2.05 SETTING MATERIALS**

A. Provide setting and grout materials from same manufacturer.

B. Latex-Portland Cement Mortar Bond Coat: ANSI A118.4.
   1. Applications: Use where large and heavy tile mortar is indicated on drawings.
   2. Products:
      a. ARDEX Engineered Cements; ARDEX X 5: www.ardexamericas.com/#sle.
      b. Custom Building Products; ProLite Premium Rapid Setting Large Format Tile Mortar, with Multi-Surface Bonding Primer: www.custombuildingproducts.com/#sle.
      c. LATICRETE International, Inc; TRI-LITE: www.laticrete.com/#sle.
      d. Mapei Corporation; Adesilex P10 Mosaic & Glass Tile: www.mapei.com/#sle.

**2.06 GROUTS**

A. High Performance Polymer Modified Grout: ANSI A118.7 polymer modified cement grout.
   1. Applications: Use where indicated on drawings and where no other type of grout is indicated.
   2. Use sanded grout for joints 1/8 inch (3.2 mm) wide and larger; use unsanded grout for joints less than 1/8 inch (3.2 mm) wide.
   3. Color: As selected by Architect from manufacturer's full line.
   4. Products:
      a. ARDEX Engineered Cements; ARDEX FL: www.ardexamericas.com/#sle.
      b. Custom Building Products; Prism Color Consistent Grout: www.custombuildingproducts.com/#sle.
      c. LATICRETE International, Inc; LATICRETE PERMACOLOR Grout: www.laticrete.com/#sle.
      d. Mapei Corporation; Ultracolor Plus FA: www.mapei.com/#sle.

### 2.07 MAINTENANCE MATERIALS

A. Tile Sealant: Gunnable, silicone, siliconized acrylic, modified silane polymer, or urethane sealant; moisture- and mildew-resistant type.
   1. Applications: Between tile and plumbing fixtures.
   2. Color: As selected by Architect from manufacturer's full line.
   3. Products:
      a. ARDEX Engineered Cements; ARDEX SX: www.ardexamericas.com/#sle.
      b. Custom Building Products; Commercial 100% Silicone Caulk: www.custombuildingproducts.com/#sle.
      c. LATICRETE International, Inc; LATICRETE LATASIL: www.laticrete.com/#sle.
      d. Mapei Corporation; Mapesil T Plus: www.mapei.com/#sle.

B. Grout Sealer: Liquid-applied, moisture and stain protection for existing or new Portland cement grout.
   1. Composition: Water-based colorless silicone.
   2. Products:
      a. STONETECH, a Division of LATICRETE International, Inc; STONETECH Heavy Duty Grout Sealer: www.laticrete.com/#sle.
      b. Merkrete, by Parex USA, Inc; Merkrete Revive: www.merkrete.com/#sle.

### 2.08 ACCESSORY MATERIALS

A. Concrete Floor Slab Crack Isolation Membrane: Material complying with ANSI A118.12; not intended as waterproofing.
   1. Crack Resistance: No failure at 1/8 inch (3.2 mm) gap, minimum.

B. Backer Board: Coated glass mat type complying with ASTM C1178/C1178M; inorganic fiberglass mat on both surfaces and integral acrylic coating vapor retarder.

C. Backer Board: High-density polystyrene with waterproof membrane and facer on both sides and compatible alkaline-resistant joint tape.
   1. Thickness: 1/2 inch (12.7 mm).
   2. Products:
      a. Schluter-Systems - Kerdi Board.

D. Mesh Tape: 2 inch (50 mm) wide self-adhesive fiberglass mesh tape.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Verify subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive tile.

B. Verify wall surfaces are smooth and flat within tolerances specified for that type of work, are dust-free, and are ready to receive tile.

C. Cementitious Subfloor Surfaces: Verify that substrates are ready for tiling installation by testing for moisture and alkalinity (pH).
   1. Obtain instructions if test results are not within limits recommended by tiling material manufacturer and setting material manufacturer.

D. Verify that required floor-mounted utilities are in correct location.

### 3.02 PREPARATION

A. Vacuum clean surfaces and damp clean.

B. Seal substrate surface cracks with filler.

C. Install cementitious backer board in accordance with ANSI A108.11 and board manufacturer's instructions. Tape joints and corners, cover with skim coat of setting material to feather edge.

### 3.03 INSTALLATION - GENERAL

A. Install tile and grout in accordance with applicable requirements of ANSI A108/A118/A136, manufacturer's instructions, and TCNA (HB) or TCNA (HB-GP) recommendations, as applicable.

B. Lay tile to pattern indicated on drawings. Do not interrupt tile pattern through openings.

C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.

D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make grout joints without voids, cracks, excess mortar or excess grout, or too little grout.

E. Form internal angles square and external angles bullnosed.

F. Install ceramic accessories rigidly in prepared openings.

G. Install non-ceramic trim in accordance with manufacturer's instructions.

H. Sound tile after setting. Replace hollow sounding units.

I. Keep control and expansion joints free of mortar, grout, and adhesive.

J. Prior to grouting, allow installation to completely cure; minimum of 48 hours.

K. Grout tile joints unless otherwise indicated on drawings. Use standard grout unless otherwise indicated on drawings.

L. At changes in plane and tile-to-tile control joints, use tile sealant instead of grout, with either bond breaker tape or backer rod as appropriate to prevent three-sided bonding.

### 3.04 INSTALLATION - FLOORS - THIN-SET METHODS

A. Over interior concrete substrates, install in accordance with TCNA (HB) Method F113, dry-set or latex-Portland cement bond coat, on ground, with standard grout, unless otherwise indicated on drawings.

1. Where crack isolation membrane is indicated on drawings, install in accordance with TCNA (HB) Method F125-Partial, with latex-Portland cement grout.

### 3.05 INSTALLATION - SHOWERS AND BATHTUB WALLS

A. At tiled showers and bathtubs, install in accordance with TCNA (HB) Method B420, mortar bed floor, and W245, thin-set over coated glass mat backer board walls.

B. Grout with standard grout.

### 3.06 INSTALLATION - WALL TILE

A. Over coated glass mat backer board on studs, install in accordance with TCNA (HB) Method W245.

B. Over gypsum wallboard on wood or metal studs, install in accordance with TCNA (HB) Method W243, thin-set with dry-set or latex-Portland cement bond coat.

C. Over interior concrete and masonry, install in accordance with TCNA (HB) Method W202I, thin-set with dry-set or latex-Portland cement bond coat.

### 3.07 CLEANING

A. Clean tile and grout surfaces.

### 3.08 PROTECTION

A. Do not permit traffic over finished floor surface for 4 days after installation.

**END OF SECTION**

# SECTION 095100
# ACOUSTICAL CEILINGS - ARMSTRONG

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Acoustical units.

B. Suspension systems.

### 1.02 REFERENCE STANDARDS

A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

B. ASTM C635/C635M - Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings; 2022.

C. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels; 2019 (Reapproved 2025).

D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

E. ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions; 2024a.

F. ASTM E1264 - Standard Classification for Acoustical Ceiling Products; 2023.

### 1.03 ADMINISTRATIVE REQUIREMENTS

A. Sequencing: Install acoustical ceilings after building is enclosed, sufficient heat is provided, dust-generating activities are terminated, and overhead work is completed, tested, and approved. Install acoustical units after interior wet work is dry.

### 1.04 SUBMITTALS

A. Product Data: Provide data on suspension system components and acoustical units.

B. Samples:
   1. Submit two samples 3 by 3 inch (76 by 76 mm) in size illustrating material and finish of acoustical units.

C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements for additional provisions.
   2. Extra Acoustical Units: Quantity equal to 5 percent of total installed.

### 1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

### 1.06 FIELD CONDITIONS

A. Maintain uniform temperature of minimum 60 degrees F (16 degrees C), and maximum humidity of 40 percent before, during, and after acoustical unit installation.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Armstrong World Industries, Inc: www.armstrongceilings.com/#sle.

### 2.02 PERFORMANCE REQUIREMENTS

A. Surface Burning Characteristics: Class A, when tested in accordance with ASTM E84.

### 2.03 ACOUSTICAL UNITS

A. Acoustical Panels, Type Square Lay-in: With the following characteristics:
   1. Classification: ASTM E1264, Type A.
      a. Form: A1.2, wet formed.

b. Pattern: E - lightly textured.
2. Size: 24 by 24 inches (610 by 610 mm).
3. Thickness: 5/8 inch (16 mm).
4. Light Reflectance: 0.81 percent, in accordance with ASTM E1264.
5. Noise Reduction Coefficient (NRC) Range: 0.50 to _____, in accordance with ASTM E1264.
6. Ceiling Attenuation Class (CAC): 30, in accordance with ASTM E1264.
7. Panel Edge: Square.
8. Color: White.
9. Suspension System, Type Prelude 15/16": Exposed grid.
10. Products:
    a. Armstrong World Industries, Inc; Dune.

**2.04 SUSPENSION SYSTEMS**

A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold-down clips, stabilizer bars, clips, and splices as required.
   1. Materials:
      a. Galvanized Steel Sheet: ASTM A653/A653M, G30 (Z90) coating.

B. Exposed Suspension System, Type _____: Hot-dip galvanized steel grid with steel cap.
   1. Structural Classification: Intermediate-duty, when tested in accordance with ASTM C635/C635M.
   2. Profile: Tee; 15/16-inch (24 mm) face width.
   3. Finish: Baked enamel.
   4. Color: White.
   5. Products:
      a. Armstrong World Industries, Inc; Prelude XL.

**2.05 ACCESSORIES**

A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.

B. Hanger Wire: 12 gauge, 0.08 inch (2 mm) galvanized steel wire.

C. Perimeter Moldings: Same metal and finish as grid.
   1. Size: As required for installation conditions.
   2. Angle Molding: L-shaped, for mounting at same elevation as face of grid.

D. Touch-Up Paint: Type and color to match acoustical and grid units.

**PART 3 EXECUTION**

**3.01 EXAMINATION**

A. Verify existing conditions before starting work.

B. Verify that layout of hangers does not interfere with other work.

**3.02 PREPARATION**

A. Install after major above-ceiling work is complete.

B. Coordinate location of hangers with other work.

**3.03 INSTALLATION - SUSPENSION SYSTEMS**

A. Install suspension system in accordance with ASTM C636/C636M, ASTM E580/E580M, and manufacturer's instructions, as supplemented in this section.

B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.

C. Locate system on room axis according to reflected ceiling plan.

D. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
   1. Use longest practical lengths.

E. Suspension System, Non-Seismic: Hang suspension system independent of walls, columns, ducts, pipes, and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

F. Where ducts or other equipment prevent regular spacing of hangers, reinforce nearest affected hangers and related carrying channels to span extra distance.

G. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.

H. Support fixture loads using supplementary hangers located within 6 inches (152 mm) of each corner, or support components independently.

I. Do not eccentrically load system or induce rotation of runners.

**3.04 INSTALLATION - ACOUSTICAL UNITS**

A. Install acoustical units in accordance with manufacturer's instructions.

B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.

C. Fit border trim neatly against abutting surfaces.

D. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.

E. Cutting Acoustical Units:
   1. Make field cut edges of same profile as factory edges.

**3.05 TOLERANCES**

A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet (3 mm in 3 m).

B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

**3.06 REPAIR**

A. Replace damaged or abraded components.

**3.07 CLEANING**

A. Clean surfaces.

**END OF SECTION**

# SECTION 096500
# RESILIENT FLOORING

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Resilient tile flooring.

B. Resilient base.

C. Installation accessories.

### 1.02 RELATED REQUIREMENTS

A. Section 090561 - Common Work Results for Flooring Preparation: Removal of existing floor coverings, cleaning, and preparation.

B. Section 090561 - Common Work Results for Flooring Preparation: Concrete slab moisture and alkalinity testing and remediation procedures.

### 1.03 REFERENCE STANDARDS

A. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; 2025a.

B. ASTM F1066 - Standard Specification for Vinyl Composition Floor Tile; 2025.

C. ASTM F1700 - Standard Specification for Solid Vinyl Floor in Modular Format such as Tile(s) or Plank(s); 2025.

D. ASTM F1861 - Standard Specification for Resilient Wall Base; 2021 (Reapproved 2025).

E. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; 2023.

### 1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.

C. Selection Samples: Submit manufacturer's complete set of color samples for Architect's initial selection.

D. Concrete Subfloor Test Report: Submit a copy of the moisture and alkalinity (pH) test reports.

E. Manufacturer's Qualification Statement.

F. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements, for additional provisions.
   2. Extra Flooring Material: 100 square feet (30 square meters) of each type and color.
   3. Extra Wall Base: 50 linear feet (15 linear meters) of each type and color.

### 1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing specified flooring with minimum three years documented experience.

B. Installer Qualifications: Company specializing in installing specified flooring with minimum three years documented experience.

### 1.06 DELIVERY, STORAGE, AND HANDLING

A. Upon receipt, immediately remove any shrink-wrap and check materials for damage and the correct style, color, quantity and run numbers.

B. Store all materials off of the floor in an acclimatized, weather-tight space.

C. Maintain temperature in storage area between 55 degrees F (13 degrees C) and 90 degrees F (72 degrees C).

D. Protect roll materials from damage by storing on end.

E. Do not double stack pallets.

### 1.07 FIELD CONDITIONS

A. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F (21 degrees C) to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F (13 degrees C).

## PART 2 PRODUCTS

### 2.01 TILE FLOORING

A. Vinyl Tile: Printed film type, with transparent or translucent wear layer; acoustic interlayer or backing.
   1. Manufacturers:
      a. Mannington Commercial; Luxury Vinyl Plank: www.manningtoncommercial.com#sle.
   2. Minimum Requirements: Comply with ASTM F1700, Class III.
   3. Plank Tile Size: 7 by 48 inch (178 by 1219 mm).
   4. Wear Layer Thickness: 0.020 inch (0.50 mm).
   5. Total Thickness: 0.10 inch (2.5 mm).
   6. Tile Edge: Micro Bevel.
   7. Color: As indicated on drawings.

### 2.02 RESILIENT BASE

A. Resilient Base - Type ____: ASTM F1861, Type TS, rubber, vulcanized thermoset; style as scheduled.
   1. Manufacturers:
      a. Roppe Corporation; Contours Profiled Wall Base System: www.roppe.com/#sle.
   2. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
   3. Height: 4 inches (100 mm).
   4. Thickness: 0.125 inch (3.2 mm).
   5. Finish: Satin.
   6. Length: Roll.
   7. Color: As indicated on drawings.

### 2.03 ACCESSORIES

A. Primers, Adhesives, and Seam Sealer: Waterproof; types recommended by flooring manufacturer.

B. Adhesive for Vinyl Flooring:
   1. Manufacturers:
      a. As recommended by base manufacturer.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.

B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.

C. Cementitious Subfloor Surfaces: Verify that substrates are ready for resilient flooring installation by testing for moisture and alkalinity (pH).

1. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.

D. Verify that required floor-mounted utilities are in correct location.

**3.02 PREPARATION**

A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.

B. Clean substrate.

**3.03 INSTALLATION - GENERAL**

A. Starting installation constitutes acceptance of subfloor conditions.

B. Install in accordance with manufacturer's written instructions.

**3.04 INSTALLATION - TILE FLOORING**

A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless otherwise indicated in manufacturer's installation instructions.

**3.05 INSTALLATION - RESILIENT BASE**

A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches (45 mm) between joints.

B. Install base on solid backing. Bond tightly to wall and floor surfaces.

**3.06 CLEANING**

A. Remove excess adhesive from floor, base, and wall surfaces without damage.

B. Clean in accordance with manufacturer's written instructions.

**3.07 PROTECTION**

A. Prohibit traffic on resilient flooring for 48 hours after installation.

**END OF SECTION**

# SECTION 096566
# RESILIENT ATHLETIC FLOORING

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Rubber tile, adhesively installed.

### 1.02 RELATED REQUIREMENTS

A. Section 090561 - Common Work Results for Flooring Preparation: Concrete slab moisture and alkalinity testing and remediation procedures.

### 1.03 REFERENCE STANDARDS

A. ASTM D2240 - Standard Test Method for Rubber Property--Durometer Hardness; 2015 (Reapproved 2021).

B. ASTM F2772 - Standard Specification for Athletic Performance Properties of Indoor Sports Floor Systems; 2024.

### 1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Manufacturer's printed data sheets for products specified.

C. Shop Drawings: Fabrication and installation details, and layout, colors, and widths of game lines and equipment locations.

D. Verification Samples: Actual flooring material specified, not less than 12 inch (305 mm) square, mounted on solid backing.

E. Test Reports: Submit test reports showing compliance with ASTM F2772.

F. Concrete Subfloor Test Report: Submit a copy of the moisture and alkalinity (pH) test reports.

G. Manufacturer's Instructions: Indicate standard and special installation procedures.

H. Manufacturer's qualification statement.

I. Installer's qualification statement.

J. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements, for additional provisions.
   2. Extra Flooring Material: 10 square yards (9 sq m) matching installed flooring.

### 1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

### 1.06 DELIVERY, STORAGE, AND HANDLING

A. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.

B. Deliver materials to project site in unopened containers clearly labeled with manufacturer's name and identification of contents.

C. Store materials in dry and clean location until needed for installation. During installation, handle in a manner that will prevent marring and soiling of finished surfaces.

### 1.07 FIELD CONDITIONS

A. Maintain temperature in spaces to receive adhesively installed resilient flooring within range of 70 to 95 degrees F (21 to 35 degrees C) for not less than 48 hours before the beginning of installation and for not less than 48 hours after installation has been completed. Subsequently,

do not allow temperature in installed spaces to drop below 50 degrees F (10 degrees C) or to go above 100 degrees F (38 degrees C).

## PART 2 PRODUCTS

### 2.01 PREFORMED ATHLETIC FLOORING

A. Rubber Tile Flooring: Recycled vulcanized rubber and colored granules.
   1. Thickness: Minimum 3/8 inch (10 mm).
   2. Tile Edge/Installation: Interlocking squares adhered to a base layer of recycled polyurethane rubber roll..
   3. Size, Interlocking Edge Tile: Nominal 22.2 inches by 22.2 inches (564 mm by 564 mm).
   4. Durometer Hardness, Type A: Minimum of 70, when tested in accordance with ASTM D2240.
   5. Surface Texture: Smooth.
   6. Color: Grey 120.
   7. Products:
      a. Basis of Design: Sportfloor - Stamina.
      b. Substitutions: See Section 016000 - Product Requirements.

### 2.02 ACCESSORIES

A. Leveling Compound: Latex-modified cement formulation as recommended by flooring manufacturer for substrate conditions.

B. Flooring Adhesive: Waterproof; types recommended by flooring manufacturer.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Examine substrates for conditions detrimental to installation of athletic flooring. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of athletic flooring to substrate.

C. Cementitious Subfloor Surfaces: Verify that substrates are ready for resilient flooring installation by testing for moisture and alkalinity (pH).
   1. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.

### 3.02 PREPARATION

A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.

B. Concrete: Use leveling compound as necessary to achieve substrate flatness of plus or minus 1/8 inch within 10 ft radius (1/1000).

C. Remove coatings that are incompatible with flooring adhesives, using methods recommended by flooring manufacturer.

D. Broom clean areas to receive athletic flooring immediately before beginning installation.

### 3.03 INSTALLATION

A. Starting installation constitutes acceptance of subfloor conditions.

B. Install in accordance with manufacturer's written instructions.

C. Rubber Tile Flooring:
   1. Lay out center lines in spaces to receive tile flooring, based on location of principal walls. Start tile installation from center, and adjust as necessary to avoid tiles less than one-half width at perimeter.
   2. Lay tiles square with room axis, matching for color and pattern by selecting from cartons and mixing as recommended by manufacturer.

3. Spread only enough adhesive to permit installation of materials before initial set.
4. Fit joints and butt seams tightly; press with heavy roller to attain full adhesion.

**3.04 CLEANING**

A. Clean flooring using methods recommended by manufacturer.

**3.05 PROTECTION**

A. Protect finished athletic flooring from construction traffic to ensure that it is without damage upon Date of Substantial Completion.

**END OF SECTION**

# SECTION 099000
# INTERIOR, EXTERIOR PAINTS AND COATINGS

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Interior paint and coating commercial systems including surface preparation.

B. Exterior paint and coating systems including surface preparation.

### 1.02 REFERENCE STANDARDS

A. ASTM D3359 - Standard Test Methods for Rating Adhesion by Tape Test; 2023.

B. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).

C. SSPC-SP 2 - Hand Tool Cleaning; 2024.

D. SSPC-SP 3 - Power Tool Cleaning; 2024.

E. SSPC-SP 5/NACE No.1 - White Metal Blast Cleaning; 2026.

F. SSPC-SP 6/NACE No.3 - Commercial Blast Cleaning; 2006.

G. SSPC-SP 7/NACE No.4 - Brush-Off Blast Cleaning; 2007.

H. SSPC-SP 10/NACE No.2 - Near-White Metal Blast Cleaning; 2024.

I. SSPC-SP 11 - Power-Tool Cleaning to Bare Metal; 2020.

J. SSPC-SP 13/NACE No.6 - Surface Preparation of Concrete; 2018.

K. SSPC-SP 16 - Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals; 2020.

L. test - sddds; sdds.

### 1.03 RELATED SECTIONS

A. Section 03 30 00 - Cast-in-Place Concrete.

B. Section 04 20 00 - Unit Masonry: Concrete Masonry Units (CMU) and brick.

C. Section 05 12 16 - Fabricated Fireproofed Steel Columns.

D. Section 05 50 00 - Metal Fabrications.

E. Section 06 20 00 - Finish Carpentry.

F. Section 06 40 00 - Architectural Woodwork.

G. Section 08 11 13.16 - Custom Hollow Metal Doors and Frames.

H. Section 09 21 16.23 - Gypsum Board Shaft Wall Assemblies.

I. Section 23 05 00 - Common Work Results for HVAC.

J. Section 26 05 00 - Common Work Results for Electrical.

### 1.04 REFERENCES

A. Steel Structures Painting Council (SSPC):
   1. SSPC-SP 1 - Solvent Cleaning.
   2. SSPC-SP 2 - Hand Tool Cleaning.
   3. SSPC-SP 3 - Power Tool Cleaning.
   4. SSPC-SP 5/NACE No.1, White Metal Blast Cleaning.
   5. SSPC-SP 6/NACE No.3, Commercial Blast Cleaning.
   6. SSPC-SP 7/NACE No.4, Brush-Off Blast Cleaning.
   7. SSPC-SP 10/NACE No.2, Near-White Blast Cleaning.
   8. SSPC-SP 11, Power Tool Cleaning to Bare Metal.
   9. SSPC-SP12/NACE No. 5, Surface Preparation and Cleaning of Metals by Waterjetting Prior to Recoating.
   10. SSPC-SP 13/NACE No.6 Surface Preparation for Concrete.

B. Material Safety Data Sheets / Environmental Data Sheets: Per manufacturer's MSDS/EDS for specific VOCs (calculated per 40 CFR 59.406). VOCs may vary by base and sheen.

**1.05 SUBMITTALS**

A. Submit under provisions of Section 01 30 00 - Administrative Requirements.

B. Product Data: For each paint system indicated, including.
   1. Product characteristics.
   2. Surface preparation instructions and recommendations.
   3. Primer requirements and finish specification.
   4. Storage and handling requirements and recommendations.
   5. Application methods.
   6. Cautions for storage, handling and installation.

C. Selection Samples: Submit a complete set of color chips that represent the full range of manufacturer's products, colors, and sheens available.

D. Verification Samples: For each finished product specified, submit samples that represent the actual product, color, and sheen.

E. Coating Maintenance Manual: Upon conclusion of project, the Contractor or paint manufacturer/supplier shall furnish a coating maintenance manual, such as Sherwin-Williams, "Custodian Project Color and Product Information" report or equal. Manual shall include an Area Summary with finish schedule, Area Detail designating where each product/color/finish was used, product data pages, Material Safety Data Sheets, care and cleaning instructions, touch-up procedures, and color samples of each color and finish used.

F. Only submit complying products based on project requirements (i.e. LEED). One must also comply with the regulations regarding VOCs (CARB, OTC, SCAQMD, LADCO). To ensure compliance with district regulations and other rules, businesses that perform coating activities should contact the local district in each area where the coating will be used.

**1.06 QUALITY ASSURANCE**

A. Installer Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

B. Paint exposed surfaces. If a color of finish, or a surface is not specifically mentioned, Architect will select from standard products, colors, and sheens available.

C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels unless indicated.

D. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
   1. Finish surfaces for verification of products, colors, and sheens.
   2. Finish area designated by Architect.
   3. Provide samples that designate primer and finish coats.
   4. Compatibility and Adhesion: Check after one week of drying and curing by testing in accordance with ASTM D3359; Adhesion by tape test. If the coating system is incompatible, additional surface preparation up to and including complete removal may be required.
   5. Do not proceed with remaining work until the Architect approves the mock-up.

**1.07 DELIVERY, STORAGE, AND HANDLING**

A. Delivery: Deliver manufacturer's unopened containers to the work site. Packaging shall bear the manufacturer's name, label, and the following list of information.
   1. Product name, and type (description).
   2. Application and use instructions.
   3. Surface preparation.
   4. VOC content.

5. Environmental handling.
6. Batch date.
7. Color number.

B. Storage: Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

C. Store materials in an area that is within the acceptable temperature range, per manufacturer's instructions. Protect from freezing.

D. Handling: Maintain a clean, dry storage area, to prevent contamination or damage to the coatings.

### 1.08 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

### 1.09 EXTRA MATERIALS

A. Furnish extra paint materials from the same production run as the materials applied and, in the quantities, described below. Package with protective covering for storage and identify with labels describing contents. Deliver extra materials to Owner.

B. Furnish Owner with an additional one percent of each material and color, but not less than 1 gal (3.8 l) or 1 case, as appropriate.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Acceptable Manufacturer: Sherwin-Williams, which is located at: 101 Prospect Ave.; Cleveland, OH 44115; ASD Toll Free Tel: 800-524-5979; Tel: 216-566-2000; Fax: 440-826-1989; Email: Brian Quick brian.w.quick@sherwin.com; Web:www.swspecs.com.

B. Requests for substitutions will be considered in accordance with the provisions of Section 01 60 00 - Product Requirements.

### 2.02 APPLICATIONS/SCOPE

A. Interior Paint and Coating Commercial Systems:
1. Concrete: Non-vehicular floors.
2. Masonry: Concrete masonry units, including split-face, scored, and smooth block.
3. Metal: Aluminum, galvanized steel.
4. Metal: Structural steel, joists, trusses, beams, partitions, and similar items.
5. Drywall: Drywall board, Gypsum board.

B. Exterior Paint and Coating Systems:
1. Metal: Miscellaneous iron, ornamental iron, ferrous metal.

### 2.03 PAINT MATERLALS - GENERAL

A. Paints and Coatings:
1. Unless otherwise indicated, provide factory-mixed coatings. When required, mix coatings to correct consistency in accordance with manufacturer's instructions before application. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.
2. For opaque finishes, tint each coat including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color. Or follow manufactures product instructions for optimal color conformance.

B. Primers: Where the manufacturer offers options on primers for a particular substrate, use a primer categorized as "best" by the manufacturer.

C. Coating Application Accessories: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials required, per manufacturer's specifications.

D. Color: Refer to Finish Schedule for paint colors, and as selected.

**2.04 INTERIOR PAINT AND COATING COMMERCIAL SYSTEMS**

A. Masonry CMU: Concrete, Split Face, Scored, Smooth, High Density, Low Density, and Fluted.
   1. Latex Systems:
      a. Eg-Shel / Satin Finish:
         1) 1st Coat: S-W Pro Industrial Heavy Duty Block Filler, B42W150 (75-100 sq ft/gal).
         2) 2nd Coat: S-W ProMar 200 Zero VOC Latex Eg-Shel, B20-2600 Series.
         3) 3rd Coat: S-W ProMar 200 Zero VOC Latex Eg-Shel, B20-2600 Series (4 mils. wet, 1.7 mils. dry per coat).
      b. Eg-Shel / Satin Finish: High Performance (HP) Upgrade.
         1) 1st Coat: S-W Pro Industrial Heavy Duty Block Filler, B42W150 (75-100 sq ft/gal).
         2) 2nd Coat: S-W ProMar 200 HP Zero VOC Latex Eg-Shel, B20-1950 Series.
         3) 3rd Coat: S-W ProMar 200 HP Zero VOC Latex Eg-Shel, B20-1950 Series (4 mils. wet, 1.7 mils. dry per coat).
   2. Epoxy Systems; Waterbased:
      a. Eg-Shel/Low Luster Finish:
         1) 1st Coat: S-W Pro Industrial Heavy Duty Block Filler, B42W150 (75-100 sq ft/gal).
         2) 2nd Coat: S-W Pro Industrial Pre-Catalyzed Waterbased Epoxy, K45- Series.
         3) 3rd Coat: S-W Pro Industrial Pre-Catalyzed Waterbased Epoxy, K45- Series (4.0 mils. wet, 1.5 mils. dry per coat).

B. Metal: Aluminum and Galvanized.
   1. Alkyd Systems; Waterbased:
      a. Semi-Gloss Finish:
         1) 1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-1310 Series (5.0 mils. wet, 2.0 mils. dry per coat).
         2) 2nd Coat: S-W Pro Industrial Waterbased Alkyd Urethane Enamel Semi-Gloss, B53-1150 Series.
         3) 3rd Coat: S-W Pro Industrial Waterbased Alkyd Urethane Enamel Semi-Gloss, B53-1150 Series (4.0-5.0 mils. wet, 1.4 - 1.7 mils. dry per coat).

C. Metal; Galvanized: Ceilings and Duct work.
   1. Dryfall Waterborne Topcoats:
      a. Flat Finish:
         1) 1st Coat: S-W Pro Industrial Waterborne Acrylic Dryfall, B42-181 Series.

D. Metal: Structural Steel Columns, Joists, Trusses, Beams, Miscellaneous and Ornamental Iron, Structural Iron, and Ferrous Metal.
   1. Alkyd Systems; Waterbased:
      a. Semi-Gloss Finish:
         1) 1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-1310 Series (5.0 mils. wet, 2.0 mils. dry per coat).
         2) 2nd Coat: S-W Pro Industrial Waterbased Alkyd Urethane Enamel Semi-Gloss, B53-1150 Series.
         3) 3rd Coat: S-W Pro Industrial Waterbased Alkyd Urethane Enamel Semi-Gloss, B53-1150 Series (4.0-5.0 mils. wet, 1.4 - 1.7 mils. dry per coat).

E. Drywall: Walls, Ceilings, Gypsum Board, and similar items.
   1. Latex Systems:
      a. Eg-Shel / Satin Finish:
         1) 1st Coat: S-W ProMar 200 Zero VOC Interior Latex Primer, B28W2600 (4 mils. wet, 1.5 mils. dry per coat).
         2) 2nd Coat: S-W ProMar 200 Zero VOC Latex Eg-Shel, B20-2600 Series.

3) 3rd Coat: S-W ProMar 200 Zero VOC Latex Eg-Shel, B20-2600 Series (4 mils. wet, 1.7 mils. dry per coat).

b. Eg-Shel / Satin Finish: High Performance (HP) Upgrade.
1) 1st Coat: S-W ProMar 200 Zero VOC Interior Latex Primer, B28W2600 (4 mils. wet, 1.5 mils. dry per coat).
2) 2nd Coat: S-W ProMar 200 HP Zero VOC Latex Eg-Shel, B20-1950 Series.
3) 3rd Coat: S-W ProMar 200 HP Zero VOC Latex Eg-Shel, B20-1950 Series (4 mils. wet, 1.7 mils. dry per coat).

c. Eg-Shel Finish Scuff Resistant Waterbase Enamel:
1) 1st Coat: Sherwin-Williams ProMar 200 Zero VOC Interior Latex Primer, B28W2600 (4 mils. wet, 1.5 mils. dry per coat).
2) 2nd Coat: Sherwin-Williams Scuff Tuff Int. Waterbased Enamel, Eg-Shel, S24-150 Series.
3) 3rd Coat: Sherwin-Williams Scuff Tuff Int. Waterbased Enamel, Eg-Shel, S24-150 Series (4 mils. wet, 1.2 mils. dry per coat).

2. Epoxy Systems; Waterbased:
a. Eg-Shel/Low Luster Finish:
1) 1st Coat: S-W ProMar 200 Zero VOC Interior Latex Primer, B28W2600 (4 mils. wet, 1.5 mils. dry per coat).
2) 2nd Coat: S-W Pro Industrial Pre-Catalyzed Waterbased Epoxy, K45- Series.
3) 3rd Coat: S-W Pro Industrial Pre-Catalyzed Waterbased Epoxy, K45- Series (4 mils. wet, 1.5 mils. dry per coat).

b. Eg-Shel/Low Luster Finish:
1) 1st Coat: S-W ProMar 200 Zero VOC Interior Latex Primer, B28W2600 (4 mils. wet, 1.5 mils. dry per coat).
2) 2nd Coat: S-W Pro Industrial Waterbased Catalyzed Epoxy, B73-360 Series.
3) 3rd Coat: S-W Pro Industrial Waterbased Catalyzed Epoxy, B73-360 Series (5.0 mils. wet, 2.0 mils. dry per coat).

**2.05 EXTERIOR PAINT AND COATING SYSTEMS**

A. Metal: Miscellaneous. Hollow Metal Doors and Frames, Structural Iron and Steel, Ferrous Metal.
1. Alkyd Systems; Waterbased:
a. Semi-Gloss Finish:
1) 1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-1310 Series (5.0 mils. wet, 2.0 mils. dry per coat).
2) 2nd Coat: S-W Pro Industrial Waterbased Alkyd Urethane Enamel Semi-Gloss, B53-1150 Series.
3) 3rd Coat: S-W Pro Industrial Waterbased Alkyd Urethane Enamel Semi-Gloss, B53-1150 Series (4.0-5.0 mils. wet, 1.4 - 1.7 mils. dry per coat).

**PART 3 EXECUTION**

**3.01 EXAMINATION**

A. Do not begin installation until the substrates have been properly prepared; notify Architect of unsatisfactory conditions before proceeding. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

B. Proceed with work only after conditions have been corrected and approved by all parties, otherwise application of coatings will be considered as an acceptance of surface conditions.

C. Previously Painted Surfaces: Verify that existing painted surfaces do not contain lead based paints, notify Architect immediately if lead based paints are encountered.

**3.02 SURFACE PREPARATION**

A. General: Surfaces shall be dry and in sound condition. Remove oil, dust, dirt, loose rust, peeling paint, or other contamination to ensure good adhesion.

1. Prior to attempting to remove mildew, it is recommended to test any cleaner on a small, inconspicuous area prior to use. Bleach and bleaching type cleaners may damage or discolor existing paint films. Bleach alternative cleaning solutions are advised.
2. Remove mildew before painting by washing with a solution of 1 part liquid household bleach and 3 parts of warm water. Apply solution and scrub the mildewed area. Allow solution to remain on the surface for 10 minutes. Rinse thoroughly with clean water and allow the surface to dry before painting. Wear protective glasses or goggles, waterproof gloves, and protective clothing. Quickly wash off any of the mixture that comes in contact with your skin. Do not add detergents or ammonia to the bleach/water solution.
3. Remove items including but not limited to thermostats, electrical outlets, switch covers and similar items prior to painting. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.
4. No exterior painting should be done immediately after a rain, during foggy weather, when rain is predicted, or when the temperature is below 50 degrees F (10 degrees C), unless products are designed specifically for these conditions. On large expanses of metal siding, the air, surface, and material temperatures must be 50 degrees F (10 degrees F) or higher to use low temperature products.

B. Aluminum: Remove all oil, grease, dirt, oxide, and other foreign material by cleaning per SSPC-SP 1, Solvent Cleaning.

C. Block (Cinder and Concrete): Remove all loose mortar and foreign material. Surface must be free of laitance, concrete dust, dirt, form release agents, moisture curing membranes, loose cement, and hardeners. Concrete and mortar must be cured at least 30 days at 75 degrees F (24 degrees C). The pH of the surface should be between 6 and 9 unless the products are designed to be used in high pH environments. On tilt-up and poured-in-place concrete, commercial detergents and abrasive blasting may be necessary to prepare the surface. Fill bug holes, air pockets, and other voids with a cement patching compound.

D. Concrete, SSPC-SP13 or NACE 6: This standard gives requirements for surface preparation of concrete by mechanical, chemical, or thermal methods prior to the application of bonded protective coating or lining systems. The requirements of this standard are applicable to all types of cementitious surfaces including cast-in-place concrete floors and walls, precast slabs, masonry walls, and shotcrete surfaces. An acceptable prepared concrete surface should be free of contaminants, laitance, loosely adhering concrete, and dust, and should provide a sound, uniform substrate suitable for the application of protective coating or lining systems.

E. Cement Composition Siding/Panels: Remove all surface contamination by washing with an appropriate cleaner, rinse thoroughly and allow to dry. Existing peeled or checked paint should be scraped and sanded to a sound surface. Pressure clean, if needed, with a minimum of 2100 psi pressure to remove all dirt, dust, grease, oil, loose particles, laitance, foreign material, and peeling or defective coatings. Allow the surface to dry thoroughly. The pH of the surface should be between 6 and 9 unless the products are designed to be used in high pH environments.

F. Copper and Stainless Steel: Remove all oil, grease, dirt, oxide, and other foreign material by cleaning per SSPC-SP 2, Hand Tool Cleaning.

G. Exterior Composition Board (Hardboard): Some composition boards may exude a waxy material that must be removed with a solvent prior to coating. Whether factory primed or unprimed, exterior composition board siding (hardboard) must be cleaned thoroughly and primed with an alkyd primer.

H. Drywall - Exterior: Must be clean and dry. All nail heads must be set and spackled. Joints must be taped and covered with a joint compound. Spackled nail heads and tape joints must be sanded smooth, and all dust removed prior to painting. Exterior surfaces must be spackled with exterior grade compounds.

I. Drywall - Interior: Must be clean and dry. All nail heads must be set and spackled. Joints must be taped and covered with a joint compound. Spackled nail heads and tape joints must be sanded smooth, and all dust removed prior to painting.

J. Galvanized Metal: Clean per SSPC-SP 1 using detergent and water or a degreasing cleaner to remove greases and oils. Apply to a test area, priming as required. Allow the coating to dry at least one week before testing. If adhesion is poor, Brush Blast per SSPC-SP 16 is necessary to remove these treatments.

K. Plaster: Must be allowed to dry thoroughly for at least 30 days before painting unless the products are designed to be used in high pH environments. Room must be ventilated while drying; in cold, damp weather, rooms must be heated. Damaged areas must be repaired with appropriate patching material. Bare plaster must be cured and hard. Textured, soft, porous, or powdery plaster should be treated with a solution of 1 pint household vinegar to 1 gallon of water. Repeat until the surface is hard, rinse with clear water and allow to dry.

L. Steel: Structural, Plate, And Similar Items: Should be cleaned by one or more of the surface preparations described below. These methods are used throughout the world for describing methods for cleaning structural steel. Visual standards are available through the Society of Protective Coatings. A brief description of these standards together with numbers by which they can be specified follow.
   1. Solvent Cleaning, SSPC-SP 1: Solvent cleaning is a method for removing all visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants. Solvent cleaning does not remove rust or mill scale. Change rags and cleaning solution frequently so that deposits of oil and grease are not spread over additional areas in the cleaning process. Be sure to allow adequate ventilation.
   2. Hand Tool Cleaning, SSPC-SP 2: Hand Tool Cleaning removes all loose mill scale, loose rust, and other detrimental foreign matter. It is not intended that adherent mill scale, rust, and paint be removed by this process. Beforehand tool cleaning, remove visible oil, grease, soluble welding residues, and salts by the methods outlined in SSPC-SP 1.
   3. Power Tool Cleaning, SSPC-SP 3: Power Tool Cleaning removes all loose mill scale, loose rust, and other detrimental foreign matter. It is not intended that adherent mill scale, rust, and paint be removed by this process. Before power tool cleaning, remove visible oil, grease, soluble welding residues, and salts by the methods outlined in SSPC-SP 1.
   4. White Metal Blast Cleaning, SSPC-SP5 or NACE 1: A White Metal Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP 1 or other agreed upon methods.
   5. Commercial Blast Cleaning, SSPC-SP6 or NACE 3: A Commercial Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except for staining. Staining shall be limited to no more than 33 percent of each square inch of surface area and may consist of light shadows, slight streaks, or minor discoloration caused by stains of rust, stains of mill scale, or stains of previously applied paint. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP 1 or other agreed upon methods.
   6. Brush-Off Blast Cleaning, SSPC-SP7 or NACE 4: A Brush-Off Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, loose mill scale, loose rust, and loose paint. Tightly adherent mill scale, rust, and paint may remain on the surface. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP 1 or other agreed upon methods.
   7. Power Tool Cleaning to Bare Metal, SSPC-SP 11: Metallic surfaces that are prepared according to this specification, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxide corrosion products, and other foreign matter. Slight residues of rust and paint may be left in the lower portions of pits if the original surface is pitted. Prior to power tool surface preparation, remove visible deposits of oil or grease by any of the methods specified in SSPC-SP 1, Solvent Cleaning, or other agreed upon methods.
   8. Near-White Blast Cleaning, SSPC-SP10 or NACE 2: A Near White Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill

scale, rust, paint, oxides, corrosion products, and other foreign matter, except for staining. Staining shall be limited to no more than 5 percent of each square inch of surface area and may consist of light shadows, slight streaks, or minor discoloration caused by stains of rust, stains of mill scale, or stains of previously applied paint. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP 1 or other agreed upon methods.

9. High- and Ultra-High Pressure Water Jetting for Steel and Other Hard Materials: SSPC-SP12 or NACE 5: This standard provides requirements for the use of high- and ultra-high pressure water jetting to achieve various degrees of surface cleanliness. This standard is limited in scope to the use of water only without the addition of solid particles in the stream.
10. Water Blasting, SSPC-SP12/NACE No. 5: Removal of oil grease dirt, loose rust, loose mill scale, and loose paint by water at pressures of 2,000 to 2,500 psi at a flow of 4 to 14 gallons per minute.

M. Vinyl Siding, Architectural Plastics, EIFS and Fiberglass: Clean vinyl siding thoroughly by scrubbing with a warm, soapy water solution. Rinse thoroughly. Do not paint vinyl siding with any color darker than the original color unless the paint system features Sherwin-Williams VinylSafe technology. Painting with darker colors that are not Sherwin-Williams VinylSafe may cause siding to warp. Follow all painting guidelines of the vinyl manufacturer when painting. Only paint properly installed vinyl siding. Deviating from the manufacturer's painting guidelines may cause the warranty to be voided.

N. Stucco: Must be clean and free of any loose stucco. If recommended procedures for applying stucco are followed, and normal drying conditions prevail, the surface may be painted in 30 days. The pH of the surface should be between 6 and 9 unless the products are designed to be used in high pH environments such as Loxon.

O. Wood: Must be clean and dry. Prime and paint as soon as possible. Knots and pitch streaks must be scraped, sanded, and spot primed before a full priming coat is applied. Patch all nail holes and imperfections with a wood filler or putty and sand smooth.

**3.03 INSTALLATION**

A. Apply all coatings and materials with the manufacturer's specifications in mind. Mix and thin coatings according to manufacturer's recommendations.

B. Do not apply it to wet or damp surfaces. Wait at least 30 days before applying to new concrete or masonry. Or follow manufacturer's procedures to apply appropriate coatings prior to 30 days. Test new concrete for moisture content. Wait until wood is fully dry after rain or morning fog or dew.

C. Apply coatings using methods recommended by manufacturer.

D. Uniformly apply coatings without runs, drips, or sags, without brush marks, and with consistent sheen.

E. Apply coatings at spreading rate required to achieve the manufacturers recommended dry film thickness.

F. Regardless of the number of coats specified, apply as many coats as necessary for complete hide, and uniform appearance.

G. Inspection: The coated surface must be inspected and approved by the Architect just prior to the application of each coat.

**3.04 PROTECTION**

A. Protect finished coatings from damage until completion of project.

B. Touch-up damaged coatings after substantial completion, following manufacturer's recommendation for touch up or repair of damaged coatings. Repair any defects that will hinder the performance of the coatings.

**END OF SECTION**

# SECTION 099300
# STAINING AND TRANSPARENT FINISHING

## PART 1 GENERAL

### 1.01 REFERENCE STANDARDS

A. 8 - test; 1.

### 1.02 SUMMARY

A. Section Includes:
   1. Transparent finishes.

### 1.03 ACTION SUBMITTALS

A. Product Data:
   1. For each type of product.
   2. Include preparation requirements and application instructions.
   3. Indicate VOC content.

B. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

C. Samples for Verification: Sample for each type of finish system and in each color and gloss of finish required on representative samples of actual wood substrates.
   1. Size: 8 inches square.
   2. Apply coats on Samples in steps to show each coat required for system.
   3. Label each coat of each Sample.
   4. Label each Sample for location and application area.

D. Product List: Cross-reference to finish system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

### 1.04 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.
   1. Maintain containers in clean condition, free of foreign materials and residue.
   2. Remove rags and waste from storage areas daily.

### 1.05 FIELD CONDITIONS

A. Apply finishes only when temperature of surfaces to be finished and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply finishes when relative humidity exceeds 85 percent, at temperatures of less than 5 deg F above the dew point, or to damp or wet surfaces.

C. Do not apply exterior finishes in snow, rain, fog, or mist.

## PART 2 PRODUCTS

### 2.01 SOURCE LIMITATIONS

A. Source Limitations: Obtain each coating product from single source from single manufacturer.

### 2.02 STAINING AND TRANSPARENT FINISHING

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Benjamin Moore & Co.
   2. Lenmar Lacquers; Benjamin Moore & Co.
   3. PPG Paints; PPG Industries, Inc.
   4. Sherwin-Williams Company (The)
   5. MINWAX

B. Material Compatibility:

1. Provide materials for use within each coating 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.

C. Material Emissions and Pollutant Control: Not less than 85 percent of field-applied paints and coatings that are inside the weatherproofing system shall comply with the following:

D. Stain Colors: As selected by Architect from manufacturer's full range

**2.03 TRANSPARENT FINISHES**

A. Varnish, Interior, Water Based, Clear, Satin: Water-based clear satin coating for interior wood trim, frames, doors, paneling and cabinetry.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Benjamin Moore & Co.
      b. Lenmar Lacquers; Benjamin Moore & Co.
      c. PPG Paints; PPG Industries, Inc.
      d. Sherwin-Williams Company (The)
      e. MINWAX
   2. Gloss and Sheen Level: Manufacturer's standard low-sheen finish

**PART 3 EXECUTION**

**3.01 EXAMINATION**

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Exterior Wood Substrates: 15 percent, when measured with an electronic moisture meter.

C. Maximum Moisture Content of Interior Wood Substrates: 10 percent, when measured with an electronic moisture meter.

D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

E. Proceed with finish application only after unsatisfactory conditions have been corrected.
   1. Beginning finish application constitutes Contractor's acceptance of substrates and conditions.

**3.02 PREPARATION**

A. Remove hardware, covers, plates, and similar items already in place that are removable. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and finishing.
   1. After completing finishing operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

B. Clean and prepare surfaces to be finished according to manufacturer's written instructions for each substrate condition and as specified.
   1. Remove dust, dirt, oil, and grease by washing with a detergent solution; rinse thoroughly with clean water and allow to dry. Remove grade stamps and pencil marks by sanding lightly. Remove loose wood fibers by brushing.
   2. Remove mildew by scrubbing with a commercial wash formulated for mildew removal and as recommended by stain manufacturer.

C. Interior Wood Substrates:
   1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
   2. Apply wood filler paste to open-grain woods to produce smooth, glasslike finish.
   3. Sand surfaces exposed to view and dust off.

4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dry.

### 3.03 APPLICATION

A. Apply finishes according to manufacturer's written instructions.
   1. Use applicators and techniques suited for finish and substrate indicated.
   2. Finish surfaces behind movable equipment and furniture same as similar exposed surfaces.
   3. Do not apply finishes over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

B. Apply finishes to produce surface films without cloudiness, holidays, lap marks, brush marks, runs, ropiness, or other surface imperfections.

### 3.04 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing finish application, clean spattered surfaces. Remove spattered materials by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from finish application. Correct damage 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 finished wood surfaces.

**END OF SECTION**

**SECTION 099723**
**CONCRETE AND MASONRY COATINGS**

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section Includes: Surface preparation and application of concrete and masonry wall coatings.
   1. Interior substrates:
      a. Concrete Floors.

### 1.02 ACTION SUBMITTALS

A. Product Data:
   1. For each type of product.
   2. Include preparation requirements and application instructions.
   3. Indicate VOC content.

B. Samples for Initial Selection: For each type of topcoat product indicated.

C. Samples for Verification: Fore each type of coating system and each color of topcoat indicated.
   1. Submit samples on actual substrate material to be coated, 8 inches square.
   2. Apply coats on Samples in steps to show each coat required for system, including primers and block fillers as applicable.
   3. Label each coat of each Sample.
   4. Label each Sample for location and application area.

D. Product List: Use same designations indicated on Drawings and specified herein. Include color designations and product runs (batch numbers)

### 1.03 INFORMATIONAL SUBMITTALS

A. Qualification data: For manufacturer and applicator.

B. Material Certificates: For each cementitious coating, from manufacturer.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency or performed by a qualified testing agency, for each product formulation.

### 1.04 MAITENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same production run (batch number), that match products installed and that are packaged with the protective covering for storage and identified with labels describing contents.

### 1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Current certificate holder for compliance with Iso 9001.

B. Applicator Qualifications: An entity that employs applicators and supervisors who are competent in techniques required by manufacturer for application of concrete and masonry coatings.
   1. Engage an applicator who employs workers for this Project who are trained or certified by coating manufacturer for application techniques required.

### 1.06 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 35 deg F and not more than 110 degrees Fahrenheit (43.33 degrees Celsius), in accordance with manufacturer’s written instructions.
   1. Maintain containers in clean condition, free of foreign materials and residue.
   2. Remove rags and waste from storage areas daily.
   3. Protect materials from direct sunlight.

### 1.07 FIELD CONDITIONS

A. Apply finishes only when temperature of surfaces to be finished and ambient air temperatures are between 45 and 95 deg F.

B. Do not apply finishes when relative humidity exceeds 85 percent, at temperatures of less than 5 deg F above the dew point, or to damp or wet surfaces.

C. Do not apply exterior finishes in snow, rain, fog, or mist.

### 1.08 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair r replace traffic coating that falls in materials within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Adhesive or cohesive failures.
      b. Abrasion or tearing failures.
      c. Surface crazing or spalling.
      d. Intrusion of water, oils, gasoline, salt, deicer chemicals, or acids into deck substrate.
   2. Warranty period: One Year from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Basis-of-Design Interior Product: Subject to compliance with requirements, provide Euclide Super Diamond Clear; Basecoat and Topcoat System or comparable product by one of the following:
   1. Euclid Chemical.

### 2.02 CONCRETE AND MASONRY COATINGS

A. Material Compatibility:
   1. Use materials appropriate for use with coating system that are compatible with one another and with substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   2. Recommended coating system products in writing for each coat and topcoat manufacturer for use in coating system and on substrate indicated.

B. VOC Content: For field applications that are inside the weatherproofing system, parts and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:
   1. Flat paints and Coatings: 50 g/l
   2. Non flat Paints and Coatings: 150 g/l.
   3. Primers, Sealers, and Under coaters: 200 g/l.

C. Crack Fillers: Coating manufacturer's recommended, factory-formulated, alkali-resistant primer compatible with substrate and other materials indicated.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Verify suitability of substrates, including surface conditions and compatibility.

C. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   1. Concrete: 12 percent.

D. Proceed with coating application only after unsatisfactory conditions have been corrected.
   1. Application of coating indicates acceptance of surfaces and conditions.

### 3.02 PREPARATION

A. Comply with manufacturer's written instructions applicable to substrates and coating systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted.
   1. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
   2. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed.
   3. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk.
   1. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in coating manufacturer's written instructions.

E. Crack Repair: Fill cracks in accordance with coating manufacturer's written instructions before coating surfaces.
   1. Cracks Larger Than 1/32 inch (0.79 mm): Cut out static cracks, voids, or honeycombing larger than 1/32 inch and patch with materials recommended in writing by coating manufacturer. Identify dynamic cracks and treat in accordance with coating manufacturer's written instructions before beginning application.

### 3.03 APPLICATION

A. Apply coatings in accordance with manufacturer's written instructions.
   1. Use applicators and techniques suited for coating and substrate indicated. Apply additional coats until cured film has a uniform coating finish, color, and appearance. Allow each coat to dry completely between coats when applying multiple coats.
   2. Coat surfaces behind movable equipment and furniture same as for similar exposed surfaces.
   3. Coat backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
   4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

B. Tint each undercoat a lighter shade to facilitate identification of each coat of multiple coats of same material are to be applied. Tint undercoats similar to color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If under coats or other conditions show through topcoat, apply additional coats until cured film has a uniform finish, color, and appearance.

D. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

E. Apply coatings to prepared surfaces as soon as practicable after preparation and before subsequent surface soiling or deterioration.

F. Brush Application: Brush out and work brush coats onto surfaces in an even film, filling all pores and voids at rate recommended in writing by coating manufacturer to achieve cured material thickness indicated. Finish coat with smooth, horizontal strokes.

G. Spray Application: Spray apply coats onto surfaces in an even film, filling all pores and voids at rate recommended in writing by coating manufacturer to achieve cured material thickness indicated.

### 3.04 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.
   1. Contractor shall touch up and restore coated surfaces damaged by testing.
   2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written instructions, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written instructions.

### 3.05 CLEANING AND PROTECTION

A. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

B. Protect work of other trades against damage from coating operation until 48 hours after application. Correct damage to work of other trades by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an un-damaged condition.

C. At completion of construction activities of other trades, touch up and restore damaged or detached coated surfaces.

### 3.06 CONCRETE AND MASONRY COATING SCHEDULE

A. Concrete Coating System:
   1. Interior Coating System:
      a. Base Coat: as recommended in writing by topcoat manufacturer.
      b. Topcoat: Elastomeric, pigmented, eater-based coating.
         1) Euclid Super Diamond Clear.

**END OF SECTION**

# SECTION 101416
# PLAQUES

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Plaques.

### 1.02 REFERENCE STANDARDS

A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.

B. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.

C. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

### 1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Manufacturer's product literature for each type of plaque sign, indicating style, font, foreground and background colors, locations, and overall dimensions of each sign.

C. Shop Drawings: Indicate dimensions, locations, elevations, materials, text and graphic layout, and attachment details.

D. Samples: One sample of each type of plaque sign, of size similar to that required for project, indicating style, font, and method of attachment.

E. Selection Samples: Where materials, colors, and finishes are not specified, submit two sets of color selection charts or chips.

F. Manufacturer's qualification statement.

### 1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

### 1.05 DELIVERY, STORAGE, AND HANDLING

A. Package plaque signs as required to prevent damage before installation.

B. Store under cover and elevated above grade.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Plaques:
   1. A.R.K. Ramos: www.arkramos.com/#sle.
   2. FASTSIGNS International, Inc; _____: www.fastsigns.com/#sle.
   3. Takeform: www.takeform.net/#sle.

### 2.02 REGULATORY REQUIREMENTS

A. Accessibility Requirements: Comply with ADA Standards and ICC A117.1 and applicable building codes, unless otherwise indicated; in the event of conflicting requirements, comply with the most restrictive requirements.

### 2.03 PLAQUES

A. Acrylic Plaques:
   1. Material Thickness: 1/4 inch (6 mm), minimum.
   2. Size: 8 inches by 10 inches (200 mm by 254 mm).
   3. Text and Typeface:
      a. Character Font: Helvetica, Arial, or other sans serif font.
      b. Character Case: Upper and lower case (title case).
      c. Character Color: Contrast with background color.

4. Border Style: As indicated on drawings.
5. Background Texture: Smooth.
6. Background Color: White.
7. Mounting: Double Sided Tape.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Verify that substrate surfaces are ready to receive work.

B. Notify Architect if conditions are not suitable for installation of signs; do not proceed until conditions are satisfactory.

### 3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install with horizontal edges level.

C. Locate plaque signs and mount at heights indicated on drawings and in accordance with ADA Standards and ICC A117.1.

**END OF SECTION**

**SECTION 101419**
**DIMENSIONAL LETTER SIGNAGE**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Dimensional letter signage.

### 1.02 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Manufacturer's product literature for each type of dimensional letter sign, indicating style, font, colors, locations, and overall dimensions of each sign.

C. Shop Drawings:
   1. Include dimensions, locations, elevations, materials, text and graphic layout, and attachment details.

D. Selection Samples: Where materials, colors, and finishes are not specified, submit two sets of selection charts or chips.

E. Verification Samples: Submit samples showing colors and finishes specified.

F. Manufacturer's qualification statement.

### 1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

### 1.04 DELIVERY, STORAGE, AND HANDLING

A. Package dimensional letter signs as required to prevent damage before installation.

B. Store under cover and elevated above grade.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Dimensional Letter Signs:
   1. Awning and Sign Contractors: www.ascfabricators.com/#sle.
   2. CityScapes Inc; _____: www.cityscapesinc.com/#sle.
   3. FASTSIGNS International, Inc; _____: www.fastsigns.com/#sle.
   4. Inpro Corporation; _____: www.inprocorp.com/#sle.

### 2.02 DIMENSIONAL LETTERS

A. Applications: Building identification.
   1. Use individual metal letters.
   2. Mounting Location: Exterior as indicated on drawings.
   3. Allow for total of 21 letters, 12 inches (300 mm) high. and 2 numbers, 48 inches 1200 mm high.

B. Metal Letters:
   1. Material: Aluminum sheet, fabricated reverse channel.
   2. Thickness: Manufacturer's standard for letter size.
   3. Letter Height: 12 inches (150 mm).
   4. Number Height: 48 inches 1200 mm.
   5. Text and Typeface:
      a. Character Font: Helvetica, Arial, or other sans serif font.
   6. Finish: Brushed, satin.
   7. Color: As selected.
   8. Mounting: Projected mount with collars.

### 2.03 ACCESSORIES

A. Concealed Screws: Noncorroding metal; stainless steel, galvanized steel, chrome plated, or other.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Verify that substrate surfaces are ready to receive work.

B. Notify Architect if conditions are not suitable for installation of signs; do not proceed until conditions are satisfactory.

### 3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install with horizontal edges level.

**END OF SECTION**

# SECTION 102800
# TOILET, BATH, AND LAUNDRY ACCESSORIES

## PART 1 GENERAL

### 1.01 REFERENCE STANDARDS

A. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2026.

B. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip; 2025b.

C. ASTM C1503 - Standard Specification for Silvered Flat Glass Mirror; 2024.

D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

### 1.02 SUMMARY

A. Section Includes:
   1. Public-use washroom accessories.
   2. Custodial accessories.

### 1.03 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

### 1.04 ACTION SUBMITTALS

A. Product Data: For each product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
   3. Include electrical characteristics.

B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
   1. Identify locations using room designations indicated.
   2. Identify accessories using designations indicated.

### 1.05 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's special warranties.

### 1.06 CLOSEOUT SUBMITTALS

A. Maintenance Data: For accessories to include in maintenance manuals.

### 1.07 WARRANTY

A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, visible silver spoilage defects.
   2. Warranty Period: 15 years from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Structural Performance: Design accessories and fasteners to comply with the following requirements:
   1. Grab Bars: Installed units are able to resist 250 lbf concentrated load applied in any direction and at any point.

**2.02 PUBLIC-USE WASHROOM ACCESSORIES**

A. Source Limitations: Obtain public-use washroom accessories from single source from single manufacturer.

B. Toilet Tissue (Roll) Dispenser:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick - B-4288 or comparable product by one of the following:
      a. ASI-American Specialties, Inc.
      b. Bobrick Washroom Equipment, Inc
      c. Bradley Corporation
   2. Description: Roll-in-reserve dispenser with hinged front secured with tumbler lockset.
   3. Mounting: Surface mounted.
   4. Operation: Theft, resistant, heavy-duty spindles. Extra roll automatically drops in place when bottom roll is depleted.
   5. Capacity: Designed for 5-inch- diameter tissue rolls.
   6. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

C. Paper Towel (Folded) Dispenser:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick B-262 or comparable product by one of the following:
      a. ASI-American Specialties, Inc.
      b. Bobrick Washroom Equipment, Inc
      c. Bradley Corporation
   2. Mounting: Surface mounted.
   3. Minimum Capacity: 400 C-fold or 525 multifold towels.
   4. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
   5. Lockset: Tumbler type and piano hinge.
   6. Refill Indicator: Pierced slots at sides or front.

D. Soap Dispenser:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick B-4112 or comparable product by one of the following:
      a. ASI-American Specialties, Inc.
      b. Bobrick Washroom Equipment, Inc
      c. Bradley Corporation
   2. Description: Designed for manual operation and dispensing soap in liquid or lotion form.
   3. Mounting: Vertically oriented, surface mounted.
   4. Capacity: 40-fl oz.
   5. Materials: Satin Finish Stainless steel.
   6. Lockset: Tumbler type.
   7. Refill Indicator: Window type.

E. Grab Bar:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick B-6806x36 and B-6806x24 or comparable product by one of the following:
      a. ASI-American Specialties, Inc.
      b. Bobrick Washroom Equipment, Inc
      c. Bradley Corporation
   2. Mounting: Flanges with concealed fasteners.
   3. Material: Stainless steel, 0.05 inch thick.

a. Finish: Smooth, ASTM A480/A480M No. 4 finish (satin) on ends and slip-resistant texture in grip area.
4. OD: 1-1/2 inches.
5. Configuration and Length: As indicated on Drawings.

F. Corner Grab Bar:
1. Basis-of Design Product: Subject to compliance with requirements, provide Bobrick B-6861 (16x31x1.5) or comparable product by one of the following:
a. ASI-American Specialties, Inc.
b. Bobrick Washroom Equipment, Inc
c. Bradley Corporation
2. Mounting: Flanges with concealed fasteners.
3. Material: Stainless Steel, 0.55 inch thick
a. Finish:, Smooth, ASTM A480/A480M No. 4 finish (satin) on ends and slip-resistant texture in grip area.
4. OD: 1-1/2 inches.
5. Configuration and Length: As indicated on Drawings.

G. Surface-Monted Towel Shelf with Towel Bar
1. Basis-of Design Product: Subject to compliance with requirements, provide Bobrick – B676x24 or comparable product by one of the following:
a. ASI-American Specialties, Inc.
b. Bobrick Washroom Equipment, Inc.
c. Bradley Corporation
2. Description: Surface-mounted towel shelf with four stainless steel tubes, 5/6 inch square, mounted in support arms.
a. Towel Bar: 5/16 inch square stainless steel towel bar below shelf.
3. Length: 24 inches.
4. Material and Finish: Stainless steel, ASTM A480/A480M No.7 finish (polished)

H. Surface-Mounted Toiletry Shelf
1. Basis-of Desig Product: Subject to compliance with requirements, provide Bobrick B-683x24 or comparable product by one of the following:
a. ASI-American Specialties, Inc
b. Bobrick Washroom Equipment, Inc
c. Bradley Corporation
2. Description: Fixed rectangular unit
3. Nominal size: 24 inches long by 4-3/4 inch wide
4. Material and Finish: Stainless Steel, ASTM A480/A480M no.7 finish (polished)

I. Mirror Unit:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick - B290 - 1836 or comparable product by one of the following:
a. ASI-American Specialties, Inc.
b. Bobrick Washroom Equipment, Inc
c. Bradley Corporation
2. Frame: Stainless steel angle, 0.05 inch thick.
a. Corners: Manufacturer's standard.
3. Size: As indicated on Drawings.
4. Hangers: Manufacturer's standard rigid, tamper and theft resistant.

J. Hook:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick B212 or comparable product by one of the following:
a. ASI-American Specialties, Inc.
b. Bobrick Washroom Equipment, Inc
c. Bradley Corporation

2. Description: Combination door bumper and coat hook.
3. Mounting: Exposed.
4. Material and Finish: Solid aluminum casting.

K. Shower Curtain Rod:
1. Basis-of-Design product: Subject to compliance with requirements, provide Bobrick B6107x48 or comparable product by one of the following:
   a. ASI-American Specialties, Inc.
   b. Bobrick Washroom Equipment, Inc.
   c. Bradley Corporation
2. Description: 1-inch OD, straight rod.
3. Configuration: As indicated on drawings
4. Mounting Flanges: Exposed fasteners; in material and finish matching rod.
5. Rod Material and Finish: Stainless steel, ASTM A480/A480M no. 4 finish (satin)

L. Vinyl Shower Curtain:
1. Basis-of Design Product: Subject to compliance with requirements, provide Bobrick 204-3 or comparable product by one of the following:
   a. ASI-American Specialties, Inc.
   b. Bobrick Washroom Equipment, Inc.
   c. Bradley Corporation
2. Size: Minimum 12 inches wider than opening by 72 inches tall.
3. Material: Opaque, matte white vinyl, .008 inch thick, antibacterial and flame retardant.
4. Color: White
5. Grommets: Corrosion resistant at a minimum 6 inches o.c. through top hem.
6. Shower Curtain Hooks: Chrome-plated or stainless steel, spring wire curtain hooks with snap fasteners. Provide one hook per grommet

## 2.03 CUSTODIAL ACCESSORIES

A. Source Limitations: Obtain custodial accessories from single source from single manufacturer.

B. Custodial Utility Shelf:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. ASI-American Specialties, Inc.
   b. Bobrick Washroom Equipment, Inc
   c. Bradley Corporation
2. Description: With exposed edges turned down not less than 1/2 inch and supported by two triangular brackets welded to shelf underside.
3. Size: 16 inches long by 6 inches deep.
4. Material and Finish: Not less than nominal 0.05-inch- thick stainless steel, ASTM A480/A480M No. 4 finish (satin).

C. Custodial Mop and Broom Holder:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick B-223x24 or comparable product by one of the following:
   a. ASI-American Specialties, Inc.
   b. Bobrick Washroom Equipment, Inc
   c. Bradley Corporation
2. Description: Anti-slip mop holders with spring loaded rubber cam.
3. Length: 24 inches.
4. Mop/Broom Holders: Three, spring-loaded, rubber hat, cam type.
5. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

### 2.04 MATERIALS

A. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.031-inch- minimum nominal thickness unless otherwise indicated.

B. Fasteners: Screws, bolts, and other devices of same material as accessory unit, unless otherwise recommended by manufacturer or specified in this Section, and tamper and theft resistant where exposed, and of stainless or galvanized steel where concealed.

C. Mirrors: ASTM C1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

### 2.05 FABRICATION

A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

## PART 3 EXECUTION

### 3.01 INSTALLATION OF TOILET, BATH, AND LAUNDRY ACCESSORIES

A. Install accessories in accordance with manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
   1. Remove temporary labels and protective coatings.

B. Grab Bars: Install to comply with specified structural-performance requirements.

### 3.02 ADJUSTING AND CLEANING

A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.

B. Clean and polish exposed surfaces in accordance with manufacturer's written instructions.

**END OF SECTION**

# SECTION 104413
# FIRE PROTECTION CABINETS

## PART 1 GENERAL

### 1.01 REFERENCE STANDARDS

A. 8 - test; 1.

B. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2026.

C. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2026.

D. ASTM D4802 - Standard Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet; 2016 (Reapproved 2024).

E. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2026.

### 1.02 SUMMARY

A. Section Includes:
   1. Fire-protection cabinets for the following:
      a. Portable fire extinguisher.

B. Related Requirements:
   1. Section 104416 "Fire Extinguishers" for portable, hand-carried fire extinguishers accommodated by fire-protection cabinets.

### 1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing recessed-, semi recessed-, or surface-mounting method and relationships of box and trim to surrounding construction.
   2. Show location of knockouts for hose valves.

B. Shop Drawings: For fire-protection cabinets.
   1. Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each type of exposed finish required.

D. Samples for Initial Selection: For each type of exposed finish required.

E. Samples for Verification: For each type of exposed finish required, prepared on samples 6 by 6 inches (152.4 mm) square.

F. Product Schedule: For fire-protection cabinets. Indicate whether recessed, semi recessed, or surface mounted. Coordinate final fire-protection cabinet schedule with fire-extinguisher schedule to ensure proper fit and function.

### 1.04 CLOSEOUT SUBMITTALS

A. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

## PART 2 PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E814 for fire-resistance rating of walls where they are installed.

### 2.02 FIRE-PROTECTION CABINET

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Babcock-Davis

2. Guardian Fire Equipment, Inc
3. JL Industries; Activar Construction Products Group, Inc.
4. Larsen's Manufacturing Company
5. Nystrom, Inc.
6. Potter Roemer LLC; a Division of Morris Group International

B. Fire-Protection Cabinet Type: Suitable for fire extinguisher

C. Cabinet Construction: Non rated,One-hour fire rated and Two-hour fire rated.
1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.043-inch- thick cold-rolled steel sheet lined with minimum 5/8-inch- thick fire-barrier material. Provide factory-drilled mounting holes.

D. Cabinet Material: Cold-rolled steel sheet
1. Shelf: Same metal and finish as cabinet.

E. Semi recessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).
1. Square-Edge Trim: 1-1/4- to 1-1/2-inch backbend depth.

F. Cabinet Trim Material: same material and finish as door.

G. Door Material: Steel sheet.

H. Door Style: Fully glazed, frameless, backless, acrylic panel.

I. Door Glazing: Tempered float glass (clear)
1. Acrylic Sheet Color:
a. Clear transparent acrylic sheet.

J. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
1. Provide projecting door pull and friction latch.
2. Provide continuous hinge, of same material and finish as trim, , permitting door to open 180 degrees.

K. Accessories:
1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated.
a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."
1) Location: Applied to cabinet glazing.
2) Application Process: Pressure-sensitive vinyl letters.
3) Lettering Color: Red.
4) Orientation: Vertical.

L. Materials:
1. Cold-Rolled Steel: ASTM A1008/A1008M, Commercial Steel (CS), Type B.
a. Finish: Baked enamel, TGIC polyester powder coat, HAA polyester powder coat, epoxy powder coat, or polyester/epoxy hybrid powder coat, complying with AAMA 2603.
b. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
c. Color: As selected by Architect from manufacturer's full range.
2. Transparent Acrylic Sheet: ASTM D4802, Category A-1 (cell-cast sheet), 0.24 inch (6 mm) thick, with Finish 1 (smooth or polished).

### 2.03 FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
   1. Weld joints and grind smooth.
   2. Miter corners and grind smooth.
   3. Provide factory-drilled mounting holes.
   4. Prepare doors and frames to receive locks.
   5. Install door locks at factory.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.
   1. Fabricate door frames of one-piece construction with edges flanged.
   2. Miter and weld perimeter door frames and grind smooth.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

### 2.04 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.

C. Finish fire-protection cabinets after assembly.

D. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Examine walls and partitions for suitable framing depth and blocking where semi recessed cabinets will be installed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

A. Prepare recesses for semi recessed fire-protection cabinets as required by type and size of cabinet and trim style.

### 3.03 INSTALLATION OF FIRE-PROTECTION CABINETS

A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.
   1. Fire-Protection Cabinet Mounting Height: 42 inches (1066.8 mm) above finished floor to top of fire extinguisher.

B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.
   1. Unless otherwise indicated, provide recessed fire-protection cabinets. If wall thickness is inadequate for recessed cabinets, provide semi recessed fire-protection cabinets.
   2. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.
   3. Fire-Rated Cabinets:
      a. Install cabinet with not more than 1/16-inch tolerance between pipe OD and knockout OD. Center pipe within knockout.

C. Identification:
   1. Apply vinyl lettering at locations indicated.

**END OF SECTION**

# SECTION 104416
# FIRE EXTINGUISHERS

## PART 1 GENERAL

### 1.01 REFERENCE STANDARDS

A. NFPA - National Fire Protection Association; 2024.

B. NFPA 10 - Standard for Portable Fire Extinguishers; 2026.

C. test - sddds; sdds.

### 1.02 SUMMARY

A. Section includes portable, hand-carried fire extinguishers.

B. Related Requirements:
   1. Section 104413 "Fire Protection Cabinets."

### 1.03 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review methods and procedures related to fire extinguishers including, but not limited to, the following:
      a. Schedules and coordination requirements.

### 1.04 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

B. Product Schedule: For fire extinguishers. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function.

### 1.05 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

### 1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

### 1.07 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

### 1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Failure of hydrostatic test according to NFPA 10 when testing interval required by NFPA 10 is within the warranty period.
      b. Faulty operation of valves or release levers.
   2. Warranty Period: Six years from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
   1. Provide fire extinguishers approved, listed, and labeled by FM Global.

### 2.02 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Ansul; brand of Johnson Controls International plc, Building Solutions North America
      b. Babcock-Davis
      c. Guardian Fire Equipment, Inc
      d. JL Industries; Activar Construction Products Group, Inc.
      e. Larsen's Manufacturing Company
      f. Nystrom, Inc.
      g. Potter Roemer LLC; a Division of Morris Group International
   2. Source Limitations: Obtain fire extinguishers, fire-protection cabinets, and accessories, from single source from single manufacturer.
   3. Valves: Manufacturer's standard.
   4. Handles and Levers: Manufacturer's standard.
   5. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.

B. Multipurpose Dry-Chemical Type in Steel Container : UL-rated -A:40-B:C, 5-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.
   1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION

A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.
   1. Mounting Height: Top of fire extinguisher to be at 42 inches (1066.8 mm) above finished floor.

**END OF SECTION**

# SECTION 105123
# PLASTIC-LAMINATE-CLAD LOCKERS

## PART 1 GENERAL

### 1.01 REFERENCE STANDARDS

A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.

### 1.02 SUMMARY

A. Section Includes:
   1. 18 -inch Wide Single Tier Designer Wood Lockers.

### 1.03 REFERENCES

A. ADAAG – Americans with Disabilities Act, Accessibility Guidelines.

B. IBC – International Building Code.

### 1.04 ACTION SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

B. Shop Drawings: Prepared specifically for this project; show dimensions of lockers and interface with other products.

C. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

### 1.05 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

### 1.06 CLOSEOUT SUBMITTALS

A. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

### 1.07 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging, in a dry, ventilated area until ready for installation.

B. Locker components shall be stored flat until assembly. All finishes shall be protected from soiling and damage during handling.

C. Store and dispose of solvent-based material, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

### 1.08 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of lockers that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures.
      b. Faulty operation of locks or hardware.
      c. Deterioration of wood, finishes, and other materials beyond normal use.
   2. Warranty Period: Three years from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: For lockers indicated to be accessible, comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design”.

**2.02 PLASTIC-LAMINATE-CLAD WOOD LOCKERS**

A. Basis-of Design Product: Subject to compliance with requirements, provide: Salsbury Industries, 18-21000 Series 18” Wide Single Tier Designer Wood lockers. Single Tier 18-inch wide designer wood lockers. Constructed of industrial grade particle board and covered with durable plastic laminate; includes lift handle and recessed hasp for added security, with electronic locks.

1. A. 18-inch Wide Designer Wood Locker Series:
    a. 18-21000 series: Single-tier.
2. B. Unit Width: 18 inches (457.2 mm).
3. C. Unit Height:
    a. 76 inches (1930.4 mm) with bases.
4. D. Unit Depth:
    a. 24 inches (609.6 mm).
5. E. Unit Assembly: Requires minor assembly.
6. F. Laminate Color:
    a. Mahogany - standard.
        1) 2.3 INTERIOR EQUIPMENT
7. A. ADA Compliant Lockers (Recessed Handles with Multi-Point Latch):
    a. 1. Single-tier: Additional shelf at maximum 48 inches (1219.2 mm) off the floor for unobstructed forward and side reach.
        1) 2. Handicapped Locker Compartment Bottom: Minimum of 15 inches (381 mm) off the floor or an extra shelf placed 15 inches (381 mm) off the floor for unobstructed forward and side reach.
        2) 3. Hooks and rods as specified.
8. B. Standard Hardware Features:

**1. SINGLE TIER DESIGNER WOOD LOCKERS:**

a. a. Padlock hasp.
b. b. One top-mounted, two-pronged stainless steel coat hook.
c. c. One full depth hat shelf.
d. d. One 5 inch (127 mm) deep shelf.
e. e. One 11-3/4 inch (298 mm) deep shoe shelf.
f. f. Three heavy duty concealed door hinges.
    1) 2.4 OPTIONAL EQUIPMENT

**3.02 BASES: 4 INCHES (101.6 MM) HIGH.**

a. C. Fillers:
b. 1. Flat top fillers:
c. a. Flat top in-line top fillers.
d. b. Flat top corner fillers.
e. 2. Front fillers:
f. a. 9 inch (228.6 mm) wide filler panels.
g. b. 15 inch (381 mm) wide filler panels.
h. c. Vertical corner fillers.
i. D. Side panels:
j. 1. Single end side panels:
k. a. Without sloping hoods.
l. b. With sloping hoods.
m. 2. Double end side panels:
n. a. Without sloping hoods.
o. b. With sloping hoods.
p. E. Built-In Locks:
q. 1. Built-in electronic locks.
r. 2. Built-in ADA keyed locks.

s. H. Additional compartment shelf.
t. I. Engraved name/number plates.
1) 2.5 CUSTOMIZATION
u. A. Custom colors – For all custom colors available, contact Salsbury Industries or visit www.lockers.com/customdesignerlockers:
v. Minimum order of fifteen locker frames.

**3.03 VENTILATION GRILL: IMPROVED AIR FLOW THROUGHOUT LOCKER COMPARTMENT.**

a. C. Coat rod: Additional garment storage capability.
b. F. Lockable interior compartment: Add protection for items.
1) 2.6 CONSTRUCTION
(a) A. Locker Body – Tops, bottoms, sides, backs and shelves are precision machined:
2) 1. Locker shall be fabricated using doweled and glued assembly process.
3) 2. Tops and bottoms with three sides formed to 90 degrees, the front offset formed to be flush with horizontal frame member.
4) 3. Shelves with four sides formed to 90 degrees.
c. B. Locker Doors – Doors are precision machined:
1) 1. Door:
(a) a. Doors have four radial edges.
(b) b. Routed inset to insert and attach number plates.
2) 2. Ventilation – 1/2 inch (12.7 mm) opening between door and frame on locker top and bottom provide unrestricted airflow:
(a) a. Customizable venting option available.

**3. SINGLE-POINT LATCHING:**

**A. RECESSED HANDLE IN DOOR.**

(1) b. Integral Pocket and Pull: 22 gauge powder coated stainless steel securely fastened to door with two lugs and a positive tamper-resistant decorative fastener.
(2) I. Pocket Depth: Sufficient to prevent a combination padlock,
(3) built-in combination lock, or key lock from protruding beyond door face.

**II. PULL: FORMED IN POCKET.**

**III. PADLOCK STAPLE: PROTRUDING THROUGH POCKET.**

**C. PROVIDE LOCK HOLE COVER PLATE FOR USE WITH PADLOCKS.**

(1) d. Locking Device: 11 gauge steel hasp welded to locker frame; include surface for engaging the bolt of a built-in combination or key lock and anti-pry lug and slot to deter prying open when locked.

**E. FIRMLY SECURE RUBBER SILENCERS TO LOCKER FRAME.**

(1) C. Fabricate locker parts square, rigid and without warp, with the finished faces flat and free of scratches and chips.
(2) D. Fabricate corners and fillers as required for installation.

**PART 3 EXECUTION**

**10.01 3.1 EXAMINATION**

(1) A. Do not begin installation until substrates have been properly prepared.
(2) B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
2) 3.2 PREPARATION
(1) A. Clean surfaces thoroughly prior to installation.

(2) B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3) 3.3 INSTALLATION
   (1) A. Install in accordance with Salsbury Industry's installation instructions.
   (2) B. Anchor the units to the wall studs through the locker back and to the floor.
   (3) C. Lockers can be either floor-mounted or installed on concrete or wood bases as scheduled or indicated. Floor or base shall be level for proper installation.
4) 3.4 PROTECTION
   (1) A. Protect installed products until completion of project.
   (2) B. Touch-up, repair or replace damaged products before Substantial Completion.

**END OF SECTION**

**SECTION 105143**
**WIRE MESH STORAGE LOCKERS**

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section Includes:
   1. Welded wire mesh storage lockers.

### 1.02 ACTION SUBMITTALS

A. Product Data:
   1. For each type of product.
      a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings:
   1. Plans, elevations, sections, and attachment details.

C. Samples for Verification: Actual sample of finished products for each type of wire mesh storage locker with factory-applied color finishes.
   1. Size: Manufacturers' standard size

### 1.03 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Qualification Statements: For Installer.

### 1.04 QUALITY ASSURANCE

A. Manufacturer shall have a minimum of fifteen years of experience in the direct manufacture of lockers.

B. Installer Qualifications: Installer shall have experience necessary to assure lockers are installed properly and according to manufacturer’s instructions.

C. Reference: Qualify procedures and personnel in accordance with the following welding codes:
   1. ASTM A513 – Minimum properties of Electric-Resistance-Welded Carbon Ally Steel Mechanical Tubing.
   2. ASTM A5410 – Minimum properties of Wire Rods and Course Round Wire, Carbon Steel and Alloy Steel.

### 1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer’s original, unopened containers with labels identifying product and manufacturer’s name.

B. Storage: Store materials in a clean dry area.

C. Handling: Protect materials and finish during installation and handling to prevent damage.

### 1.06 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of construction contiguous with wire mesh storage lockers by field measurements and coordinate before fabrication.

## PART 2 PRODUCTS

### 2.01 WELDED WIRE MESH STORAGE LOCKERS

A. Basis-of-Design Product: Acceptable Manufacturers: Subject to compliance of the contract documents, acceptable manufacturers are as follows:
   1. GearGrid Corporation, 670 SW 15th Street, Forest Lake, MN 55025. Toll Free 888-643-6694. Phone 651-464-4468. Web Site www.geargrid.com, Email sales@geargrid.com
   2. Additional manufacturer’s may be approved; however, approval does not preclude the manufacturer from providing documentation supporting that their product meets or

exceeds all aspects of this specification section. Failure to provide proper documentation will result in the rejection of submitted product.

**2.02 TURNOUT GEAR LOCKER FABRICATION**

A. Lockers must be fabricated and manufactured in the U.S.A. Products not manufactured in the U.S.A. will be rejected at the time of submittal.

B. Model: GEARGRID Wall mounted Storage System.

C. Locker Size:
   1. Width: 24 inches (609.6 mm)
   2. Depth: 20 inches (508 mm)
   3. Height: 74.5 inches (1892.3 mm)

D. Construction: Units shall be welded at all applicable joints. Forming of metal shall be completed by standard cold-forming operations. Use of fasteners will only be required to allow for knock-down shipping, securing units to mounting surface and on applicable accessories.

E. Vertical Dividers:
   1. Outer Frames: 1.25-inch x 16 gage wall thickness ASTM A513 steel tubing.
   2. Inner Grid: .25" diameter ASTM 510 cold drawn steel wire resistance welded to a 3" square pattern.
   3. Inner Grid wires must be full length and width of inside vertical divider frame. Wires not running full length or width, thus creating exposed wire ends will not be acceptable.
   4. Inner Grid wires must run horizontally and vertically creating a square or rectangle grid pattern only. Grid wires not creating a square or rectangular grid pattern will not be acceptable
   5. Inner Grid wire shall intersect and cross all perpendicular wires, and shall be welded at all intersections.

F. Back Panels:
   1. Required on each locker to protect the locker contents and wall substrate, as well as provide an additional panel for accessory attachment.
   2. Grid: .25 inch (6.35 mm) diameter ASTM 510 cold drawn steel wire resistance welded to a 3" square pattern.
   3. Back panel must engage and be secured to vertical dividers via horizontal wires which extend into mounting holes pre-drilled in vertical dividers. Back panels are sandwiched between vertical dividers, preventing them from being removed after assembly.
   4. Inner Grid wires must be full length and width of inside vertical divider frame. Wires not running full length or width, thus creating exposed wire ends will not be acceptable.
   5. Inner Grid wires musts run horizontally and vertically creating a square or rectangular grid pattern only. Grids not creating a square or rectangular pattern will not be acceptable.
   6. Inner Grid wires shall intersect and cross all perpendicular wires and shall be welded at all intersections.

G. Shelves: (1) Upper, (1) Lower. .25-inch diameter ASTM 510 cold drawn steel wire resistance welded and cold formed. Upper shelf shall include an integrated 20 gage steel bracket to accept a 2-inch x 16-inch name placard (not included), unless doors are selected as an option, in which case the name placard holder will be integrated into the door.
   1. Load Capacity: 250 lb, uniformly distributed.

H. Apparel Hooks: (3) per locker opening, .192-inch diameter ASTM 510 cold drawn steel wire resistance welded, cold formed and powder coated. Apparel hooks must securely engage and snap onto side or back grid, to prevent unintentional disengagement of hook.

**2.03 ACCESSORIES:**

A. Name Placard:
   1. Provide 2-inch x 16” shelf name placard inscribed as directed by owner and Architect.

B. Helmet Holder:

1. .25-inch diameter ASTM 510 cold drawn steel wire resistance welded. Powder coated finish in specified color.

**2.04 FINISH**

A. General: All system components excluding assembly and mounting hardware and stainless-steel components are to receive the standard finish.

B. Standard Finish: Components to be cleaned using a phosphatized bath, clear water rinse and electro-statically coated with a durable and UV-stable TGIS powder coating process. Thickness of applied finish shall be 3-0.16 inch (4 mm) for added protection.
   1. Anti-Corrosive Primer:

C. Color: Red Baron

**2.05 EXAMINATION**

A. Examine area to receive lockers. Notify Architect if areas are not acceptable. Do not begin installation until unacceptable conditions have been corrected.

**2.06 INSTALLATION**

A. Install Lockers in accordance with manufacturer’s instructions.

B. Use manufacturer’s hardware for assembly.

C. Anchor to mounting surface with proper hardware.

**END OF SECTION**

**SECTION 107300**
**– ALUMINUM CANOPY**

## PART 1 – GENERAL

### 1.01 REFERENCE STANDARDS

A. AAMA 611 - Specification for Anodized Architectural Aluminum; 2026.

B. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2026.

C. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2026.

D. ASTM D3451 - Standard Guide for Testing Coating Powders and Powder Coatings; 2024.

### 1.02 SUMMARY

A. Section Includes: Helios Canopy.

B. Related Requirements: Division 1 – General Requirements

### 1.2 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. Publications are referenced within the text by the basic designation only.

B. American Welding Society (AWS):
   1. Standard D1.2 – Structural Welding Code – Aluminum
   2. American Architectural Manufacturers Association (AAMA):
   3. Aluminum finishes AAMA 2603 Powder Coat
   4. Aluminum finishes AAMA 2605 Kynar
   5. Aluminum finishes AAMA 611 Anodize

### 2.02 SUBMITTALS

A. Shop Drawings: Indicate size, material and finish. Include plan elevation pages to clearly outline canopy locations. Include installation procedures, details of joints, attachments and clearances. Provide lead time for product and note possible conflicts with standard line.

B. Color charts showing manufacturer’s full range of colors from standard line.

### 2.03 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal canopies that fail in materials or workmanship within specified warranty period.

### 2.04 1. WARRANTY PERIOD: ONE YEAR FROM DATE OF SUBSTANTIAL COMPLETION.

## PART 2 – PRODUCTS

### 3.01 APPROVED MANUFACTURERS

A. Specifications are based on Architectural Fabrication, Inc. – Helios Canopy. Architectural Fabrication, Inc. – Manufacturer and Installer is located at 2100 E. Richmond Avenue, Fort Worth, TX 76104. 800.962.8027. www.arch-fab.com

### 3.02 MATERIALS

A. Framing: Gutter fascia, tube, angles: 6063-T5 alloy extruded aluminum

B. Decking: Interlocking panels, extruded aluminum or sheet metal

C. Hanger Rods: Zinc plated steel and powder coat (Prime and paint are not acceptable)

D. Connections: Wall plates and canopy mounting brackets are to be aluminum.

E. Hardware and Fasteners: Nuts, bolts, washers, clevis pins, screws, anchors and pipe spacers to be zinc plated or galvanized steel required to suit application.

F. Flashing: Shall be minimum 0.040-inch aluminum, fabricated to prevent leakage and sealed with Novaflex metal roof sealant in clear or color match. Other equivalent sealant is acceptable.

G. Finish: Powder coat finish per ASTM D3451, complying with finish manufacturer's written instructions for surface preparation including pretreatment, application, baking and minimum dry film thickness. Color to be selected from standard color line.

**PART 3 – EXECUTION**

**4.01 FABRICATION**

A. Fabricate and preassemble canopies in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

**3.2 INSTALLATION**

A. Install canopies per manufacturer's written instructions and as indicated on drawings.

B. Locate and place canopies level, plumb and at indicated alignment with adjacent work.

C. Use concealed anchors where possible.

D. Repair damaged finishes so no evidence remains of corrective work. Return items to the factory that cannot be refinished in the field. Make required alterations and refinish entire unit or provide new units.

E. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a coating of bituminous paint or elastomeric coating on surfaces that will be in contact with concrete, masonry or dissimilar metals.

**END OF SECTION**

# SECTION 107516
# GROUND-SET FLAGPOLES

## PART 1 GENERAL

### 1.01 REFERENCE STANDARDS

A. AAMA 611 - Specification for Anodized Architectural Aluminum; 2026.

B. NAAMM FP 1001 - Guide Specifications for Design Loads of Metal Flagpoles; 2007.

### 1.02 SUMMARY

A. Section includes ground-set flagpoles made from aluminum.

B. Owner-Furnished Material: Flags.

### 1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, operating characteristics, fittings, accessories, and finishes for flagpoles.

B. Shop Drawings: For each flagpole.
   1. Include the following
      a. Plans, elevations, and attachment details. Show general arrangement, jointing, fittings, accessories, grounding, anchoring, and support.
      b. Section, and details of foundation system.

C. Samples for Verification: For each type of exposed finish, in manufacturer's standard sizes.

D. Delegated Design Submittals: For flagpoles.

### 1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flagpoles to include in operation and maintenance manuals.

## PART 2 PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design flagpole assemblies.

B. Structural Performance: Flagpole assemblies, including anchorages and supports, to withstand design loads indicated within limits and under conditions indicated.
   1. Wind Loads: Determine according to NAAMM FP 1001. Basic wind speed for Project location is 100 mph.

### 2.02 ALUMINUM FLAGPOLES

A. Exposed Height: 40 feet (1219.2 cm)

B. Basis of Design: Baartol Co., Inc

C. Construct flagpoles in one piece if possible. If more than one piece is necessary, comply with the following:
   1. Fabricate shop and field joints without using fasteners, screw collars, or lead calking.
   2. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.

D. Cast-Metal Shoe Base: Made from aluminum with same finish and color as flagpoles for anchor-bolt mounting; furnish with anchor bolts.
   1. Furnish ground spike.

### 2.03 FITTINGS

A. Finial Ball: Flush-seam ball, sized as indicated or, if not indicated, to match flagpole-butt diameter.
   1. 0.063-inch Stainless Steel.

B. External Halyard: Ball-bearing, non fouling, revolving truck assembly of cast metal with continuous 5/16-inch- diameter, braided polypropylene halyard and 9-inch cast-metal cleats with fasteners. Finish exposed metal surfaces to match flagpole.
   1. Halyards and Cleats: One at each flagpole.
   2. Halyard Flag Snaps: Bronze swivel snap hooks with neoprene or vinyl covers. Furnish two per halyard.

**2.04 MISCELLANEOUS MATERIALS**

A. Elastomeric Joint Sealant: joint sealant complying with requirements in Section 079200 "Joint Sealants."

**2.05 ALUMINUM FINISHES**

A. Natural Satin Finish: AA-M32, fine, directional, medium satin polish; buff complying with AA-M20; seal aluminum surfaces with clear, hard-coat wax.

B. Clear Anodic Finish: AAMA 611, AA-M12C22A41.
   1. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

**PART 3 EXECUTION**

**3.01 FLAGPOLE INSTALLATION**

A. General: Install flagpoles where indicated and according to Shop Drawings and manufacturer's written instructions.

B. Foundation Tube: Place flagpole in tube, seated on bottom plate between steel centering wedges, and install hardwood wedges to secure flagpole in place. Place and compact sand in foundation tube and remove hardwood wedges. Seal top of foundation tube with a 2-inch layer of elastomeric joint sealant and cover with flashing collar.

C. Baseplate: Cast anchor bolts in concrete foundation. Install baseplate on washers placed over leveling nuts on anchor bolts and adjust until flagpole is plumb. After flagpole is plumb, tighten retaining nuts and fill space under baseplate solidly with nonshrink, nonmetallic grout. Finish exposed grout surfaces smooth and slope 45 degrees away from edges of baseplate.

**END OF SECTION**

# SECTION 113013
# RESIDENTIAL APPLIANCES

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Kitchen appliances.

B. Laundry appliances.

### 1.02 RELATED REQUIREMENTS

A. Section 221005 - Plumbing Piping: Plumbing connections for appliances.

B. Section 260583 - Wiring Connections: Electrical connections for appliances.

### 1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Manufacturer's data indicating dimensions, capacity, and operating features of each piece of residential equipment specified.

C. Copies of Warranties: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

### 1.04 QUALITY ASSURANCE

A. Electric Appliances: Listed and labeled by UL (DIR) and complying with NEMA Standards (National Electrical Manufacturers Association).

B. Gas Appliances: Bearing design certification seal of American Gas Association (AGA).

### 1.05 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Provide five (5) year manufacturer warranty on refrigeration system of refrigerators.

C. Provide ten (10) year manufacturer warranty on tub and door liner of dishwashers.

## PART 2 PRODUCTS

### 2.01 KITCHEN APPLIANCES

A. Provide Equipment Eligible for Energy Star Rating: Energy Star Rated.

B. Refrigerator: Free-standing, side-by-side, and frost-free.
   1. Capacity: Total minimum storage of 39.93 cubic ft (____ cu m); minimum 25 percent freezer capacity. For Kitchen 122 and 11.6 cubic ft for Break Room 105
   2. Energy Usage: Minimum 20 percent more energy efficient than energy efficiency standards set by U.S. Department of Energy (DOE).
   3. Features: Include light in freezer compartment and PE coated wire shelves.
   4. Exterior Finish: Stainless steel.
   5. Manufacturers:
      a. Frigidaire Home Products; Basis of Design: FFHTSOSSA @ Breakroom 105: www.frigidaire.com/#sle.
      b. GE Appliances: www.geappliances.com/#sle.
      c. Whirlpool Corp: www.whirlpool.com/#sle.
      d. Turbo Air: Basis of Design: M3RF45-2-N: www.Turboairinc.com @ Kitchen 122.
      e. Substitutions: See Section 016000 - Product Requirements.

C. Range: Natural gas, free-standing, with standard burners and removable drip pans.
   1. Size: 30 inches (762 mm) wide.
   2. Oven: Self-cleaning with electronic ignition.
   3. Burners: Four (4).
   4. Controls: Solid state electronic.

5. Features: Include automatic meat thermometer, storage drawer, oven door window, broiler pan and grid, and oven light.
6. Exterior Finish: Stainless steel.
7. Manufacturers:
   a. Frigidaire Home Products: www.frigidaire.com/#sle.
   b. GE Appliances: www.geappliances.com/#sle.
   c. Whirlpool Corp: www.whirlpool.com/#sle.
   d. Frigidaire Basis of Design: FCFG3062AS:.
   e. Substitutions: See Section 016000 - Product Requirements.

D. Cooking Exhaust, Type ____: Range hood.
1. Size: 30 inches (762 mm) wide.
2. Fan: Two-speed, 500 cfm (236 L/s)
3. Exhaust: Rectangular, vented to exterior.
4. Features: Include cooktop light, night light, backdraft damper, removable grease filter, retractable visor, and retrofit ANSUL system Basis of Design: Kitchen Stop.
5. Exterior Finish: Stainless steel.
6. Manufacturers:
   a. Frigidaire Home Products; ____: www.frigidaire.com/#sle.
   b. GE Appliances; Basis of Design:JVX3300SJSS: www.geappliances.com/#sle.
   c. Whirlpool Corp; ____: www.whirlpool.com/#sle.
   d. Substitutions: See Section 016000 - Product Requirements.

E. Waste Disposer: Standard type, overload protection, direct wired, dishwasher connection, drain elbow, drain connector, sound reduction features, and _____.
1. Power: 1/3 HP.
2. Capacity: Large.
3. Height: 14-1/2 inch (368 mm).
4. Depth: 8-1/2 inch (216 mm).
5. Controls: Wall switch.
6. Voltage: 115 volts, 60 Hz, 4 amps.
7. Sink Flange Kit: Stainless steel.
8. Exterior Finish: Black.
9. Manufacturers:
   a. Frigidaire Home Products; ____: www.frigidaire.com/#sle.
   b. GE Appliances; ____: www.geappliances.com/#sle.
   c. Whirlpool Corp; ____: www.whirlpool.com/#sle.

F. Dishwasher: Undercounter.
1. Controls: Solid state electronic.
2. Wash Levels: Five.
3. Cycles: Five (5), including: China/Crystal, Eco, High Temperature Wash, Quick Wash, Sanitize
4. Features: Include 3rd Rack, Cycle Staturs, Filtered Water, Fingerprint Resistant, Hard Food Disposer, Hard Food Filter, Hidden Controls, Leak Sensor, Movable Tines.
5. Finish: Stainless steel , color as indicated.
6. Manufacturers:
   a. Frigidaire Home Products; Basis of Design: PDSH4816B: www.frigidaire.com/#sle.

## 2.02 LAUNDRY APPLIANCES

A. Provide Equipment Eligible for Energy Star Rating: Energy Star Rated.

B. Clothes Washer: Front-loading.
1. Size: 3.1 cu. ft..
2. Controls: Solid state electronic.
3. Cycles: Include Colors, Delicates, Whites.

4. Motor Speed: Single-speed.
5. Features: Include bleach dispenser, fabric softener dispenser, and end of cycle signal.
6. Finish: Painted steel , color as indicated.
7. Manufacturers:
   a. GE Appliances: www.geappliances.com/#sle.
   b. Whirlpool Corp; Basis of Design: CHW9160GW: www.whirlpool.com/#sle.
   c. LG Electronics; www.lg.com.
   d. Substitutions: See Section 016000 - Product Requirements.

C. Clothes Dryer: Electric, stationary.
1. Size: 6.7 cu. ft..
2. Controls: Solid state electronic, with timer dry control.
3. Temperature Selections: Three.
4. Cycles: Include COlors/Delicates. Cotton/Whites, Permanent Press.
5. Features: Include interior light, reversible door, and end of cycle signal.
6. Finish: Painted steel , color as indicated.
7. Manufacturers:
   a. GE Appliances; ____: www.geappliances.com/#sle.
   b. Whirlpool Corp; Basis of Design: CED9160GW: www.whirlpool.com/#sle.
   c. LG Electronics: www.lg.com.
   d. Substitutions: See Section 016000 - Product Requirements.

## 2.03 ACCESSORIES

A. Dryer Vent Assembly: Comply with ICC (IMC)-2021 and ICC (IRC)-2021.
1. Exhaust Duct: Aluminum ribbon, 4-inch (101.6 mm) diameter, comply with UL 2158A.
   a. Elbows: 26-gauge, 0.018-inch (0.46 mm) aluminized steel; 45 degree angle, nonsectioned curve; 4-inch (101.6 mm) diameter.
   b. Clamps: Stainless steel, 3-1/2 to 4-3/4-inch (88.9 mm to 120.65 mm) diameter range.
2. Wall Termination: 26-gauge, 0.018-inch (0.46 mm) aluminized steel with rain drip edge, rubber magnetic bumpers, angled damper, and removable backing plate; 6-1/2 inches (165.1 mm) wide by 6.45 inches (163.83 mm) tall.
3. Pest Protection Gate: 26-gauge, 0.018-inch (0.46 mm) zinc-coated steel, vertical bar gate, manufacturer's recommended size to fit termination.
4. Finish for Exposed Metals: Color to match adjacent surface.

# PART 3 EXECUTION

## 3.01 EXAMINATION

A. Verify utility rough-ins are provided and correctly located.

## 3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

## 3.03 ADJUSTING

A. Adjust equipment to provide efficient operation.

## 3.04 CLEANING

A. Remove packing materials from equipment and properly discard.

B. Wash and clean equipment.

**END OF SECTION**

# SECTION 114000
# FOODSERVICE EQUIPMENT

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Foodservice equipment.

B. Connections to utilities.

### 1.02 RELATED REQUIREMENTS

A. Section 079200 - Joint Sealants: Sealing joints between equipment and adjacent walls, floors, and ceilings.

### 1.03 REFERENCE STANDARDS

A. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.

B. FM (AG) - FM Approval Guide; Current Edition.

C. ITS (DIR) - Directory of Listed Products; Current Edition.

D. NEMA MG 00001 - Motors and Generators; 2024.

E. UL (DIR) - Online Certifications Directory; Current Edition.

### 1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on appliances; indicate configuration, sizes, materials, finishes, locations, and utility service connection locations, service characteristics, and wiring diagrams.

C. Operation Data: Provide operating data for the specified equipment.

D. Maintenance Data: Provide lubrication and periodic maintenance requirement schedules.

E. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

### 1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacture of standard products of the type specified.

### 1.06 DELIVERY, STORAGE, AND HANDLING

A. Store products clear of floor in a manner to prevent damage.

B. Coordinate size of access and route to place of installation.

### 1.07 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for replacement or repair of scheduled equipment, refrigerant and compressors, including disconnection and removal of defective unit, and connection of replacement unit.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Foodservice Equipment:
   1. Atosa; www.atosausa.com.

### 2.02 REGULATORY REQUIREMENTS

A. Comply with applicable codes for utility requirements.

B. Products Requiring Electrical Connection: Listed and classified by FM (AG), ITS (DIR), UL (DIR), or testing agency acceptable to local authorities having jurisdiction as suitable for the purpose specified and indicated.

**2.03 EQUIPMENT**

A. Equipment Schedule: Refer to schedule at end of this section.
   1. Equipment Eligible for Energy Star Rating: Provide Energy Star Rated equipment

B. Installation Accessories: Provide rough-in hardware, supports and connections, attachment devices, closure trim, and accessories as required for complete installation.

**2.04 MATERIALS**

A. Stainless Steel Sheet: ASTM A666/A666M Type 304 commercial grade, No. 4 finish.

**2.05 FINISHES**

A. Stainless Steel: No. 4 finish.

**PART 3 EXECUTION**

**3.01 EXAMINATION**

A. Verify ventilation outlets, service connections, and supports are correct and in required location.

B. Verify that electric power is available and of the correct characteristics.

**3.02 INSTALLATION**

A. Install items in accordance with manufacturers' instructions.

B. Insulate to prevent electrolysis between dissimilar metals.

**3.03 ADJUSTING**

A. Adjust equipment and apparatus to ensure proper working order and conditions.

B. Remove and replace equipment creating excessive noise or vibration.

**3.04 CLEANING**

A. Remove masking or protective covering from stainless steel and other finished surfaces.

B. Wash and clean equipment.

C. Polish glass, plastic, hardware, accessories, fixtures, and fittings.

**3.05 CLOSEOUT ACTIVITIES**

A. At completion of work, provide qualified and trained personnel to demonstrate operation of each item of equipment and instruct Owner in operating procedures and maintenance.
   1. Test equipment prior to demonstration.
   2. Individual Performing Demonstration: Fully knowledgeable of all operating and service aspects of equipment.

**3.06 PROTECTION**

A. Remove protective coverings from prefinished work.

B. Protect finished work from damage.

**3.07 FOODSERVICE EQUIPMENT SCHEDULE**

A. Atosa Model YR450-AP-161 Ice Maker with CYR400P ice bin:
   1. Electrical Characteristics:
      a. 9.6 rated load amperes.
      b. 115 volts, single phase, 60 Hz.

**END OF SECTION**

# SECTION 122513
# WINDOW ROLLER SHADES

**** NOTE TO SPECIFIER ** MECHO; INTERIOR MANUALLY-OPERATED AND ELECTRICALLY-OPERATED ROLLER SHADES AND CONTROL SYSTEMS.**

## PART 1 GENERAL

### 2.01 SECTION INCLUDES

A. Roller shades, manual operation and accessories.

B. Shade fabric.

### 2.02 REFERENCE STANDARDS

A. ANSI - American National Standards Institute; N/A.

B. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).

C. C2C (DIR) - C2C Certified Products Registry; Cradle to Cradle Products Innovation Institute; Current Edition.

D. NFPA 701 - Standard Methods of Fire Tests for Flame Propagation of Textiles and Films; 2023, with Errata.

E. UL (GGG) - GREENGUARD Gold Certified Products; Current Edition.

F. WCMA A100.1 - Standard for Safety of Window Covering Products; 2022.

### 2.03 RELATED SECTIONS

A. Section 06100 - Rough Carpentry: Wood blocking and grounds for mounting roller shades and accessories.

B. Section 09260 - Gypsum Board Assemblies: Coordination with gypsum board assemblies for installation of shade pockets, closures and related accessories.

C. Section 09510 - Acoustical Ceilings: Coordination with acoustical ceiling systems for installation of shade pockets, closures and related accessories.

### 2.04 REFERENCES

A. ASTM International (ASTM):
   1. ASTM G21 and E 2180 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

B. Cradle to Cradle Products Innovation Institute (C2C):
   1. C2C (DIR)- C2C Certified Products Registry.

C. National Fire Protection Association (NFPA):
   1. NFPA 701 - Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.

D. Window Covering Manufacturers Association (WCMA):
   1. ANSI/WCMA A100.1-2022- Safety of Window Covering Products; 2022.

### 2.05 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: One week prior to commencing work related to this section. Require attendance of all affected installers.

B. Sequencing:
   1. Do not fabricate shades until field dimensions for each opening have been taken with finished conditions in place. "Hold to" dimensions are not acceptable.
   2. Do not install shades until final surface finishes and painting are complete.

### 2.06 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Bid Submittal: Information Required with Submittal of Bid: In order to evaluate proposals for integrated lighting control and window shade systems, the Architect requires the following information be submitted prior to the award of the system.
   1. Bid proposal shall be accompanied with a document that notes all deviations from these specifications on a line-by-line basis.

C. Product Data: Manufacturer's catalog pages and data sheets for products specified including materials, finishes, dimensions, profiles, mountings, and accessories.
   1. Preparation instructions and recommendations.
   2. Styles, material descriptions, dimensions of individual components, profiles, features, finishes , accessories, and operating instructions.
   3. Storage and handling requirements and recommendations.
   4. Mounting details and installation methods.
   5. Manufacturer's Instructions: Include storage, handling, protection, examination, preparation, and installation.
   6. Project Record Documents: Record actual locations of control system components and show interconnecting wiring.
   7. Operation and Maintenance Data: Component list with part numbers, and operation and maintenance instructions.

D. Shop Drawings: Plans, elevations, sections, product details, installation details, operational clearances, and relationship to adjacent work.
   1. Prepare shop drawings on AutoCad or MicroStation format using base sheets provided electronically by the Architect.
   2. Provide location plan showing all manual shade control locations. Cross-reference furniture plans for optimal positioning of chains.
   3. Provide elevation drawings showing shade band layout. Indicate any necessary seam or batten locations, and align with horizontal mullions where possible.

E. Window Treatment Schedule: For all roller shades. Use same room designations as indicated on the Drawings and include opening sizes and key to typical mounting details.

F. Verification Samples: For each finish product specified, one complete set of shade components, unassembled, demonstrating compliance with specified requirements.
   1. Shadecloth Sample: Mark face of material to indicate interior faces.
      a. Test reports indicating compliance with specified fabric properties.
      b. Verification Samples: 6 inches (150 mm) square, representing actual materials, color and pattern.

G. Maintenance Data: Bill of materials for all components with part numbers. Methods for maintaining roller shades, precautions regarding cleaning materials and methods, instructions for operating hardware and controls.

H. Warranty: Provide manufacturer’s warranty documents as specified in this Section.

**2.07 QUALITY ASSURANCE**

A. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

B. Manufacturer Qualifications: Obtain roller shades system through one source from a single manufacturer with a minimum of ten years experience and minimum of five projects of similar scope and size in manufacturing products comparable to those specified in this section.

C. Installer for Roller Shade System - Qualifications: Installer trained and certified by the manufacturer with a minimum of ten years experience in installing products comparable to those specified in this section.
   1. Requirements for Roller Shade Installer/Contractor:
      a. Roller Shade Hardware, shade fabric and all related controls shall be furnished and installed as a complete assembly.

D. Product Listing Organization Qualifications: Organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

E. Fire-Test-Response Characteristics: Passes NFPA 701 small and large-scale vertical burn. Materials tested shall be identical to products proposed for use.

F. ShadeCloth Anti-Microbial Characteristics: 'No Growth' per ASTM G21 results for fungi ATCC9642, ATCC9644 and ATCC9645, and E2180.

G. ShadeCloth Cleanability and Disinfecting: ShadeCloth must meet cleanability and disinfecting requirements via 3rd party testing to comply with ((BIFMA HCF ((8)).1))-2014 standards using chemical solutions compliant with EPA guidelines for use against COVID-19.

H. Environmental Certification: Submit written certification from the manufacturer, including third party evaluation, recycling characteristics, and perpetual use certification as specified. Initial submittals, which do not include the Environmental Certification will be rejected. Materials that are simply 'PVC free' without identifying their inputs shall not qualify as meeting the intent of this specification and shall be rejected.

I. Third Party Evaluation: Provide documentation stating the shade cloth has undergone third party evaluation for all chemical inputs, down to a scale of 100 parts per million, that have been evaluated for human and environmental safety. Identify any and all inputs, which are known to be carcinogenic, mutagenic, teratogenic, reproductively toxic, or endocrine disrupting. Also identify items that are toxic to aquatic systems, contain heavy metals, or organohalogens. The material shall contain no inputs that are known problems to human or environmental health per the above major criteria, except for an input that is required to meet local fire codes.

J. Recycling Characteristics: Provide documentation that the shade cloth can, and is part of a closed loop of perpetual use and not be required to be down cycled, incinerated or otherwise thrown away. Scrap material can be sent back to the mill for reprocessing and recycling into the same quality yarn and woven into new material, without down cycling. Certify that this process is currently underway and will be utilized for this project.

K. Perpetual Use Certification: Certify that at the end of the useful life of the shade cloth, that the material can be sent back to the manufacturer for recapture as part of a closed loop of perpetual use and that the material can and will be reconstituted into new yarn, for weaving into new shade cloth. Provide information on each shade band indicating that the shade band can be sent back to the manufacturer for this purpose.

**2.08 MOCK-UP**

A. Provide a mock-up of one roller shade assembly for evaluation of mounting, appearance and accessories.
   1. Locate mock-up in window designated by Architect.
   2. Mockup Size: Full size.
   3. Mockup Size (WxH): 3 x 3 feet (0.94 x 0.94 m) minimum.
   4. Intent of mock-up is to demonstrate quality of workmanship and visual appearance.
   5. If mock-up is not acceptable, rebuild mock-up until satisfactory results are achieved.
   6. Do not proceed with remaining work until, mock-up is accepted by Architect.
   7. Retain mock-up during construction as a standard for comparison with completed work.
   8. Do not alter or remove mock-up until work is completed or removal is authorized.
   9. Full-sized mock-up may become part of the final installation.
   10. Full-sized mock-up will become the property of the Owner to be used for spare parts.

**2.09 DELIVERY, STORAGE, AND HANDLING**

A. Deliver in factory-labeled packages, marked with manufacturer and product name, fire-test-response characteristics, and location of installation using same room designations indicated on Drawings and in Window Treatment Schedule.

B. Store and handle products per manufacturer's recommendations.

### 2.10 PROJECT CONDITIONS

A. Environmental Limitations: Install roller shades after finish work including painting is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

### 2.11 WARRANTY

A. Roller Shade Hardware and Chain Warranty: Manufacturer's standard non-depreciating, transferrable warranty for interior shading.
   1. Shade Hardware – 10 years unless otherwise indicated:
      a. Mecho/5 and Mecho/5x with ThermoVeil, EuroTwill, Soho, Equinox, Midnite, Chelsea, or Classic Blackout shade fabric: 25-years.
   2. Standard Shadecloth: Manufacturer's standard 25-year warranty.
   3. Roller Shade Installation: One year from date of Substantial Completion, not including scaffolding, lifts or other means to reach inaccessible areas, which are deemed owners responsibility.

## PART 2 PRODUCTS

### 3.01 MANUFACTURERS

A. Acceptable Manufacturer for Window Shade Control System as basis of design, performance and warranty: Mecho, which is located at: 42-03 35th St.; Long Island City, NY 11101; ASD Tel: 718-729-2020; Fax: 718-729-2941; Email: marketing@mechoshade.com; Web: www.mechoshade.com. For your local Mecho rep: https://www.mechoshade.com/find-a-rep/

B. Requests for substitutions will be considered in accordance with provisions of Section 01600.

### 3.02 APPLICATIONS/SCOPE

A. Roller Shade Schedule:
   1. Shade Type 1: Manual operating, chain drive, sunscreen single roller shades and related mounting systems and accessories as indicated on drawings.
   2. CPSC Compliance: All manually operated window coverings with accessible cords, chains, continuous loop cords, etc. shall meet all current Federally mandated CPSC (Consumer Products Safety Commission) safety standards at time of manufacturing. Depending on the product type, additional hardware components may be required and added to meet new regulatory compliant anti-ligature requirements.
   3. WCMA Compliance: Chain tensioning device complying with ANSI/WCMA A100.1-2022 manufacuted on every manual roller shade.
      a. ROLLER SHADES, MANUAL OPERATION AND ACCESSORIES

B. Shade System; General:
   1. Components capable of being removed or adjusted without removing mounted shade brackets, or cassette support channel.
   2. Smoothly operation raising or lowering shades.
   3. Cradle-to-Cradle certified and listed in C2C (DIR).

C. Basis of Design: Mecho/5 System as manufactured by Mecho. (Shade Type 1)
   1. Description: Manually operated fabric window shades.
      a. Shade Type: Single Roller.
      b. Universal drive capability to offset drive chain for reverse or regular roll shades.
      c. Drop Position: Regular roll.
      d. Mounting: Srface Mount.
      e. Fabric: As indicated under Shade Fabric article.
   2. Brackets and Mounting Hardware: As recommended by manufacturer for mounting indicated and to accommodate shade fabric roll-up size and weight.
      a. Material: Steel, 1/8 inch (3 mm) thick.
   3. Roller Tubes:
      a. Material: Extruded aluminum.

b. Size: As recommended by manufacturer; selected for suitability for installation conditions, span, and weight of shades.
c. Fabric Attachment: Utilize extruded channel in tube to accept vinyl spline welded to fabric edge. Shade band to be removable and replaceable without removing roller tube from brackets or inserting spline from the side of the roller tube.
d. Roller tubes to be capable of being removed and reinstalled without affecting roller shade limit adjustments.

4. Hembars: Designed to maintain bottom of shade straight and flat.
   a. Style: Full wrap fabric covered bottom bar, flat profile with heat sealed closed ends.
5. Clutch Operator: Manufacturer's standard material and design integrated with bracket/brake assembly.
   a. Heavy-duty, 1/8” steel mounting bracket and integrated steel brake, clutch and sprocket assembly rigidly affix the shade support and user control to the building structure fully independent of the roller tube components.
   b. Permanently lubricated maintenance-free brake assembly employs an oil-impregnated steel hub with wrapped spring clutch.
   c. Brake must withstand minimum pull force of 50 pounds (22.7 kg) in the stopped position.
   d. Direct drive clutch requires no interstitial gear stages or plastic parts between the building structure and clutch ensuring reliable operation across the full range of shade sizes.
   e. Maximum shade hanging weight of 18 pounds (8.2 kg).
6. Drive Chain: Continuous loop stainless steel beaded ball chain, 100 pound (45 kg) minimum breaking strength. Provide upper and lower limit stops.
   a. Chain Tensioner: Chain tensioning device complying with ANSI/WCMA A100.1-2022.
   b. Limit stops: Bead stops affixed to the chain maintain consistent shadeband alignment at the top and bottom of shade travel across multiple shades, and help prevent shade damage resulting from unmanaged user control.
7. Accessories:
   a. Fascia: Removable extruded aluminum fascia, size as required to conceal shade mounting, attachable to brackets without exposed fasteners.
      1) Finish: Baked enamel.
         (a) Color: White.
      2) Can be installed across two or more shade bands in one piece.
      3) Single Fascia: Accommodate regular roll shades.
   b. Room-Darkening Channels: Extruded aluminum side and center channels with brush pile edge seals, SnapLoc mounting base, and concealed fasteners. Channels to accept one-piece exposed blackout hembar to assure side light control and sill light control.

### 3.03 ROLLER SHADE FABRICATION

A. Field measure finished openings prior to ordering or fabrication.

B. Dimensional Tolerances: Fabricate shades to fit openings within specified tolerances.
   1. Vertical Dimensions: Fill Opening from Head to Sill: 1/2 inch (13 mm) space between bottom bar and window sill.
   2. Horizontal Dimensions: Outside mounting.
      a. Cover window frames, trim, and casings completely.

C. Openings Requiring Continuous Multiple Shade Units with Separate Rollers: Locate roller joints at window mullion centers; butt rollers end-to-end.

### 3.04 SHADE FABRIC

A. Basis of Design: Shade fabric as manufactured by MechoShade Systems LLC.
   1. Solar Shadecloths:

a. Fabric: Classic Blackout: 0700 series. Opaque. Vinyl coated fabric blackout material same color reverse side (for exterior).
   1) Low-Emitting Material Certification: Greenguard Gold certified and listed in UL (GGG).
   2) Environmental Product Declaration (EPD): Published disclosure of product's environmental impacts based on a full Life Cycle Assessment (LCA). Manufacturer must have EPD certification by independent 3rd party evaluation service.
b. Color: Selected from manufacturer's standard colors.

2. Performance Requirements:
   a. Flammability per NFPA 701: Pass. Large or small scale test.
   b. Fungal Resistance: No growth when tested per ASTM G21.
   c. Cleanability and Disinfecting: ShadeCloth must meet cleanability and disinfecting requirements via 3rd party testing to comply with ((BIFMA HCF ((8)).1))-2014 standards using chemical solutions compliant with EPA guidelines for use against COVID-19.
3. Fabrication:
   a. Fabric Orientation: Railroaded, fabric is turned 90 degrees off the roll.
   b. Battens: Manufacturer's standard material, full width of shade, and enclosed in welded shade fabric pocket; locate as indicated on drawings.
   c. Seams for Railroaded Fabric: Manufacturer's standard seam; locate as indicated on drawings.
   d. Welded Zipper Edge: Full height on both sides of fabric ensuring smooth operation within ShadeLoc channels.

## PART 3 EXECUTION

### 4.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

C. Start of installation shall be considered acceptance of substrates.

### 4.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using methods recommended by manufacturer for achieving best result for substrate under the project conditions.

C. Coordinate with window installation and placement of concealed blocking to support shades.

### 4.03 INSTALLATION

A. Contractor Furnish and Install Responsibilities:
   1. Window Covering Contractor (WC) shall provide an on site, Project Manager, and shall be present for all related jobsite scheduling meetings.
   2. WC shall supervise the roller shade installation, and setting of intermediate stops of all shades.
   3. WC shall be responsible for field inspection on an area-by- area and floor-by-floor basis during construction to confirm proper mounting conditions per approved shop drawings.
   4. Verification of Conditions: examine the areas to receive the work and the conditions under which the work would be performed and notify General Contractor and Owner of conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected. Commencement of installation shall constitute acceptance of substrate conditions by the installer.
   5. WC shall provide accurate to 0.0625" inch (1.5875mm); field measurements for custom shade fabrication on the Roller Shades manufacturers input forms.

6. WC Installer shall install roller shades level, plumb, square, and true according to manufacturer's written instructions, and as specified here in. Blocking for roller shades installed under the contract of the interior General Contractor shall be installed plumb, level, and fitted to window mullion as per interior architect's design documents and in accordance with industry standard tolerances. The horizontal surface of the shade pocket shall not be out-of-level more than 0.625" (15.875mm) over 20 linear feet (6.096 meters)
7. Shades shall be located so the shade band is not closer than 2 inches (50 mm) to the interior face of the glass. Allow proper clearances for window operation hardware.
8. Adjust, align and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.
9. Installer shall set Upper and Lower limits of all manual shade bands, and assure alignment in accordance with the above requirements.
10. Clean roller shade surfaces after installation, according to manufacturer's written instructions.
11. WC shall train Owner's maintenance personnel to adjust, operate and maintain roller shade systems.
    a. Use operation and maintenance manual as a reference, supplemented with additional training materials as required.

**4.04 PROTECTION AND CLEANING**

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.
   1. Clean soiled shades and exposed components as recommended by manufacturer.
   2. Replace shades that cannot be cleaned to "like new" condition.

**END OF SECTION**

# SECTION 133419
# METAL BUILDING SYSTEMS

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Manufacturer-engineered, shop-fabricated structural steel building frame.

B. Metal roof panels including gutters and downspouts.

### 1.02 RELATED REQUIREMENTS

A. Section 079200 - Joint Sealants: Sealing joints between accessory components and wall system.

B. Section 081113 - Hollow Metal Doors and Frames.

C. Section 081213 - Hollow Metal Frames.

D. Section 083600 - Overhead Door

E. Section 083613 - Sectional Doors - Four Fold

F. Section 088000 - Glazing.

### 1.03 REFERENCE STANDARDS

A. AISC 360 - Specification for Structural Steel Buildings; 2022, with Errata (2025).

B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.

D. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

E. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2023.

F. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; 2021.

G. ASTM A529/A529M - Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality; 2026.

H. ASTM A572/A572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel; 2025.

I. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

J. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process; 2025a.

K. ASTM A992/A992M - Standard Specification for Structural Steel Shapes; 2022.

L. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.

M. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength; 2020.

N. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi, 144 ksi, and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength; 2025a.

O. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2020.

P. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025, with Amendment (2026).

Q. IAS AC472 - Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems; 2024, with Editorial Revision (2025).

### 1.04 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene one week before starting work of this section.

### 1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on profiles, component dimensions, fasteners.

C. Shop Drawings: Indicate assembly dimensions, locations of structural members, connections; wall and roof system dimensions, panel layout, general construction details, anchors and methods of anchorage, and installation; framing anchor bolt settings, sizes, locations from datum, and foundation loads; indicate welded connections with AWS A2.4 welding symbols; indicate net weld lengths; provide professional seal and signature.

D. Manufacturer's Instructions: Indicate preparation requirements, anchor bolt placement.

E. Erection Drawings: Indicate members by label, assembly sequence, and temporary erection bracing.

F. Designer's Qualification Statement.

G. Manufacturer's Qualification Statement: Provide documentation showing metal building manufacturer is accredited under IAS AC472.
   1. Include statement that manufacturer designs and fabricates metal building system as integrated components and assemblies, including but not limited to primary structural members, secondary members, joints, roof, and wall cladding components specifically designed to support and transfer loads and properly assembled components form a complete or partial building shell.

H. Erector's Qualification Statement.

I. Project Record Documents: Record actual locations of concealed components and utilities.

### 1.06 QUALITY ASSURANCE

A. Designer Qualifications: Design structural components, develop shop drawings, and perform shop and site work under direct supervision of a Professional Structural Engineer experienced in design of this type of work.
   1. Design Engineer Qualifications: Licensed in the State in which the Project is located.
   2. Comply with applicable code for submission of design calculations as required for acquiring permits.
   3. Cooperate with regulatory agency or authorities having jurisdiction (AHJ), and provide data as requested.

B. Manufacturer Qualifications: Company specializing in the manufacture of products similar to those required for this project.
   1. Not less than three years of documented experience.

C. Erector Qualifications: Company specializing in performing the work of this section approved by manufacturer.

D. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and no more than 12 months before start of scheduled welding work.

### 1.07 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Correct defective Work within a one year period after Date of Substantial Completion.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Metal Buildings Systems:

1. Kirby Building Systems, a Nucor Company: www.kirbybuildingsystems.com/#sle.
2. Nucor Building Systems: www.nucorbuildingsystems.com/#sle.
3. Basis of Design: American Buildings; www.americanbuildings.com.
4. Substitutions: See Section 016000 - Product Requirements.

**2.02 ASSEMBLIES**

A. Single span rigid frame.

B. Bay Spacing: Varies see plans.

C. Primary Framing: Rigid frame of rafter beams and columns, canopy beams, and wind bracing.

D. Secondary Framing: Purlins, and other items detailed.

E. Wall System: Preformed metal panels of vertical profile provided by other manufacturer, see section # 074213 - Metal Wall Panels, with sub-girt framing/anchorage assembly, and accessory components by metal building manufacturer.

F. Roof System: Preformed metal panels oriented parallel to slope, with sub-girt framing/anchorage assembly, insulation, and liner panels, and accessory components.

G. Roof Slope: 1 inches in 12 inches (1/12).

**2.03 PERFORMANCE REQUIREMENTS**

A. Installed Thermal Resistance of Wall System: R-13 + R-6.5 ci

B. Installed Thermal Resistance of Roof System: R-19 + R-11 LS

C. Design structural members to withstand dead load, applicable snow load, and design loads due to pressure and suction of wind calculated in accordance with applicable code.

D. Provide drainage to exterior for water entering or condensation occurring within wall or roof system.

E. Size and fabricate wall and roof systems free of distortion or defects detrimental to appearance or performance.

**2.04 MATERIALS - FRAMING**

A. Structural Steel Members: ASTM A36/A36M.

B. Structural Tubing: ASTM A500/A500M Grade B cold-formed.

C. Plate or Bar Stock: ASTM A529/A529M, Grade 50.

**2.05 MATERIALS - ROOF**

A. Steel Sheet: ASTM A792/A792M aluminum-zinc alloy coated to AZ50/AZM150.

B. Joint Seal Gaskets: Manufacturer's standard type.

C. Fasteners: Manufacturer's standard type, galvanized to comply with requirements of ASTM A153/A153M, finish to match adjacent surfaces when exterior exposed.

D. Sealant: Manufacturer's standard type.

E. Trim, Closure Pieces, Caps, Flashings, Gutters, Downspouts, Rain Water Diverter, Fascias, and Infills: Same material, thickness and finish as exterior sheets; brake formed to required profiles.

**2.06 COMPONENTS**

A. Doors and Frames: See Section 081113.

B. Frames: See Section 081213.

C. Overhead Doors: See Section 083613 and Section 083600.

**2.07 FABRICATION - FRAMING**

A. Fabricate members in accordance with AISC 360 for plate, bar, tube, or rolled structural shapes.

B. Anchor Bolts: Formed with bent shank, assembled with template for casting into concrete.

C. Provide wall opening framing for doors, windows, and other accessory components.

**2.08 FABRICATION - WALL AND ROOF PANELS**

A. Siding: See Section #074213 - Metal Wall Panels

B. Roofing: Minimum 0.0225 inch (0.5715 mm) metal thickness, SS360 profile, lapped edges fitted with continuous gaskets.

C. Liner: Minimum 0.0238 inch (0.060452 mm) metal thickness, flat profile indicated, lapped V edges fitted with continuous gaskets.

D. Soffit Panels: See Section #074213 Metal Wall Panels

E. Girts/Purlins: Rolled formed structural shape to receive siding, roofing and liner sheet.

F. Internal and External Corners: See Section #074213 - Metal Wall Panels

G. Flashings, Closure Pieces, Fascia: Same material and finish as adjacent material, profile to suit system.

H. Fasteners: To maintain load requirements and weather tight installation, same finish as cladding, non-corrosive type.

**2.09 FABRICATION - GUTTERS AND DOWNSPOUTS**

A. Fabricate of same material and finish as roofing metal.

B. Form gutters and downspouts of pre-engineered metal building manufacturer standard profile and size indicated to collect and remove water. Fabricate with connection pieces.

C. Form sections in maximum possible lengths. Hem exposed edges. Allow for expansion at joints.

D. Fabricate support straps of same material and finish as roofing metal, color as selected.

**2.10 FINISHES**

A. Framing Members: Clean, prepare, and shop prime. Do not prime surfaces to be field welded.

**PART 3 EXECUTION**

**3.01 EXAMINATION**

A. Verify that foundation, floor slab, mechanical and electrical utilities, and placed anchors are in correct position

**3.02 ERECTION - FRAMING**

A. Erect framing in accordance with AISC 360.

B. Provide for erection and wind loads. Provide temporary bracing to maintain structure plumb and in alignment until completion of erection and installation of permanent bracing. Locate braced bays as indicated.

C. Set column base plates with non-shrink grout to achieve full plate bearing.

D. Do not field cut or alter structural members without approval.

E. After erection, prime welds, abrasions, and surfaces not shop primed.

**3.03 ERECTION - WALL AND ROOF PANELS**

A. Install in accordance with manufacturer's instructions.

B. Exercise care when cutting prefinished material to ensure cuttings do not remain on finish surface.

C. Fasten cladding system to structural supports, aligned level and plumb.

D. Locate end laps over supports. End laps minimum 2 inches (50 mm). Place side laps over bearing.

E. Provide expansion joints where indicated.

F. Use concealed fasteners.

G. Install sealant and gaskets, providing weather tight installation.

**3.04 ERECTION - GUTTERS AND DOWNSPOUTS**

A. Rigidly support and secure components. Join lengths with formed seams sealed watertight. Flash and seal gutters to downspouts.

B. Slope gutters minimum .125 inch/ft (3.175 mm/m).

C. Connect downspouts to storm sewer system.

**3.05 INSTALLATION - ACCESSORY COMPONENTS IN WALL SYSTEM**

A. Install insulation in accordance with manufacturer's instructions.

**3.06 TOLERANCES**

A. Framing Members: 1/4 inch (6 mm) from level; 1/8 inch (3 mm) from plumb.

B. Siding and Roofing: 1/8 inch (3 mm) from true position.

**END OF SECTION**

# SECTION 21 05 00 - COMMON WORK RESULTS FOR FIRE PROTECTION

## 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. Requirements in this Section apply to all Division 21 Sections.

### 1.2 SUMMARY

A. This Section includes the following:

1. Scope of Work and Construction Considerations.
2. Coordination Drawings.
3. Quality Assurance.
4. Submittal Requirements.
5. Change Orders.
6. Delivery, Storage, and Handling.
7. Coordination.

### 1.3 SCOPE OF WORK AND CONSTRUCTION CONSIDERATIONS

A. This Specification and the associated Scope Drawings govern the furnishing, installation, testing, and placing into satisfactory operation the Fire Protection Systems.

B. Contractor shall design hydraulically calculated shop drawings, provide all new materials indicated on the Drawings and/or in these Specifications, and all items required to make his portion of the Fire Protection Work a finished and working system.

C. Refer to the Construction Manager’s scope statements for complete scope of work description.

D. All work that will produce excessive noise or interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during unoccupied hours. The Owner reserves the right to determine when restricted construction hours will be required.

### 1.4 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system

components and required access areas to ensure that no two objects will occupy the same space.

a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.

b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.

c. Communications trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.

d. Maintenance clearances and code-required dedicated space shall be included.

e. The coordination drawings shall include all underground, underfloor, infloor, in chase, and vertical trade items.

2. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.

2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the **[Mechanical Contractor] [General Contractor] [Construction Manager]**.

a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.

3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. TRC will provide electronic file copies of drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by TRC. TRC will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.

a. Scale of drawings:

1) General plans: 1/4 Inch = 1 '-0" (minimum).

2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).

3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).

4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1 '-0" (minimum).

5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).

b. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.

c. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.

d. The minimum quantity of drawings will be established at the first coordination meeting and sent to the Architect and Engineer for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the Architect, Engineer, and Owner's Representative. The Architect and Engineer will only review identified conflicts and give an opinion, but will not perform as a coordinator.

2. A plotted set of coordination drawings shall be available at the project site.

3. Coordination drawings are not shop drawings and shall not be submitted as such.

4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in his bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.

5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.

6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.

7. The Architect and Engineer reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.

8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the Architect and Engineer.

9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.

    a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.

    b. Potential layout changes shall be made to avoid additional access panels.

    c. Additional access panels shall not be allowed without written approval from the Architect and Engineer at the coordination drawing stage.

    d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the Architect, Engineer, and the Owner's Representative.

    e. When additional access panels are required, they shall be provided without additional cost to the Owner.

10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.

11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.

12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

## 1.5 QUALITY ASSURANCE

A. Contractor’s Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the drawings are of a representative nature only and may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such details can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.

2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor’s own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor’s risk.

B. Qualifications:

1. Only products of reputable manufacturers are acceptable.

2. All Contractors and subcontractors shall employ only workers skilled in their trades.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all State Codes.

2. Conform to all requirements of the **[City] [County]** of _____, Laws, Ordinances, and other regulations having jurisdiction.

3. Conform to all published standards of **[*Client Name*]**.

4. Conform to Federal Act S.3874 requiring the reduction of lead in drinking water.

5. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment to be used.

6. If the Contractor notes, at the time of bidding, any parts of the drawings or specifications that do not comply with the codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, he shall submit with his proposal a separate price to make the system comply with the codes and regulations.

7. All changes to the system made after letting of the contract in order to comply with codes or requirements of Inspectors shall be made by the Contractor without cost to the Owner, Architect, or Engineer.

8. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.

9. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.

2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.

3. Pay all charges for permits or licenses.

4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.

5. Pay all charges arising out of required inspections by an authorized body.

6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.

7. Where applicable, all fixtures, equipment and materials shall be listed by Underwriters' Laboratories, Inc. and approved by FM Global.

E. Utility Company Requirements:

1. Secure from the appropriate private or public utility company all applicable requirements.

2. Comply with all utility company requirements.

3. Make application for and pay for utility connections and metering systems.

F. Examination of Drawings:

1. The drawings are diagrammatic in nature, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.

2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.

3. Scaling of the drawings is not sufficient or accurate for determining these locations.

4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner, Architect, or Engineer.

5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.

6. If an item is either on the drawings, in the specifications, or in the code, it shall be included in this contract.

7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.

8. Where used in these documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.

a. Any item listed as furnished shall also be installed, unless otherwise noted.

b. Any item listed as installed shall also be furnished, unless otherwise noted.

G. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

H. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing **[Revit MEP 201_] [AutoCAD]**.

2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.

3. Upon request for electronic media, the Contractor shall complete and return a signed “Electronic File Transmittal” form provided by TRC.

4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.

5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.

6. The drawings prepared by TRC for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.

7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.

8. The information is provided to expedite the project and assist the Contractor with no guarantee by TRC as to the accuracy or correctness of the information provided. TRC accepts no responsibility or liability for the Contractor’s use of these documents.

## 1.6 SUBMITTAL REQUIREMENTS

A. General Submittal Requirements: In addition to the requirements of Division 1, the following are required:

1. Transmittal Sheet.

   a. Date.
   b. Project title and number.
   c. Contractor’s and subcontractors’ name and address.
   d. Division of work (e.g., fire protection, plumbing, heating, ventilating, etc.).
   e. Description of items submitted and relevant specification number (only one specification number per submittal).
   f. Notations of deviations from the contract documents.
   g. Other pertinent data.

2. Submittal Cover Sheet: All of the information provided on the Transmittal Sheet, plus:

   a. Supplier and manufacturer’s names and addresses.
   b. Contractor’s review stamp indicating he has thoroughly reviewed and approved all shop drawings before submitting them to the

Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed. Unstamped submittals will be rejected.

c. Space for Architect/Engineer's review stamp

3. Submittal content shall include the following:

a. Fabrication/layout drawings.
b. Manufacturer's specification cut sheets with features, options and dimensions.
c. Listed codes and standards.
d. Wiring and control diagrams.
e. Physical characteristics (size, weight, shipping notes, service requirements).
f. Every page shall be marked up with project specific annotations and strikeouts to clearly identifying models, options, capacities, etc. being provided in compliance with the contract documents.
g. Contractor shall use the same nomenclature as the contract documents.
h. Reproduction of the contract documents alone is not acceptable for submittals.
i. Incomplete or improperly prepared submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.

B. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal.

1. Initial review: Allow 10 business days for initial review of each submittal. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. Engineer will advise Contractor when a submittal must be delayed for coordination.

2. Concurrent review: Where concurrent review of submittals by Architect/Engineer's Consultants, Owner or other parties is required, allow 15 business days for initial review of each submittal.

C. Submittal Schedule:

1. Contractor shall submit all submittals to the Engineer for initial review within 30 days of award of contract, or within the first 10% of the duration of the project, whichever is less. Submittals which require processing completion prior to 40 business days after award of contract shall be scheduled with the Engineer at least 15 business days in advance of their requested due date.

2. Submittals shall be reviewed by the Architect/Engineer before releasing any equipment for manufacture or shipment.

3. Contractor's responsibility for errors, omissions, code compliance, or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's review.

4. Submittals shall be submitted electronically as PDF files in compliance with the naming, formatting, and organization requirements in Division 1.

D. Operations Manual: Include the following:

1. Final processed submittals of all Division 21 specification sections.

2. Subcontractor contact list including name, phone number and e-mail contact information.

3. Valve tag charts.

4. Field reports, including piping pressure testing.

5. Startup reports for all fire protection systems.

6. Certifications of piping systems, equipment or systems if specified in the individual specification section.

7. Operations and maintenance information for all fire protection equipment.

8. Final, coordinated record drawings.

a. Submit one set of Record Drawings for review by Architect/Engineer prior to submission of closeout documents. Record Drawings shall be submitted using the established submittal process.

b. Upon satisfactory review of the Record Drawing submittals by Engineer, provide three (3) printed sets of the Record Drawings and three (3) copies in electronic format with closeout documents

c. Paper Record Drawings shall be printed full size using the same sheet size as the construction documents issued to the contractor with the contractor's title block.

1) Electronic Record Drawings shall include **[AutoCAD] [a REVIT]** compatible **[files] [model]** and **[individual PDF files named by sheet and organized in folders by disciplines] [multi-sheet PDF files combined and named by discipline]**.

## 1.7 CHANGE ORDERS

A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders with inadequate breakdown will be rejected.

B. Change order work shall not proceed until authorized.

## 1.8 DELIVERY, STORAGE, AND HANDLING

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

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

C. Deliver, store and install materials and equipment (including supports and hangers) such that they are maintaining “as-new” condition (e.g. no rust) upon installation and up through the date of Substantial Completion. Account for environmental conditions of the construction site and schedule work accordingly.

D. Do not allow any materials nor equipment to be stored in standing water.

E. Keep all bearings properly lubricated and all belts properly tensioned and aligned.

F. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.

G. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate his/her work with other trades.

1.9 COORDINATION

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

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for fire protection items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

D. Existing Utilities: Do not interrupt utilities serving facilities occupied or partially occupied by the Owner or others unless specifically allowed under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Owner at least seven days in advance of proposed utility interruptions. Identify extent and duration of utility interruptions.
2. Indicate method of proposed utility interruptions in detail.
3. Do not proceed with proposed utility interruptions without Owner’s permission.

E. Coordinate new installations with the existing installations which will remain in place and be reutilized or those that are abandoned in place. Provide transitions and fittings in piping as well as extra lengths of ductwork and piping as required to route around these existing installations. Illustrate all such pipe fittings on the as-built drawings submittal. Existing installations include HVAC, plumbing, electrical, and other building systems components including, but not limited to, ductwork, diffusers, hydronic piping, drain/vent piping, plumbing piping, fire protection piping, fire protection heads, electrical conduits, lights, etc. Coordinate installation of above ceiling components and devices such that maintenance access is achieved at the completion of the project when all ceiling mounted components are installed. Coordinate with all trades. Ultimate responsibility for any rework required to achieve maintenance access is the responsibility of the Contractor responsible for

coordination as noted in Division 1 Sections. The required maintenance access is defined here for this contract:

1. A person with a 24” arm length can stand on a folding ladder which rests on the finished floor and which does not extend through the ceiling grid. All lights and diffusers remain in the grid when defining maintenance access. Ceiling tiles with sprinkler heads, smoke detectors, fire alarm devices and other system devices remain in the grid when defining maintenance access. Light fixtures and diffusers/grilles remain in the ceiling grid when defining maintenance access.
2. While standing on a step of this ladder which is rated for standing upon and while not leaning against the ceiling grid, this person can touch and visually monitor the following items with both hands at the same time:

    a. Shutoff valves and check valves.
    b. Flow switches and alarm devices.
    c. Pressure gauges.

F. Locate buried utility and distribution services within the project area.

G. Provide temporary connections to maintain existing systems in service during the construction. This may include piping, power, controls and water, as well as other connections as required.

H. Provide the Owner a schedule prior to the start of demolition with phased selected demolition identified by system and by floor. Identify required outages on the schedule and any temporary measures required to maintain existing systems in service.

I. Coordinate the fire protection demolition with all aspects of demolition and temporary construction (including dust barriers) by other trades.

## PART 2 - PRODUCTS

NOT APPLICABLE

## PART 3 - EXECUTION

### 3.1 JOBSITE SAFETY

A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer, his employees, or subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely respon-

sible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 EXCAVATION, FILL, BACKFILL, COMPACTION

A. General:

1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found by calling 811.

2. The Contractor shall do all excavating, filling, backfilling and compacting associated with his work.

B. Excavation:

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.

2. Where excavations are made in error below foundations, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer, shall be placed in such excess excavations. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.

3. Trim bottom and sides of excavations to grades required for foundations.

4. Protect excavations against frost and freezing.

5. Take care in excavating not to damage surrounding structures, equipment or buried pipe. Do not undermine footing or foundation.

6. Perform all trenching in a manner to prevent cave-ins and risk to workmen.

7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.

8. Where satisfactory bearing soil for foundations is not found at the indicated levels, the Architect/Engineer or their representative shall be notified immediately, and no further work shall be done until further instructions are given by the Architect/Engineer or their representative.

C. Dewatering:

1. Contractor shall furnish, install, operate and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.

D. Underground Obstructions:

1. Known underground piping, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Use great care in making installations near underground obstruction.

2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.

E. Fill and Backfilling:

1. No rubbish or waste material is permitted for fill or backfill.

2. Provide all necessary sand for backfilling.

3. Dispose of the excess excavated earth as directed.

4. Backfill materials shall be suitable for required compaction, clean and free of perishable materials and stones greater than 4 inches in diameter. Water shall not be permitted to rise in unbackfilled trenches. No material shall be used for backfilling that contains frozen earth, debris or earth with a high void content.

5. Backfill all trenches and excavations immediately after installing pipes, or removal of forms, unless other protection is provided.

6. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Fill and backfill materials shall be spread in 6 inch uniform horizontal layers with each layer compacted separately to required density.

7. Lay all piping on a compacted bed of sand at least 3 inches deep. Backfill around pipes with sand, 6 inch layers, and compact each layer.

8. Use sand for backfill up to grade for all piping under slabs or paved areas. All other piping shall have sand backfill to 6 inches above the top of the pipe.

9. Place all backfill above the sand in uniform layers not exceeding 6 inches deep. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement.

10. Where the fill and backfill will ultimately be under a building, floor or paving, each layer of fill shall be compacted to 95% of the maximum density determined by AASHTO Designation T-99 or ASTM Designation D-698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content determined by AASHTO T-99 or ASTM D-698 test.

F. Surface Restoration:

1. Where trenches are cut through graded, planted or landscaped areas, the areas shall be restored to the original condition. Replace all planting removed or damaged to its original condition. A minimum of 6 inches of topsoil shall be applied where disturbed areas are to be seeded or sodded.

2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition.

3.3 ARCHITECT/ENGINEER OBSERVATION OF WORK

A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Placing fill over underground and underslab utilities.
2. Covering exterior walls, interior partitions and chases.
3. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:

a. Pipe wall penetrations are sealed.
b. Pipe identification and valve tags are installed.
c. Branch piping in the location of sprinklers shall be dropped to the ceiling.

2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.

3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

3.4 PROJECT CLOSEOUT

A. The following paragraphs supplement the requirements of Division 1.

B. Final Jobsite Observation:

1. The Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.

2. The Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.

3. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

C. Before final payment is authorized, this Contractor must submit the following:

1. Operation and maintenance manuals with copies of reviewed shop drawings.

2. Record documents including reproducible drawings and specifications.

3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.

4. Start-up reports on all equipment requiring a factory installation inspection or start-up.

5. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed; receipt by Owner to Architect/Engineer required prior to final payment approval.

3.5 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer’s review. The electronic copy shall be corrected as required to address the Architect/Engineer’s comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.

2. Reviewed O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.

2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.

3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.

a. O&M file name: O&M.div21.contractor.YYYYMMDD

b. Transmittal file name: O&Mtransmittal.div21.contractor.YYYYMMDD

5. File Size: Electronic file size shall be limited to a maximum of 4MB. Larger files shall be divided into files that are clearly labeled as “1 of 2”, “2 of 2”, etc.

6. Provide the Owner with a reviewed copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title “Operation and Maintenance Instructions”, title

of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.

7. All text shall be searchable.

8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Paper Copy Submittal Procedures:

1. Once the electronic version of the manuals has been reviewed by the Architect/Engineer, three (3) paper copies of the O&M manual shall be provided to the Owner. The content of the paper copies shall be identical to the corrected electronic copy.

2. Binder Requirements: The Contractor shall submit three sets of O&M manuals in heavy duty, locking three ring binders. Incorporate clear vinyl sheet sleeves on the front cover and spine for slip-in labeling. “Peel and stick” labels are **not** acceptable. Sheet lifters shall be supplied at the front of each notebook. The three-ring binders shall be 1/2" thicker than initial material to allow for future inserts. If more than one notebook is required, label in consecutive order. For example; 1 of 2, 2 of 2. No other form of binding is acceptable.

3. Binder Labels: Label the front and spine of each binder with “Operation and Maintenance Instructions”, title of project, and subject matter.

4. Index Tabs: Divide information by specification section, major equipment, or systems using index tabs. All tab titling shall be clearly printed under reinforced plastic tabs. All equipment shall be labeled to match the identification in the construction documents.

D. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.

2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.

3. Copies of all final reviewed shop drawings and submittals. Include Architect’s/Engineer’s shop drawing review comments and change orders. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.

4. Copy of final reviewed test and balance reports.

5. Copies of all factory inspections and/or equipment startup reports.

6. Copies of warranties.

7. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.

8. Dimensional drawings of equipment.

9. Capacities and utility consumption of equipment.

10. Detailed parts lists with lists of suppliers.

11. Operating procedures for each system.

12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.

13. Repair procedures for major components.

14. List of lubricants in all equipment and recommended frequency of lubrication.

15. Instruction books, cards, and manuals furnished with the equipment.

## 3.6 INSTRUCTING THE OWNER'S REPRESENTATIVES

A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.

B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.

D. The instructions shall include:

1. Explanation of all system flow diagrams.
2. Maintenance of equipment.
3. Start-up procedures for all major equipment.
4. Explanation of seasonal system changes.

E. The Architect/Engineer shall be notified of the time and place instructions will be given to the Owner's representatives so he or his representative can attend if desired.

F. Refer to the respective specification sections for minimum hours of instruction for each system.

G. The Contractor shall prepare a detailed, written training agenda and submit it to the Architect/Engineer a minimum of two weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts, etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.

H. Operating Instructions:

1. Contractor is responsible for all instructions to the Owner's representatives for the mechanical and control systems.

2. If the Contractor does not have staff that can adequately provide the required instructions he shall include in his bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.7 SYSTEM COMMISSIONING

A. The fire protection systems shall be complete and operating. System start-up, testing, balancing, and satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final adjustments as required.

B. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.

C. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.8 RECORD DOCUMENTS

A. The following paragraph supplements Division 1 requirements:

1. Contractor shall maintain at the job site a separate and complete set of fire protection coordination drawings and specifications on which he shall clearly and permanently mark in complete detail all changes made to the fire protection systems.

2. Mark drawings to:

a. Indicate revisions to piping size and location, both exterior and interior. Note changes specifically due to Change Orders or RFI’s by name and number

b. Identify devices, requiring periodic maintenance or repair.

c. Identify and dimension from column lines actual locations of all equipment, underground piping (including inverts), mains and branches of piping systems, valves, and control system devices.

3. Mark specifications to show formally documented substitutions; Change Orders, and actual equipment and materials used.

4. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.

5. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

3.9 PAINTING

A. This Contractor shall paint the following items:

1. All equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.

2. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, he shall have the equipment and all its supports, hangers, etc., painted to match the room decor.

3. Equipment cabinets, casings, covers, metal jackets, etc., in equipment rooms or concealed spaces, shall be furnished in standard or prime finish, free from scratches, abrasions, chips, etc.

4. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chips, etc. If color option is specified or is standard to the unit, this Contractor shall, before ordering, verify with the Architect/Engineer his color preference and furnish this color.

5. All equipment in unfinished areas such as boiler room, mechanical spaces, storage room, etc., furnished by this Contractor. Equipment furnished with a factory coat of paint and enamel need not be painted, provided the factory applied finish is not marred or spattered. If so, equipment shall be refinished with the same paint as was factory applied.

6. All outdoor uninsulated steel piping the color selected by Owner or Architect/Engineer.

B. After surfaces have been thoroughly cleaned and are free of oil, dirt, and other foreign matter; paint all pipes and equipment with the following:

a. Bare Metal Surfaces - Apply one coat of primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.

b. Color of paint shall be as selected by the Architect.

3.10 ADJUST AND CLEAN

A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.

B. Clean all areas where moisture is present. Immediately report any mold, biological growth, or water damage.

C. Remove all rubbish, debris, etc., accumulated during construction from the premises.

## 3.11 SPECIAL REQUIREMENTS

A. Contractor shall coordinate the installation of all equipment, valves, dampers, operators, etc., with other trades to maintain clear access area for servicing.

B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.

C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

## 3.12 IAQ MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

A. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:

1. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:

   a. Minimizing the amount of dust generated.

   b. Reducing solvent fumes and VOC emissions.

   c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.

   d. Protect stored on-site and installed absorptive materials from moisture damage.

2. Request that the Owner designate an IAQ representative.

3. Review and receive approval from the Owner's IAQ representative for all IAQ related construction activities and negative pressure containment plans.

4. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.

5. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.

6. Request copies of and follow all of the Owner's IAQ and infection control policies.

7. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.

8. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.

9. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings Under Construction".

END OF SECTION 21 05 00

# SECTION 21 05 17 - SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Grout.

### 1.3 SUBMITTALS

A. Submittals shall not be prepared for the Architect/Engineer's review. Project specific product data shall be included with the O&M Manuals.

B. Products provided under this specification will be inspected during job site observations. Failure to comply with these specifications will require remedial action at the expense of the Contractor, and the construction schedule will not be delayed.

## PART 2 - PRODUCTS

### 2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

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

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

## 2.2 STACK-SLEEVE FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. J. R. Smith.
2. Zurn.

B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

## 2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

## 2.4 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

## PART 3 - EXECUTION

### 3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, fire-rated partitions, roofs, and fire-rated walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

### 3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.

4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

## 3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

## 3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves.
   b. Piping NPS 6 and Larger: Cast-iron wall sleeves.

2. Exterior Concrete Walls below Grade:

   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system sleeve-seal fittings.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

   b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

   b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:

   a. Piping Smaller Than NPS 6: Stack-sleeve fittings.
   b. Piping NPS 6 and Larger: Stack-sleeve fittings.

5. Interior Partitions:

   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
   b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 21 05 17

# SECTION 21 05 18 - ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

### 1.3 SUBMITTALS

A. Submittals shall not be prepared for the Architect/Engineer's review. Project specific product data shall be included with the O&M Manuals.

B. Products provided under this specification will be inspected during job site observations. Failure to comply with these specifications will require remedial action at the expense of the Contractor, and the construction schedule will not be delayed.

## PART 2 - PRODUCTS

### 2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

### 2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.

2. Escutcheons for Existing Piping:

a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
e. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated finish.
f. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with concealed hinge.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

### 3.2 FIELD QUALITY CONTROL

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

END OF SECTION 21 05 18

# Section 21 05 53 - Identification For Fire-Suppression Piping And Equipment

## PART 1 - General

### 1.1 Related Documents

A. Drawings And General Provisions Of The Contract, Including General And Supplementary Conditions And Division 01 Specification Sections, Apply To This Section.

### 1.2 Summary

A. Section Includes:

1. Equipment Labels.
2. Warning Signs And Labels.
3. Pipe Labels.
4. Stencils.
5. Valve Tags.
6. Warning Tags.

### 1.3 Submittals

A. Submittals Shall Not Be Prepared For The Architect/Engineer's Review. Project Specific Product Data Shall Be Included With The O&M Manuals Along With The Following:

1. Equipment-Label Schedule Including Equipment Name, System, Description And Location.
2. Valve Schedules Including Valve Number, System, Description And Location.

B. Products Provided Under This Specification Will Be Inspected During Job Site Observations. Failure To Comply With These Specifications Will Require Remedial Action At The Expense Of The Contractor, And The Construction Schedule Will Not Be Delayed.

### 1.4 Coordination

A. Coordinate Installation Of Identifying Devices With Completion Of Covering And Painting Of Surfaces Where Devices Are To Be Applied.

B. Coordinate Installation Of Identifying Devices With Locations Of Access Panels And Doors.

C. Install Identifying Devices Before Installing Acoustical Ceilings And Similar Concealment.

PART 2 - Products

2.1 Equipment Labels

A. Metal Labels For Equipment:

1. Material And Thickness: Brass, 0.032 Inch Thick Or Stainless Steel, 0.025-Inch With Predrilled Holes For Attachment Hardware.
2. Letter Color: White.
3. Background Color: Red.
4. Minimum Label Size: Length And Width Vary For Required Label Content, But Not Less Than 2-1/2 By 3/4 Inch.
5. Minimum Letter Size: 1/4 Inch For Name Of Units If Viewing Distance Is Less Than 24 Inches, 1/2 Inch For Viewing Distances Up To 72 Inches, And Proportionately Larger Lettering For Greater Viewing Distances. Include Secondary Lettering Two-Thirds To Three-Fourths The Size Of Principal Lettering.
6. Fasteners: Stainless-Steel Rivets Or Self-Tapping Screws.
7. Adhesive: Contact-Type Permanent Adhesive, Compatible With Label And With Substrate.

B. Plastic Labels For Equipment:

1. Material And Thickness: Multilayer, Multicolor, Plastic Labels For Mechanical Engraving, 1/8 Inch Thick, With Predrilled Holes For Attachment Hardware.
2. Letter Color: White.
3. Background Color: Red.
4. Maximum Temperature: Able To Withstand Temperatures Up To 160° F.
5. Minimum Label Size: Length And Width Vary For Required Label Content, But Not Less Than 2-1/2 By 3/4 Inch.
6. Minimum Letter Size: 1/4 Inch For Name Of Units If Viewing Distance Is Less Than 24 Inches, 1/2 Inch For Viewing Distances Up To 72 Inches, And Proportionately Larger Lettering For Greater Viewing Distances. Include Secondary Lettering Two-Thirds To Three-Fourths The Size Of Principal Lettering.
7. Fasteners: Stainless-Steel Rivets Or Self-Tapping Screws.
8. Adhesive: Contact-Type Permanent Adhesive, Compatible With Label And With Substrate.

C. Label Content: Include Equipment's Drawing Designation Or Unique Equipment Number, Drawing Numbers Where Equipment Is Indicated (Plans, Details, And Schedules), And The Specification Section Number And Title Where Equipment Is Specified.

D. Equipment-Label Schedule: For Each Item Of Equipment To Be Labeled, On 8-1/2-By-11-Inch (A4) Bond Paper. Tabulate Equipment Identification Number And Identify Drawing Numbers Where Equipment Is Indicated (Plans, Details, And Schedules) And The Specification Section Number And Title Where Equipment Is Specified. Equipment Schedule Shall Be Included In Operation And Maintenance Data.

2.2 Warning Signs And Labels

A. Material And Thickness: Multilayer, Multicolor, Plastic Labels For Mechanical Engraving, 1/8 Inch Thick, With Predrilled Holes For Attachment Hardware.

B. Letter Color: White.

C. Background Color: Red.

D. Maximum Temperature: Able To Withstand Temperatures Up To 160° F.

E. Minimum Label Size: Length And Width Vary For Required Label Content, But Not Less Than 2-1/2 By 3/4 Inch.

F. Minimum Letter Size: 1/4 Inch For Name Of Units If Viewing Distance Is Less Than 24 Inches, 1/2 Inch For Viewing Distances Up To 72 Inches, And Proportionately Larger Lettering For Greater Viewing Distances. Include Secondary Lettering Two-Thirds To Three-Fourths The Size Of Principal Lettering.

G. Fasteners: Stainless-Steel Rivets Or Self-Tapping Screws.

H. Adhesive: Contact-Type Permanent Adhesive, Compatible With Label And With Substrate.

I. Label Content: Include Caution And Warning Information, Plus Emergency Notification Instructions.

2.3 Pipe Labels

A. General Requirements For Manufactured Pipe Labels: Preprinted, Color-Coded, With Lettering Indicating Service And Showing Flow Direction.

B. Pretensioned Pipe Labels: Precoiled, Semirigid Plastic Formed To Cover Full Circumference Of Pipe And To Attach To Pipe Without Fasteners Or Adhesive.

C. Self-Adhesive Pipe Labels: Printed Plastic With Contact-Type, Permanent-Adhesive Backing.

D. Pipe-Label Contents: Include Identification Of Piping Service Using Same Designations Or Abbreviations As Used On Drawings; Pipe Size; And An Arrow Indicating Flow Direction.

1. Flow-Direction Arrows: Integral With Piping-System Service Lettering To Accommodate Both Directions, Or As Separate Unit On Each Pipe Label To Indicate Flow Direction.
2. Lettering Size: At Least 1-1/2 Inches High.

E. Pipe-Label Colors:

1. Background Color: Red.
2. Letter Color: White.

2.4 Stencils

A. Stencils: Prepared With Letter Sizes According To Asme A13.1 For Piping; And Minimum Letter Height Of 3/4 Inch For Access Panel And Door Labels, Equipment Labels, And Similar Operational Instructions.

1. Stencil Material: Fiberboard Or Metal.
2. Stencil Paint: Exterior, Gloss, Acrylic Enamel Black Unless Otherwise Indicated. Paint May Be In Pressurized Spray-Can Form.
3. Identification Paint: Exterior, Acrylic Enamel In Colors According To Asme A13.1 Unless Otherwise Indicated.

2.5 Valve Tags

A. Valve Tags: Stamped Or Engraved With 1/4-Inch Letters For Piping-System Abbreviation And 1/2-Inch Numbers.

1. Tag Material: Brass, 0.032 Inch Or Stainless Steel, 0.025-Inch Minimum Thick, With Predrilled Holes For Attachment Hardware.
2. Fasteners: Brass Beaded Chain.
3. Valve-Tag Color: Red.
4. Letter Color: White.

B. Valve Schedules: For Each Piping System, On 8-1/2-By-11-Inch (A4) Bond Paper. Tabulate Valve Number, Piping System, System Abbreviation (As Shown On Valve Tag), Location Of Valve (Room Or Space), Normal-Operating Position (Open, Closed, Or Modulating), And Variations For Identification. Mark Valves For Emergency Shutoff And Similar Special Uses.

1. Valve-Tag Schedule Shall Be Included In Operation And Maintenance Data.

2.6 Warning Tags

A. Warning Tags: Preprinted Or Partially Preprinted, Accident-Prevention Tags, Of Plasticized Card Stock With Matte Finish Suitable For Writing.

1. Size: 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 Preparation

A. Clean Piping And Equipment Surfaces Of Substances That Could Impair Bond Of Identification Devices, Including Dirt, Oil, Grease, Release Agents, And Incompatible Primers, Paints, And Encapsulants.

3.2 Label Installation

A. Coordinate Installation Of Identifying Devices With Completion Of Covering And Painting Of Surfaces Where Devices Are To Be Applied.

B. Coordinate Installation Of Identifying Devices With Locations Of Access Panels And Doors.

C. Install Or Permanently Fasten Labels On Each Major Item Of Mechanical Equipment.

D. Locate Equipment Labels Where Accessible And Visible.

E. Piping Color-Coding: Painting Of Piping Is Specified In Division 09.

F. Stenciled Pipe-Label Option: Stenciled Labels May Be Provided Instead Of Manufactured Pipe Labels, At Installer's Option. Install Stenciled Pipe Labels, Complying With Asme A13.1, With Painted, Color-Coded Bands Or Rectangles On Each Piping System.

1. Identification Paint: Use For Contrasting Background.
2. Stencil Paint: Use For Pipe Marking.

G. Pipe-Label Locations: Locate Pipe Labels Where Piping Is Exposed Or Above Accessible Ceilings In Finished Spaces; Machine Rooms; Accessible Maintenance Spaces Such As Shafts, Tunnels, And Plenums; And Exterior Exposed Locations As Follows:

1. Near Each Valve And Control Device.
2. Near Each Branch Connection Excluding Short Takeoffs. Where Flow Pattern Is Not Obvious, Mark Each Pipe At Branch.
3. Near Penetrations Through Walls, Floors, Ceilings, And Inaccessible Enclosures.
4. At Access Doors, Manholes, And Similar Access Points That Permit View Of Concealed Piping.
5. Near Major Equipment Items And Other Points Of Origination And Termination.
6. Spaced At Maximum Intervals Of 25 Feet Along Each Run. Reduce Intervals To 12.5 Feet In Areas Of Congested Piping And Equipment.
7. On Piping Above Removable Acoustical Ceilings. Omit Intermediately Spaced Labels.

H. Pipe Label Color Schedule:

1. Fire Protection System Piping:

   a. Background Color: Red.
   b. Letter Color: White.

2. Fire Water Supply Piping:

   a. Background Color: White.
   b. Letter Color: Red.

3. Low-Pressure, Compressed-Air Piping:

   a. Background Color: Green.

b. Letter Color: White.

3.3 Valve-Tag Installation

A. Install Tags On Valves And Control Devices In Piping Systems. List Tagged Valves In A Valve-Tag Schedule.

B. Valve-Tag Application Schedule: Tag Valves According To Size, Shape, And With Captions Similar To Those Indicated In "Valve-Tag Size And Shape" Subparagraph Below:

1. Valve-Tag Size And Shape:

a. Fire-Suppression Standpipe: 1-1/2 Inches, Round.
b. Wet-Pipe Sprinkler System: 1-1/2 Inches, Round.
c. Dry-Pipe Sprinkler System: 1-1/2 Inches, Round.
d. Foam-Water System: 1-1/2 Inches, Round.
e. Clean-Agent Fire-Extinguishing System: 1-1/2 Inches, Round.

3.4 Warning-Tag Installation

A. Write Required Message On, And Attach Warning Tags To, Equipment And Other Items Where Required.

End Of Section 21 05 53

# SECTION 21 13 13 - WET-PIPE SPRINKLER SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Fire-department connections.
4. Sprinklers.
5. Alarm devices.
6. Manual control stations.
7. Control panels.
8. Pressure gages.

B. Related Sections:

1. Section 21 12 00 "Fire-Suppression Standpipes" for standpipe piping.
2. Section 21 13 16 "Dry-Pipe Sprinkler Systems" for dry-pipe sprinkler piping.
3. Section 21 13 39 "Foam-Water Systems" for AFFF piping.
4. Section 21 31 13 "Electric-Drive Fire Pumps" for fire pumps, pressure-maintenance pumps, and fire-pump controllers.

### 1.3 DEFINITIONS

A. High-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure higher than standard 175 psig, but not higher than 300 psig.

B. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig maximum.

### 1.4 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

B. Deluge Sprinkler System: Open sprinklers are attached to piping connected to water supply through deluge valve. Fire-detection system, in same area as sprinklers, opens valve. Water flows into piping system and discharges from attached sprinklers when valve opens.

## 1.5 PERFORMANCE REQUIREMENTS

A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

B. High-Pressure Piping System Component: Listed for 300-psig working pressure.

C. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer or NICET level 3 of higher, using performance requirements and design criteria indicated.

1. Refer to the Drawings for available fire-hydrant flow test records. Contractor shall perform current hydrant flow test prior to design of sprinkler system.

D. Sprinkler system design shall be approved by authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
2. Sprinkler Occupancy Hazard Classifications:

    a. Automobile Parking Areas: Ordinary Hazard, Group 1.
    b. Building Service Areas: Ordinary Hazard, Group 1.
    c. Churches: Light Hazard.
    d. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
    e. General Storage Areas: Ordinary Hazard, Group 1.
    f. Laundries: Ordinary Hazard, Group 1.
    g. Libraries except Stack Areas: Light Hazard.
    h. Library Stack Areas: Ordinary Hazard, Group 2.
    i. Machine Shops: Ordinary Hazard, Group 2.
    j. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
    k. Office, Patient and Public Areas: Light Hazard.
    l. Repair Garages: Ordinary Hazard, Group 2.
    m. Restaurant Service Areas: Ordinary Hazard, Group 1.

3. Minimum Density for Automatic-Sprinkler Piping Design:

    a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
    b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
    c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
    d. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. area.
    e. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. area.
    f. Special Occupancy Hazard: As determined by authorities having jurisdiction.

4. Minimum Density for Deluge-Sprinkler Piping Design:

    a. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over entire area.

5. Maximum Protection Area per Sprinkler:

    a. Office Spaces: 225 sq. ft.
    b. Storage Areas: 130 sq. ft.
    c. Mechanical Equipment Rooms: 130 sq. ft.
    d. Electrical Equipment Rooms: 130 sq. ft.
    e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.
    f. Sprinkler shall not protect more area than its UL listing.

6. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:

    a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
    b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.
    c. Extra-Hazard Occupancies: 500 gpm for 90 to 120 minutes.

E. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13, ASCE/SEI 7 and all local code requirements.

## 1.6 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. LEED Submittal:

1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content and chemical components.

C. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

D. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

E. Qualification Data: For qualified Installer and professional engineer.

F. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

G. Welding certificates.

H. Fire-hydrant flow test report.

I. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

J. Field quality-control reports.

K. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

## 1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. 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.

D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems."
2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

## 1.8 PROJECT CONDITIONS

A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:

1. Notify Architect, Construction Manager and Owner no fewer than seven days in advance of proposed interruption of sprinkler service.
2. Do not proceed with interruption of sprinkler service without Architect's, Construction Manager's and Owner's written permission.

1.9 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.2 STEEL PIPE AND FITTINGS

A. Schedule 40 Weight, Galvanized and Black Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Schedule 10, Black Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, plain end.

C. Galvanized and Black Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard weight, seamless steel pipe with threaded ends.

D. Galvanized and Uncoated, Steel Couplings: ASTM A 865, threaded.

E. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

F. Malleable- or Ductile-Iron Unions: UL 860.

G. Cast-Iron Flanges: ASME 16.1, Class 125.

H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

I. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

J. Grooved-Joint, Steel-Pipe Appurtenances:

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

   a. Anvil International, Inc.
   b. Shurjoint Piping Products.
   c. Tyco Fire & Building Products LP.
   d. Victaulic Company.

2. Pressure Rating: 175 psig minimum.
3. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

K. Steel Pressure-Seal Fittings: UL 213, FM-approved, 175-psig pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.

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

   a. Victaulic Company.

## 2.3 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.

B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.

D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

E. 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.

F. Grooved-Joint, Copper-Tube Appurtenances:

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

   a. Anvil International, Inc.
   b. Shurjoint Piping Products.

c. Victaulic Company.

2. Grooved-End, Copper Fittings: ASTM B 75 (ASTM B 75M), copper tube or ASTM B 584, bronze castings.
3. Grooved-End-Tube Couplings: To fit copper-tube dimensions, with design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gasket suitable for hot and cold water, and bolts and nuts.

## 2.4 CPVC PIPE AND FITTINGS

A. Piping shall meet or exceed the requirements of ASTM F442 material designation CPVC 4120-06 in standard dimension ratio (SDR) 13.5.

B. Piping shall be marked with the following pressure ratings: “320 PSI @ 73° F”, “175 PSI @ 150° F” and “100 PSI @ 180° F”.

C. Fittings shall meet or exceed the requirements of ASTM F437 (schedule 80 threaded), ASTM F438 (schedule 40 socket) and ASTM F439 (schedule 80 socket).

D. Both pipe and fittings shall be Listed by Underwriters Laboratories for use in wet automatic fire sprinkler systems and shall bear the logo of the Listing Agency. See UL Fire Protection Equipment Directory, categories VIWT and HFYH.

E. Ancillary products coming into contact with pipe and fittings must be chemically compatible as determined by CPVC pipe and fittings manufacturer or compound manufacturer, and thus Listed on pipe, fittings or compound manufacturer’s chemical compatibility program.

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

1. Georg Fischer Harvel
2. NIBCO INC.
3. Tyco Fire Suppression & Building Products
4. The Viking Corporation

## 2.5 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.

1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

E. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493, solvent cement recommended by pipe and fitting manufacturer, and made for joining CPVC sprinkler pipe and fittings. Include cleaner or primer recommended by pipe and fitting manufacturer.

1. Use solvent cement that has a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Use adhesive primer that has a VOC content of 650 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Plastic, Pipe-Flange Gasket, and Bolts and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

## 2.6 LISTED FIRE-PROTECTION VALVES

A. General Requirements:

1. Valves shall be UL listed or FM approved.
2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig.
3. Minimum Pressure Rating for High-Pressure Piping: 300 psig.

B. Ball Valves:

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

   a. Anvil International, Inc.
   b. Victaulic Company.

2. Standard: UL 1091 except with ball instead of disc.
3. Valves NPS 1-1/2 and Smaller: Bronze body with threaded ends.
4. Valves NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
5. Valves NPS 3: Ductile-iron body with grooved ends.

C. Bronze Butterfly Valves:

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

a. Global Safety Products, Inc.
b. Milwaukee Valve Company.

2. Standard: UL 1091.
3. Pressure Rating: 175 psig.
4. Body Material: Bronze.
5. End Connections: Threaded.

D. Iron Butterfly Valves:

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

a. Anvil International, Inc.
b. Kennedy Valve; a division of McWane, Inc.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Shurjoint Piping Products.
f. Tyco Fire & Building Products LP.
g. Victaulic Company.

2. Standard: UL 1091.
3. Pressure Rating: 175 psig.
4. Body Material: Ductile iron.
5. Style: Lug or wafer.
6. End Connections: Grooved.

E. Check Valves:

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

a. Anvil International, Inc.
b. Clow Valve Company; a division of McWane, Inc.
c. Crane Co.; Crane Valve Group; Crane Valves.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Division.
f. Globe Fire Sprinkler Corporation.
g. Kennedy Valve; a division of McWane, Inc.
h. Metraflex, Inc.
i. Milwaukee Valve Company.
j. Mueller Co.; Water Products Division.
k. NIBCO INC.
l. Potter Roemer.
m. Reliable Automatic Sprinkler Co., Inc.
n. Shurjoint Piping Products.
o. Tyco Fire & Building Products LP.
p. Victaulic Company.
q. Viking Corporation.

r. Watts Water Technologies, Inc.

2. Standard: UL 312.
3. Pressure Rating: 250 psig minimum.
4. Type: Swing check.
5. Body Material: Cast iron.
6. End Connections: Flanged or grooved.

F. Iron OS&Y Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Valve, Inc.
   b. Clow Valve Company; a division of McWane, Inc.
   c. Crane Co.; Crane Valve Group; Crane Valves.
   d. Crane Co.; Crane Valve Group; Jenkins Valves.
   e. Crane Co.; Crane Valve Group; Stockham Division.
   f. Hammond Valve.
   g. Milwaukee Valve Company.
   h. Mueller Co.; Water Products Division.
   i. NIBCO INC.
   j. Shurjoint Piping Products.
   k. Tyco Fire & Building Products LP.
   l. Watts Water Technologies, Inc.

2. Standard: UL 262.
3. Pressure Rating: 250 psig minimum.
4. Body Material: Ductile iron.
5. End Connections: Flanged or grooved.

G. Indicating-Type Butterfly Valves:

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

   a. Anvil International, Inc.
   b. Kennedy Valve; a division of McWane, Inc.
   c. Milwaukee Valve Company.
   d. NIBCO INC.
   e. Shurjoint Piping Products.
   f. Tyco Fire & Building Products LP.
   g. Victaulic Company.

2. Standard: UL 1091.
3. Pressure Rating: 175 psig minimum.
4. Valves NPS 2 and Smaller:

   a. Valve Type: Ball or butterfly.
   b. Body Material: Bronze.

c. End Connections: Threaded.

5. Valves NPS 2-1/2 and Larger:

a. Valve Type: Butterfly.
b. Body Material: Ductile iron.
c. End Connections: Flanged, grooved, or wafer.

6. Valve Operation: Integral electrical, 115-V ac, prewired, two-circuit, supervisory switch indicating device.

H. Indicator Posts:

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

a. American Valve, Inc.
b. Clow Valve Company; a division of McWane, Inc.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Kennedy Valve; a division of McWane, Inc.
e. Mueller Co.; Water Products Division.
f. NIBCO INC.
g. Tyco Fire & Building Products LP.

2. Standard: UL 789.
3. Type: Horizontal for wall mounting.
4. Body Material: Cast iron with extension rod and locking device.
5. Operation: Wrench.

## 2.7 TRIM AND DRAIN VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig minimum.

B. Angle Valves:

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

a. Fire Protection Products, Inc.
b. United Brass Works, Inc.

C. Ball Valves:

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

    a. Anvil International, Inc.
    b. Conbraco Industries, Inc.; Apollo Valves.
    c. Jomar International, Ltd.
    d. Kennedy Valve; a division of McWane, Inc.
    e. Legend Valve.
    f. Milwaukee Valve Company.
    g. NIBCO INC.
    h. Potter Roemer.
    i. Tyco Fire & Building Products LP.
    j. Victaulic Company.
    k. Watts Water Technologies, Inc.

D. Globe Valves:

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

    a. Fire Protection Products, Inc.
    b. United Brass Works, Inc.

## 2.8 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating:

    a. Standard-Pressure Piping Specialty Valves: 175 psig minimum.
    b. High-Pressure Piping Specialty Valves: 250 psig minimum.

3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Alarm Valves:

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

    a. Globe Fire Sprinkler Corporation.
    b. Reliable Automatic Sprinkler Co., Inc.
    c. Tyco Fire & Building Products LP.
    d. Victaulic Company.
    e. Viking Corporation.

2. Standard: UL 193.
3. Design: For horizontal or vertical installation.
4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.
5. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
6. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

C. Dry-Pipe Valves:

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

    a. CLA-VAL Automatic Control Valves.
    b. Globe Fire Sprinkler Corporation.
    c. Reliable Automatic Sprinkler Co., Inc.
    d. Tyco Fire & Building Products LP.
    e. Victaulic Company.
    f. Viking Corporation.

2. Standard: UL 260.
3. Design: Differential-pressure type.
4. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
5. Air-Pressure Maintenance Device:

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

        1) Globe Fire Sprinkler Corporation.
        2) Reliable Automatic Sprinkler Co., Inc.
        3) Tyco Fire & Building Products LP.
        4) Victaulic Company.
        5) Viking Corporation.

    b. Standard: UL 260.
    c. Type: Automatic device to maintain minimum air pressure in piping.
    d. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig adjustable range, and 175-psig outlet pressure.

6. Air Compressor:

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

        1) Gast Manufacturing Inc.

2) General Air Products, Inc.
3) Viking Corporation.

b. Standard: UL's "Fire Protection Equipment Directory" listing.
c. Motor Horsepower: Fractional.
d. Power: 120-V ac, 60 Hz, single phase.

D. Deluge Valves:

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

a. CLA-VAL Automatic Control Valves.
b. Globe Fire Sprinkler Corporation.
c. Reliable Automatic Sprinkler Co., Inc.
d. Tyco Fire & Building Products LP.
e. Victaulic Company.
f. Viking Corporation.

2. Standard: UL 260.
3. Design: Hydraulically operated, differential-pressure type.
4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, drip cup assembly piped without valves and separate from main drain line, fill-line attachment with strainer, and push-rod chamber supply connection.
5. Wet, Pilot-Line Trim Set: Include gage to read push-rod chamber pressure, globe valve for manual operation of deluge valve, and connection for actuation device.

E. Automatic (Ball Drip) Drain Valves:

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

a. Reliable Automatic Sprinkler Co., Inc.
b. Tyco Fire & Building Products LP.

2. Standard: UL 1726.
3. Pressure Rating: 175 psig minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4.
6. End Connections: Threaded.

## 2.9 FIRE-DEPARTMENT CONNECTIONS

A. Exposed-Type, Fire-Department Connection:

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

a. Elkhart Brass Mfg. Company, Inc.
b. Fire Protection Products, Inc.
c. Guardian Fire Equipment, Inc.
d. Tyco Fire & Building Products LP.

2. Standard: UL 405.
3. Type: Exposed, projecting, for wall mounting.
4. Pressure Rating: 175 psig minimum.
5. Body Material: Corrosion-resistant metal.
6. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
7. Caps: Brass, lugged type, with gasket and chain.
8. Escutcheon Plate: Round, brass, wall type.
9. Outlet: Back, with pipe threads.
10. Number of Inlets: Two, unless otherwise indicated.
11. Escutcheon Plate Marking Similar to:

a. "AUTO SPKR & STANDPIPE" for systems with sprinklers and standpipes.
b. "AUTO SPKR" for sprinklers systems only.
c. "STANDPIPE" for standpipes only.

12. Finish: Custom finish, color/type as determined by the Architect.
13. Outlet Size: Match size of connected piping.

B. Flush-Type, Fire-Department Connection:

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

a. Elkhart Brass Mfg. Company, Inc.
b. Guardian Fire Equipment, Inc.
c. Potter Roemer.

2. Standard: UL 405.
3. Type: Flush, for wall mounting.
4. Pressure Rating: 175 psig minimum.
5. Body Material: Corrosion-resistant metal.
6. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
7. Caps: Brass, lugged type, with gasket and chain.
8. Escutcheon Plate: Rectangular, brass, wall type.
9. Outlet: With pipe threads.
10. Body Style: Horizontal.
11. Number of Inlets: Two, unless otherwise indicated.
12. Outlet Location: Coordinate with construction limitations.
13. Escutcheon Plate Marking Similar to:

a. "AUTO SPKR & STANDPIPE" for systems with sprinklers and standpipes.
b. "AUTO SPKR" for sprinklers systems only.
c. "STANDPIPE" for standpipes only.

14. Finish: Custom finish, color/type as determined by the Architect.
15. Outlet Size: Match size of connected piping.

C. Yard-Type, Fire-Department Connection:

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

a. Elkhart Brass Mfg. Company, Inc.
b. Fire Protection Products, Inc.
c. Guardian Fire Equipment, Inc.

2. Standard: UL 405.
3. Type: Exposed, freestanding.
4. Pressure Rating: 175 psig minimum.
5. Body Material: Corrosion-resistant metal.
6. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
7. Caps: Brass, lugged type, with gasket and chain.
8. Escutcheon Plate: Round, brass, floor type.
9. Outlet: Bottom, with pipe threads.
10. Number of Inlets: Two, unless otherwise indicated.
11. Sleeve: Brass.
12. Sleeve Height: 18 inches.
13. Escutcheon Plate Marking Similar to:

a. "AUTO SPKR & STANDPIPE" for systems with sprinklers and standpipes.
b. "AUTO SPKR" for sprinklers systems only.
c. "STANDPIPE" for standpipes only.

14. Finish: Custom finish, color/type as determined by the Architect.
15. Outlet Size: Match size of connected piping.

## 2.10 VALVE CABINETS

A. Cabinet: White powder-coated 20 gage steel, box and door with 18 gage frame, lever door handle, and continuous steel hinge. Tempered safety glass window in door with the words “Fire Department Valve” written in red. Field paint all visible metal surfaces custom color as specified by architect. Specific size requirements shall accommodate the installed valve dimensions as determined by the system pressure.

B. Valve: 2-1/2” hose valve with end cap and chain. For installations in portions of the system that may exceed 175 PSI, provide a pressure regulator type hose valve. The valve cabinet shall be sized accordingly.

C. Fire Rating: For installations in fire rated walls up to 2-hours, provide a UL-listed box listed at 2 hours for flame, temperature, and/or hose stream.

D. Mounting Type: Fully recessed in dry wall installations. Surface mounted in CMU and concrete wall installations, unless otherwise noted on the drawings.

## 2.11 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:

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

    a. Anvil International, Inc.
    b. Shurjoint Piping Products.
    c. Tyco Fire & Building Products LP.
    d. Victaulic Company.

2. Standard: UL 213.
3. Pressure Rating: 175 psig minimum.
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-T and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

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

    a. Reliable Automatic Sprinkler Co., Inc.
    b. Tyco Fire & Building Products LP.
    c. Victaulic Company.

2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig minimum.
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

C. Branch Line Testers:

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

    a. Elkhart Brass Mfg. Company, Inc.
    b. Potter Roemer.

2. Standard: UL 199.
3. Pressure Rating: 175 psig.
4. Body Material: Brass.
5. Size: Same as connected piping.
6. Inlet: Threaded.
7. Drain Outlet: Threaded and capped.
8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:

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

    a. Tyco Fire & Building Products LP.
    b. Victaulic Company.
    c. Viking Corporation.

2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig minimum.
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:

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

    a. CECA, LLC.
    b. Corcoran Piping System Co.
    c. Merit Manufacturing; a division of Anvil International, Inc.

2. Standard: UL 1474.
3. Pressure Rating: 250 psig minimum.
4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
5. Size: Same as connected piping.
6. Length: Adjustable.
7. Inlet and Outlet: Threaded.

F. Flexible, Sprinkler Hose Fittings:

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

    a. Fivalco Inc.
    b. FlexHead Industries, Inc.
    c. Gateway Tubing, Inc.
    d. Reliable Automatic Sprinkler Co., Inc.
    e. Tyco Fire & Building Products LP.
    f. Victaulic Company.

2. Standard: UL 1474.
3. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
4. Pressure Rating: 175 psig minimum.
5. Size: Same as connected piping, for sprinkler.

## 2.12 SPRINKLERS

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

1. Globe Fire Sprinkler Corporation.
2. Reliable Automatic Sprinkler Co., Inc.
3. Tyco Fire & Building Products LP.
4. Victaulic Company.
5. Viking Corporation.

B. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Residential Sprinklers: 175 psig maximum.
3. Pressure Rating for Automatic Sprinklers: 175 psig minimum.
4. Pressure Rating for High-Pressure Automatic Sprinklers: 250 psig minimum.

C. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Residential Applications: UL 1626.
4. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
5. Coverage: Standard coverage unless otherwise specified on the drawings.

D. Open Sprinklers with Heat-Responsive Element Removed: UL 199.

1. Characteristics:

a. Nominal 1/2-inch Orifice: With Discharge Coefficient K between 5.3 and 5.8.
b. Nominal 17/32-inch Orifice: With Discharge Coefficient K between 7.4 and 8.2.

2. Coverage: Standard coverage unless otherwise specified on the drawings.

E. Sprinkler Finishes:

1. Installed in white hard ceiling or tiles: White; factory applied.
2. Installed in wood or non-white hard ceiling or tiles: Custom color/finish selected by Architect; factory applied.
3. Installed in occupied areas without ceilings: Chrome plated.
4. Installed in unoccupied areas without ceilings: Bronze.

F. Special Coatings:

1. Installed in corrosive environments: Corrosion-resistant paint, custom color selected by Architect; factory applied.

G. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Plastic, white finish, one piece, flat.
2. Sidewall Mounting: Plastic, white finish, one piece, flat.

H. Sprinkler Guards:

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

a. Reliable Automatic Sprinkler Co., Inc.
b. Tyco Fire & Building Products LP.
c. Victaulic Company.
d. Viking Corporation.

2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

## 2.13 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Electrically Operated Alarm Bell:

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

a. Fire-Lite Alarms, Inc.; a Honeywell company.

b. Notifier; a Honeywell company.
c. Potter Electric Signal Company.

2. Standard: UL 464.
3. Type: Vibrating, metal alarm bell.
4. Size: 8-inch minimum diameter.
5. Finish: Red-enamel factory finish, suitable for outdoor use.

C. Water-Flow Indicators:

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

a. ADT Security Services, Inc.
b. Potter Electric Signal Company.
c. System Sensor; a Honeywell company.
d. Viking Corporation.
e. Watts Industries (Canada) Inc.

2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig.
7. Design Installation: Horizontal or vertical.

D. Pressure Switches:

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

a. Potter Electric Signal Company.
b. System Sensor; a Honeywell company.
c. Tyco Fire & Building Products LP.
d. United Electric Controls Co.
e. Viking Corporation.

2. Standard: UL 346.
3. Type: Electrically supervised water-flow switch with retard feature.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design Operation: Rising pressure signals water flow.

E. Valve Supervisory Switches:

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

a. Fire-Lite Alarms, Inc.; a Honeywell company.
b. Kennedy Valve; a division of McWane, Inc.
c. Potter Electric Signal Company.
d. System Sensor; a Honeywell company.

2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.

F. Indicator-Post Supervisory Switches:

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

a. Potter Electric Signal Company.
b. System Sensor; a Honeywell company.

2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled indicator-post valve is in other than fully open position.

## 2.14 MANUAL CONTROL STATIONS

A. Description: UL listed or FM approved, hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

## 2.15 CONTROL PANELS

A. Description: Single-area, two-area, or single-area cross-zoned control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire-alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.

1. Panels: UL listed and FM approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
2. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

3. Manual Control Stations: Hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

## 2.16 PRESSURE GAGES

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

1. AMETEK; U.S. Gauge Division.
2. Ashcroft, Inc.

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch diameter.

D. Pressure Gage Range: 0 to 300 psig.

E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

F. Air System Piping Gage: Include retard feature and "AIR" or "AIR/WATER" label on dial face.

# PART 3 - EXECUTION

## 3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

## 3.2 SERVICE-ENTRANCE PIPING

A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Section 21 11 00 "Facility Fire-Suppression Water-Service Piping."

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Comply with requirements for backflow preventers in Section 21 11 00 "Facility Fire-Suppression Water-Service Piping."

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

## 3.3 WATER-SUPPLY CONNECTIONS

A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 22 11 16 "Domestic Water Piping."

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-distribution piping. Comply with requirements for backflow preventers in Section 22 11 19 "Domestic Water Piping Specialties."

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

## 3.4 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.

C. Install seismic restraints on piping. Comply with requirements for seismic-restraint device materials and installation in NFPA 13.

D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.

F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

H. Install sprinkler piping with drains for complete system drainage.

I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

J. Install deluge valves in branch piping service elevator shafts, elevator machine rooms, and other locations identifies on the Drawings. Coordinate electrical connection with fire alarm contractor.

K. Install automatic ball drip drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

L. Connect air compressor to the following piping and wiring:

1. Pressure gages and controls.
2. Electrical power system.
3. Fire-alarm devices, including low-pressure alarm.

M. Install alarm devices in piping systems.

N. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

O. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

P. Pressurize and check preaction sprinkler system piping and air-pressure maintenance devices.

Q. Fill sprinkler system piping with water.

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 21 05 18 "Escutcheons for Fire-Suppression Piping."

## 3.5 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.

I. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

K. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

L. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

M. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

N. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

O. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and copper pressure-seal fittings with tools recommended by fitting manufacturer.

P. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

Q. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

R. 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. Apply primer.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

## 3.6 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

A. Install cover system, brackets, and cover components for sprinkler piping according to manufacturer's "Installation Manual" and with NFPA 13 for supports.

## 3.7 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.
3. Deluge Valves: Install in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

## 3.8 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.

B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

## 3.9 FIRE-DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type, fire-department connections.

B. Install yard-type, fire-department connections in concrete slab support. Comply with requirements for concrete in Section 03 30 00 "Cast-in-Place Concrete."

1. Install two protective pipe bollards on sides of each fire-department connection. Comply with requirements for bollards in Section 05 50 00 "Metal Fabrications."

C. Install automatic ball drip drain valve at each check valve for fire-department connection.

D. Install alarm bell above each wall-type fire-department connection and on the building adjacent to each yard-type fire-department connection. Coordinate final mounting height and alternate locations with the local Fire Department and AHJ.

## 3.10 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

## 3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Coordinate with fire-pump tests. Operate as required.
7. Verify that equipment hose threads are same as local fire-department equipment.

C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

## 3.12 CLEANING

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

## 3.13 DEMONSTRATION

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

## 3.14 PIPING SCHEDULE

A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

C. Copper-tube, extruded-tee connections may be used for tee branches in copper tubing instead of specified copper fittings. Branch-connection joints must be brazed.

D. Standard-pressure, wet-pipe sprinkler system, NPS 1 and smaller:

1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

E. Standard-pressure, wet-pipe sprinkler system, NPS 1 to NPS 2:

1. Schedule 40, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

F. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 and larger:

1. Thinwall Schedule 10, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

G. Standard-pressure, wet-pipe sprinkler system, light hazard occupancies, NPS 3 and smaller:

1. CPVC Pipe with CPVC fittings.

H. Standard-pressure, wet-pipe sprinkler system located in MRI rooms:

1. Hard copper tube with solder-joint fittings.

I. High-pressure, wet-pipe sprinkler system:

1. Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.

## 3.15 SPRINKLER SCHEDULE

A. Provide sprinkler types for the following applications unless otherwise indicated on the drawings:

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings or Hard Ceilings: Concealed sprinklers.
3. Wall Mounting: Sidewall sprinklers.
4. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated.
5. Deluge-Sprinkler Systems: Upright and pendent, open sprinklers.
6. Special Applications: Quick response in all “I” occupancy spaces.

B. Provide sprinkler temperature classification ratings for the following applications unless otherwise indicated on the drawings:

1. General, office, clinical, laboratory: Ordinary; 100° F.
2. Mechanical rooms, electrical rooms, garages, equipment rooms: Intermediate; 150° F.
3. Boiler rooms, generator rooms, kitchens, kilns, incinerators, sterilization equipment rooms, laundry dryer rooms, maintenance rooms: High; 225° F.

END OF SECTION 21 13 13

# SECTION 21 22 00 - CLEAN-AGENT FIRE-EXTINGUISHING SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Piping and piping specialties.
2. Extinguishing-agent containers.
3. Extinguishing agent.
4. Detection and alarm devices.
5. Control and alarm panels.
6. Accessories.
7. Connection devices for and wiring between system components.
8. Connection devices for power and integration into building's fire-alarm system.

### 1.3 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. EPO: Emergency Power Off.

### 1.4 ACTION SUBMITTALS

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

B. LEED Submittals:

1. Product Data for EA Credit: Documentation indicating that clean agents comply.

C. Shop Drawings: For clean-agent fire-extinguishing system signed and sealed by a qualified professional engineer.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include design calculations.
3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Wiring Diagrams: For power, signal, and control wiring.

D. Delegated-Design Submittal: For clean-agent fire-extinguishing system signed and sealed by the qualified professional engineer.

1. Indicate compliance with performance requirements and design criteria, including analysis data.
2. Include design calculations for weight, volume, and concentration of extinguishing agent required for each hazard area.
3. Indicate the Following on Reflected Ceiling Plans:

    a. Ceiling penetrations and ceiling-mounted items.
    b. Extinguishing-agent containers if mounted above floor, piping and discharge nozzles, detectors, and accessories.
    c. Method of attaching hangers to building structure.
    d. Other ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, and access panels.

4. Indicate the Following on Occupied Work Area Plans:

    a. Controls and alarms.
    b. Extinguishing-agent containers, piping and discharge nozzles if mounted in space, detectors, and accessories.
    c. Equipment and furnishings.

5. Indicate the Following on Access Floor Space Plans:

    a. Extinguishing-agent containers, piping and discharge nozzles, detectors, and accessories.
    b. Method of supporting piping.

6. Indicate the Following on Ceiling Plans:

    a. Extinguishing-agent containers, piping and discharge nozzles, detectors, and accessories.
    b. Method of supporting piping.
    c. Other equipment located in the ceiling space that is being protected including sprinkler piping, HVAC equipment, raceways, or conduit.

## 1.5 INFORMATIONAL SUBMITTALS

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

1. Domestic water piping.
2. Items Penetrating Finished Ceiling Include the Following:

    a. Lighting fixtures.
    b. Air outlets and inlets.

3. Ductwork.
4. HVAC piping.

B. Permit Approved Drawings: Working plans, prepared according to NFPA 2001, that have been approved by authorities having jurisdiction. Include design calculations.

C. Seismic Qualification Certificates: For extinguishing-agent containers and control panels from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
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 reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For special agent system to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.

1. Detection Devices: Not less than 20 percent of amount of each type installed.
2. Container Valves: Not less than 10 percent of amount of each size and type installed.
3. Nozzles: Not less than 20 percent of amount of each type installed.
4. Extinguishing Agent: Not less than 100 percent of amount installed in largest hazard area. Include pressure-rated containers with valves.

1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. FM Global Compliance: Provide components that are FM Approved and that are listed in FM Global's "Approval Guide."

C. UL Compliance: Provide equipment and systems listed in UL's "Fire Protection Equipment Directory."

PART 2 - PRODUCTS

2.1 CLEAN-AGENT SYSTEMS

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

1. Ansul Incorporated.
2. Chemetron Fire Systems; a UTC Fire & Security company.
3. Fike Corporation.

B. Description: Clean-agent fire-extinguishing system shall be an engineered system for total flooding of the hazard area including the room cavity above the ceiling, below the ceiling, and below the raised floor. System includes separate zones above and below the ceiling and beneath the raised floor. If smoke is detected below the raised floor, extinguishing agent shall be discharged in the underfloor zone only. If smoke is detected below the ceiling, extinguishing agent shall be discharged in zones above and below the ceiling and below the floor. If smoke is detected above the ceiling, extinguishing agent shall be discharged in the zone above the ceiling only.

C. Delegated Design: Design clean-agent fire-extinguishing system and obtain approval from authorities having jurisdiction. Design system for Class A, B, and C fires as appropriate for areas being protected, and include safety factor. Use clean agent indicated and in concentration suitable for normally occupied areas.

**D. HFC 227ea Clean Agent (Trade Name: FM-200): Heptafluoropropane.**

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

    a. DuPont.
    b. Great Lakes Chemical Corporation; a Chemtura company.

2. Performance Requirements:

    a. Discharge HFC 227ea within 10 seconds and maintain 7.1 percent concentration by volume at 70 deg F for 10-minute holding time in hazard areas.
    b. HFC 227ea concentration in hazard areas greater than 9.0 percent immediately after discharge or less than 5.8 percent throughout holding time will not be accepted without written authorization from Owner and authorities having jurisdiction.
    c. System Capabilities: Minimum 620-psig calculated working pressure and 360-psig initial charging pressure.

**E. FK-5-1-12 Clean Agent (Trade Name: NOVEC 1230): Dodecaflouro-2-methylpentan-3-one.**

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

    a. 3M.

2. Performance Requirements:

    a. Discharge FK-5-1-12 within 10 seconds and maintain 6.6 percent concentration by volume at 70 deg F for 10-minute holding time in hazard areas.
    b. FK-5-1-12 concentration in hazard areas greater than 10.0 percent immediately after discharge or less than 6.5 percent throughout holding time will not be accepted without written authorization from Owner and authorities having jurisdiction.
    c. System Capabilities: Minimum 620-psig calculated working pressure and 360-psig initial charging pressure..

**F. IG-541 Clean Agent (Trade Name: Inergen): Mixture of nitrogen, argon, and carbon dioxide inert gases:**

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

    a. Ansul Incorporated.

2. Performance Requirements:

    a. Discharge IG-541 within 60 seconds and maintain 38 percent concentration by volume at 70 deg F for 10-minute holding time in hazard areas.
    b. IG-541 concentration in hazard areas greater than 40 percent immediately after discharge or less than 32 percent throughout holding time will not be accepted without written authorization from Owner and authorities having jurisdiction.
    c. System Capabilities: Minimum 2175-psig calculated working pressure upstream from orifice union, minimum 1000-psig calculated working pressure downstream from orifice union, and 2175-psig initial charging pressure.

G. Cross-Zoned Detection: Devices located in two separate zones. Sound alarm on activating single-detection device, and discharge extinguishing agent on actuating single-detection device in other zone.

H. Verified Detection: Devices located in single zone. Sound alarm on activating single-detection device, and discharge extinguishing agent on actuating second-detection device.

I. System Operating Sequence:

1. Actuating First Detector: Visual indication on annunciator panel. Energize audible and visual alarms (slow pulse), shut down air-conditioning and ventilating systems serving protected area, close doors in protected area, and send signal to fire-alarm system.
2. Actuating Second Detector: Visual indication on annunciator panel. Energize audible and visual alarms (fast pulse), shut down power to protected equipment, start time delay for extinguishing-agent discharge for 30 seconds, and discharge extinguishing agent. On agent discharge, release preaction valve to allow water to fill sprinkler system.
3. Extinguishing-agent discharge will operate audible alarms and strobe lights inside and outside the protected area.

J. System Operating Sequence: System shall be cross-zoned, air-sampling detectors and photoelectric detectors reporting to a fully programmable microprocessor-based control panel programmed to operate as follows:

1. If one photoelectric detector and air-sampling detector reaches the third detection level (Fire 1), agent discharge will be initiated as described for the third detection level (Fire 1) below.
2. Air-Sampling System:

    a. First Detection Level (Alert): Mild audible and visual indication on annunciator panel. Strobe lights flash slowly in the protected area.

b. Second Detection Level (Action): Strong audible and visual indication on annunciator panel. Strobe lights flash rapidly in the protected area.
c. Third Detection Level (Fire 1): Strong audible and visual indication on annunciator panel. Energize horn(s), bell(s), and strobe light(s) in the protected area and outside entry doors. Shut down air-conditioning and ventilating systems serving the protected area, and close doors in the protected area. Send signal to fire-alarm system, initiate 30-second time delay for extinguishing-agent discharge, and discharge extinguishing agent. At agent discharge, terminate power to equipment in the protected area, and release preaction valve to allow water flow to sprinkler system.
d. Fourth Detection Level (Fire 2): Same as Fire 1.

K. Manual stations shall immediately discharge extinguishing agent when activated.

L. Operating abort switches will delay extinguishing-agent discharge while being activated, and switches must be reset to prevent agent discharge. Release of hand pressure on the switch will cause agent discharge if the time delay has expired.

M. EPO: Will terminate power to protected equipment immediately on actuation.

N. Low-Agent Pressure Switch: Initiate trouble alarm if sensing less than set pressure.

O. Power Transfer Switch: Transfer from normal to stand-by power source.

P. Seismic Performance: Fire-suppression piping and containers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and local code requirements.

1. 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."

## 2.2 PIPE AND FITTINGS

A. Piping, Valves, and Discharge Nozzles: Comply with types and standards listed in NFPA 2001, Section "Distribution," for charging pressure of system.

B. Steel Pipe: ASTM A 53/A 53M, Type S, Grade B or ASTM A 106/A 106M, Grade A and Grade B; Schedule 40, Schedule 80, and Schedule 160, seamless steel pipe.

1. Threaded Fittings:

a. Malleable-Iron Fittings: ASME B16.3, Class 300.
b. Flanges and Flanged Fittings: ASME B16.5, Class 300 unless Class 600 is indicated.
c. Fittings Working Pressure: 620 psig minimum.
d. Flanged Joints: Class 300 minimum.

2. Forged-Steel Welding Fittings: ASME B16.11, Class 3000, socket pattern.
3. Steel, Grooved-End Fittings: FM Approved and NRTL listed, ASTM A 47/A 47M malleable iron or ASTM A 536 ductile iron, with dimensions matching steel pipe and ends factory grooved according to AWWA C606.

C. 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 (3.2-mm) maximum thickness unless thickness or specific material is indicated.

D. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

E. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Steel, Keyed Couplings: UL 213, AWWA C606, approved or listed for clean-agent service, and matching steel-pipe dimensions. Include ASTM A 536, ductile-iron housing, rubber gasket, and steel bolts and nuts.

## 2.3 VALVES

A. General Valve Requirements:

1. UL listed or FM Approved for use in fire-protection systems.
2. Compatible with type of clean agent used.

B. Container Valves: With rupture disc or solenoid and manual-release lever, capable of immediate and total agent discharge and suitable for intended flow capacity.

C. Valves in Sections of Closed Piping and Manifolds: Fabricate to prevent entrapment of liquid, or install valve and separate pressure relief device.

D. Valves in Manifolds: Check valve; installed to prevent loss of extinguishing agent when container is removed from manifold.

## 2.4 EXTINGUISHING-AGENT CONTAINERS

A. Description: Steel tanks complying with ASME Boiler and Pressure Vessel Code: Section VIII, for unfired pressure vessels. Include minimum working-pressure rating that matches system charging pressure, valve, pressure switch, and pressure gage.

1. Finish: Red, enamel or epoxy paint.
2. Manifold: Fabricate with valves, pressure switches, and connections for multiple storage containers, as indicated.
3. Manifold: Fabricate with valves, pressure switches, selector switch, and connections for main- and reserve-supply banks of multiple storage containers.
4. Storage-Tank Brackets: Factory- or field-fabricated retaining brackets consisting of steel straps and channels; suitable for container support, maintenance, and tank refilling or replacement.

## 2.5 DISCHARGE NOZZLES

A. Equipment manufacturer's standard one-piece brass or aluminum alloy of type, size, discharge pattern, and capacity required for application.

## 2.6 MANIFOLD AND ORIFICE UNIONS

A. Description: NRTL-listed device with minimum 2175-psig pressure rating, to control flow and reduce pressure of IG-541 gas in piping.

1. NPS 2 and Smaller: Piping assembly with orifice, sized for system design requirements.
2. NPS 2-1/2 and Larger: Piping assembly with nipple, sized for system design requirements.

## 2.7 CONTROL PANELS

A. Description: FM Approved or NRTL listed, including equipment and features required for testing, supervising, and operating fire-extinguishing system.

B. Power Requirements: 120/240-V ac; with electrical contacts for connection to system components and fire-alarm system, and transformer or rectifier as needed to produce power at voltage required for accessories and alarm devices.

C. Enclosure: NEMA ICS 6, Type 1, enameled-steel cabinet.

1. Mounting: Surface.

D. Supervised Circuits: Separate circuits for each independent hazard area.

1. Detection circuits equal to the required number of zones, or addressable devices assigned to the required number of zones.
2. Manual pull-station circuit.
3. Alarm circuit.
4. Release circuit.
5. Abort circuit.
6. EPO circuit.

E. Control-Panel Features:

1. Electrical contacts for shutting down fans, activating dampers, and operating system electrical devices.
2. Automatic switchover to standby power at loss of primary power.
3. Storage container, low-pressure indicator.
4. Service disconnect to interrupt system operation for maintenance with visual status indication on the annunciator panel.

F. Annunciator Panel: Graphic type showing protected, hazard-area plans, as well as locations of detectors and abort, EPO, and manual stations. Include lamps to indicate device-initiating alarm, electrical contacts for connection to control panel, and stainless-steel or aluminum enclosure.

G. Standby Power: Sealed lead calcium or sealed valve-regulated, recombinant lead acid or vented, wet-cell pocket, plate nickel cadmium batteries with capacity to operate system for 24 hours and alarm for minimum of 15 minutes. Include automatic battery charger that has a varying charging rate between trickle and high depending on battery voltage, and that is capable of maintaining batteries fully charged. Include manual voltage control, dc voltmeter, dc ammeter, electrical contacts for connection to control panel, automatic transfer switch, and suitable enclosure.

## 2.8 DETECTION DEVICES

A. General Requirements for Detection Devices:

1. Comply with NFPA 2001, NFPA 72, and UL 268.
2. 24-V dc, nominal.

B. Ionization Detectors: Dual-chamber type, having sampling and referencing chambers, with smoke-sensing element.

C. Photoelectric Detectors: LED light source and silicon photodiode receiving element.

D. Remote Air-Sampling Detector System: Includes air-sampling pipe network, a laser-based photoelectric detector, a sample transport fan, and a control unit.

1. Pipe Network: CPVC tubing connects control unit with calibrated sampling holes.
2. Smoke Detector: Particle-counting type with continuous laser beam. Sensitivity adjustable to a minimum of four preset values.
3. Sample Transport Fan: Centrifugal type, creating a minimum static pressure of 0.05-inch wg at all sampling ports.
4. Control Unit: Multizone unit as indicated on Drawings. Provides same system power supply, supervision, and alarm features as specified for the control panel plus separate trouble indication for airflow and detector problems.

E. Signals to the Central Fire Alarm Control Panel: Any type of local system trouble is reported to the central fire alarm control panel as a composite "trouble" signal. Alarms on each system zone are individually reported to the central fire alarm control panel as separately identified zones.

## 2.9 MANUAL STATIONS

A. General Description: Surface FM Approved or NRTL listed, with clear plastic hinged cover, 120-V ac or low voltage compatible with controls. Include contacts for connection to control panel.

B. Manual Release: "MANUAL RELEASE" caption, and red finish. Unit can manually discharge extinguishing agent with operating device that remains engaged until unlocked.

C. Abort Switch: "ABORT" caption, momentary contact, with green finish.

D. EPO Switch: "EPO" caption, with yellow finish.

## 2.10 SWITCHES

A. Description: FM Approved or NRTL listed, where available, 120-V ac or low voltage compatible with controls. Include contacts for connection to control panel.

1. Low-Agent Pressure Switches: Pneumatic operation.
2. Power Transfer Switches: Key-operation selector, for transfer of release circuit signal from main supply to reserve supply.

3. Door Closers: Magnetic retaining and release device or electrical interlock to cause the door operator to drive the door closed.

2.11 ALARM DEVICES

A. Description: Listed and labeled by an NRTL or FM Approved, low voltage, and surface mounting. Comply with requirements in Section 283111 "Digital, Addressable Fire-Alarm System" or Section 283112 "Zoned (DC Loop) Fire-Alarm System" for alarm and monitoring devices.

B. Bells: Minimum 6-inch diameter.

C. Horns: 90 to 94 dBA.

D. Strobe Lights: Translucent lens, with "FIRE" or similar caption.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with hazard-area leakage requirements, installation tolerances, and other conditions affecting work performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 HFC 227ea agent PIPING APPLICATIONS SCHEDULE**

A. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.

B. NPS 2 and Smaller: Schedule 40, steel pipe; malleable-iron threaded fittings; and threaded joints.

C. NPS 2-1/2 and Larger: Schedule 40, steel pipe; forged-steel welding fittings; and welded joints or steel, grooved-end fittings; steel, keyed couplings; and grooved joints.

**3.3 IG-541 agent PIPING APPLICATIONS SCHEDULE**

A. Piping between Storage Containers and Orifice Union: Schedule 160, steel pipe; forged-steel welding fittings; and welded joints.

B. Piping Downstream from Orifice Union: Schedule 40, steel pipe; malleable-iron fittings with threaded or flanged joints.

**3.4 FK-5-1-12 agent PIPING APPLICATIONS SCHEDULE**

A. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.

B. NPS 2 and Smaller: Schedule 40, steel pipe; malleable-iron threaded fittings; and threaded joints.

C. NPS 2-1/2 and Larger: Schedule 40, steel pipe; forged-steel welding fittings; and welded joints.

## 3.5 CLEAN-AGENT PIPING INSTALLATION

A. Install clean-agent extinguishing piping and other components level and plumb, according to manufacturers' written instructions.

B. Grooved Piping Joints: Groove pipe ends according to AWWA C606 dimensions. Assemble grooved-end steel pipe and steel, grooved-end fittings with steel, keyed couplings and lubricant according to manufacturer's written instructions.

C. Install extinguishing-agent containers anchored to substrate.

D. Install pipe and fittings, valves, and discharge nozzles according to requirements listed in NFPA 2001, Section "Distribution."

1. Install valves designed to prevent entrapment of liquid, or install pressure relief devices in valved sections of piping systems.
2. Support piping using supports and methods according to NFPA 13.
3. Install seismic restraints for extinguishing-agent containers and piping systems.
4. Install control panels, detection system components, alarms, and accessories, complying with requirements of NFPA 2001, Section "Detection, Actuation, and Control Systems," as required for supervised system application.

## 3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

C. Connect electrical devices to control panel and to building's fire-alarm system. Electrical power, wiring, and devices are specified in Section 283111 "Digital, Addressable Fire-Alarm System" or Section 283112 "Zoned (DC Loop) Fire-Alarm System."

## 3.7 IDENTIFICATION

A. Identify system components and equipment. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Identify piping, extinguishing-agent containers, other equipment, and panels according to NFPA 2001.

C. Install signs at entry doors for protected areas to warn occupants that they are entering a room protected with a clean-agent fire-extinguishing system.

D. Install signs at entry doors to advise persons outside the room the meaning of the horn(s), bell(s), and strobe light(s) outside the protected space.

## 3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

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.

D. Tests and Inspections:

1. After installing clean-agent extinguishing piping system and after electrical circuitry has been energized, test for compliance with requirements.
2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections "Inspection and Test Procedures" and "System Function Tests." Certify compliance with test parameters.
3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Units will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

## 3.9 CLEANING

A. Each pipe section shall be cleaned internally after preparation and before assembly by means of swabbing, using a suitable nonflammable cleaner. Pipe network shall be free of particulate matter and oil residue before installing nozzles or discharge devices.

## 3.10 SYSTEM FILLING

A. Preparation:

1. Verify that piping system installation is completed and cleaned.
2. Check for complete enclosure integrity.
3. Check operation of ventilation and exhaust systems.

B. Filling Procedures:

1. Fill extinguishing-agent containers with extinguishing agent, and pressurize to indicated charging pressure.
2. Install filled extinguishing-agent containers.

3. Energize circuits.
4. Adjust operating controls.

## 3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain clean-agent fire-extinguishing systems.

END OF SECTION 21 22 00

# SECTION 22 05 00 - COMMON WORK RESULTS FOR PLUMBING

## 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. Requirements in this Section apply to all Division 22 Sections.

### 1.2 SUMMARY

A. This Section includes the following:

1. Scope of Work and Construction Considerations.
2. Coordination Drawings.
3. Quality Assurance.
4. Submittal Requirements.
5. Change Orders.
6. Delivery, Storage, and Handling.
7. Coordination.

### 1.3 SCOPE OF WORK AND CONSTRUCTION CONSIDERATIONS

A. This Specification and the associated Drawings govern the furnishing, installation, testing, and placing into satisfactory operation the Plumbing Systems.

B. Contractor shall provide all new materials indicated on the Drawings and/or in these Specifications, and all items required to make his portion of the Plumbing Work a finished and working system.

C. Refer to the Construction Manager’s scope statements for complete scope of work description.

D. All work that will produce excessive noise or interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during unoccupied hours. The Owner reserves the right to determine when restricted construction hours will be required.

### 1.4 COORDINATION DRAWINGS

A. Definitions:


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1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.

    a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.

    b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5” and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.

    c. Communications trades shall include, but are not limited to, technology equipment, racks, conduit 1.5” and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.

    d. Maintenance clearances and code-required dedicated space shall be included.

    e. The coordination drawings shall include all underground, underfloor, infloor, in chase, and vertical trade items.

2. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.

2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the **[Mechanical Contractor] [General Contractor] [Construction Manager]**.

    a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.

3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. TRC will provide electronic file copies of drawings for contractor’s use if the contractor signs and returns an “Electronic File Transfer” waiver provided by TRC. TRC will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.


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C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.

   a. Scale of drawings:

      1) General plans: 1/4 Inch = 1 '-0" (minimum).

      2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).

      3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).

      4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1 '-0" (minimum).

      5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).

   b. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.

   c. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.

   d. The minimum quantity of drawings will be established at the first coordination meeting and sent to the Architect and Engineer for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the Architect, Engineer, and Owner's Representative. The Architect and Engineer will only review identified conflicts and give an opinion, but will not perform as a coordinator.

2. A plotted set of coordination drawings shall be available at the project site.

3. Coordination drawings are not shop drawings and shall not be submitted as such.

4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in his bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.

5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.

6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent

sizes to those shown on the drawings and determined necessary through the coordination process.

7. The Architect and Engineer reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.

8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the Architect and Engineer.

9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.

    a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.

    b. Potential layout changes shall be made to avoid additional access panels.

    c. Additional access panels shall not be allowed without written approval from the Architect and Engineer at the coordination drawing stage.

    d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the Architect, Engineer, and the Owner's Representative.

    e. When additional access panels are required, they shall be provided without additional cost to the Owner.

10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.

11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.

12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

## 1.5 QUALITY ASSURANCE

A. Contractor’s Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the drawings are of a representative nature only and may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such details can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require


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each subcontractor to likewise study the documents and report at once any deficiencies discovered.

2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers are acceptable.

2. All Contractors and subcontractors shall employ only workers skilled in their trades.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all State Codes.

2. Conform to all requirements of the **[City] [County]** of _____, Laws, Ordinances, and other regulations having jurisdiction.

3. Conform to all published standards of **[*Client Name*]**.

4. Conform to Federal Act S.3874 requiring the reduction of lead in drinking water.

5. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment to be used.

6. If the Contractor notes, at the time of bidding, any parts of the drawings or specifications that do not comply with the codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, he shall submit with his proposal a separate price to make the system comply with the codes and regulations.

7. All changes to the system made after letting of the contract in order to comply with codes or requirements of Inspectors shall be made by the Contractor without cost to the Owner, Architect, or Engineer.

8. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.

9. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.


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2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.

3. Pay all charges for permits or licenses.

4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.

5. Pay all charges arising out of required inspections by an authorized body.

6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.

7. Where applicable, all fixtures, equipment and materials shall be listed by Underwriters' Laboratories, Inc. and approved by FM Global.

E. Utility Company Requirements:

1. Secure from the appropriate private or public utility company all applicable requirements.

2. Comply with all utility company requirements.

3. Make application for and pay for utility connections and metering systems.

F. Examination of Drawings:

1. The drawings are diagrammatic in nature, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.

2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.

3. Scaling of the drawings is not sufficient or accurate for determining these locations.

4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner, Architect, or Engineer.

5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.

6. If an item is either on the drawings, in the specifications, or in the code, it shall be included in this contract.

7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.

8. Where used in these documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.

    a. Any item listed as furnished shall also be installed, unless otherwise noted.

    b. Any item listed as installed shall also be furnished, unless otherwise noted.

G. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

H. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing **[Revit MEP 201_] [AutoCAD]**.

2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.

3. Upon request for electronic media, the Contractor shall complete and return a signed “Electronic File Transmittal” form provided by TRC.

4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.

5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.

6. The drawings prepared by TRC for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.

7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.

8. The information is provided to expedite the project and assist the Contractor with no guarantee by TRC as to the accuracy or correctness of the information provided. TRC accepts no responsibility or liability for the Contractor’s use of these documents.

## 1.6 SUBMITTAL REQUIREMENTS

A. General Submittal Requirements: In addition to the requirements of Division 1, the following are required:


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1. Transmittal Sheet.

    a. Date.
    b. Project title and number.
    c. Contractor's and subcontractors' name and address.
    d. Division of work (e.g., fire protection, plumbing, heating, ventilating, etc.).
    e. Description of items submitted and relevant specification number (only one specification number per submittal).
    f. Notations of deviations from the contract documents.
    g. Other pertinent data.

2. Submittal Cover Sheet: All of the information provided on the Transmittal Sheet, plus:

    a. Supplier and manufacturer's names and addresses.
    b. Contractor's review stamp indicating he has thoroughly reviewed and approved all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed. Unstamped submittals will be rejected.
    c. Space for Architect/Engineer's review stamp

3. Submittal content shall include the following:

    a. Fabrication/layout drawings.
    b. Manufacturer's specification cut sheets with features, options and dimensions.
    c. Listed codes and standards.
    d. Wiring and control diagrams.
    e. Physical characteristics (size, weight, shipping notes, service requirements).
    f. Every page shall be marked up with project specific annotations and strikeouts to clearly identifying models, options, capacities, etc. being provided in compliance with the contract documents.
    g. Contractor shall use the same nomenclature as the contract documents.
    h. Reproduction of the contract documents alone is not acceptable for submittals.
    i. Incomplete or improperly prepared submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.

B. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal.

1. Initial review: Allow 10 business days for initial review of each submittal. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. Engineer will advise Contractor when a submittal must be delayed for coordination.

2. Concurrent review: Where concurrent review of submittals by Architect/Engineer's Consultants, Owner or other parties is required, allow 15 business days for initial review of each submittal.

C. Submittal Schedule:

1. Contractor shall submit all submittals to the Engineer for initial review within 30 days of award of contract, or within the first 10% of the duration of the project, whichever is less. Submittals which require processing completion prior to 40 business days after award of contract shall be scheduled with the Engineer at least 15 business days in advance of their requested due date.

2. Submittals shall be reviewed by the Architect/Engineer before releasing any equipment for manufacture or shipment.

3. Contractor's responsibility for errors, omissions, code compliance, or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's review.

4. Submittals shall be submitted electronically as PDF files in compliance with the naming, formatting, and organization requirements in Division 1.

D. Operations Manual: Include the following:

1. Final processed submittals of all Division 22 specification sections.

2. Subcontractor contact list including name, phone number and e-mail contact information.

3. Valve tag charts.

4. Field reports, including piping pressure testing.

5. Startup reports for all plumbing systems.

6. Certifications of piping systems, equipment or systems if specified in the individual specification section.

7. Operations and maintenance information for all plumbing equipment.

8. Final, coordinated record drawings.

a. Submit one set of Record Drawings for review by Architect/Engineer prior to submission of closeout documents. Record Drawings shall be submitted using the established submittal process.

b. Upon satisfactory review of the Record Drawing submittals by Engineer, provide three (3) printed sets of the Record Drawings and three (3) copies in electronic format with closeout documents

c. Paper Record Drawings shall be printed full size using the same sheet size as the construction documents issued to the contractor with the contractor's title block.

1) Electronic Record Drawings shall include **[AutoCAD] [a REVIT]** compatible **[files] [model]** and **[individual PDF files named by sheet**


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**and organized in folders by disciplines] [multi-sheet PDF files combined and named by discipline]**.

1.7 CHANGE ORDERS

A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders with inadequate breakdown will be rejected.

B. Change order work shall not proceed until authorized.

1.8 DELIVERY, STORAGE, AND HANDLING

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

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

C. Deliver, store and install materials and equipment (including supports and hangers) such that they are maintaining “as-new” condition (e.g. no rust) upon installation and up through the date of Substantial Completion. Account for environmental conditions of the construction site and schedule work accordingly.

D. Do not allow any materials nor equipment to be stored in standing water.

E. Keep all bearings properly lubricated and all belts properly tensioned and aligned.

F. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.

G. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate his/her work with other trades.

1.9 COORDINATION

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

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.


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C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

D. Existing Utilities: Do not interrupt utilities serving facilities occupied or partially occupied by the Owner or others unless specifically allowed under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Owner at least seven days in advance of proposed utility interruptions. Identify extent and duration of utility interruptions.
2. Indicate method of proposed utility interruptions in detail.
3. Do not proceed with proposed utility interruptions without Owner's permission.

E. Coordinate new installations with the existing installations which will remain in place and be reutilized or those that are abandoned in place. Provide transitions and fittings in piping as well as extra lengths of ductwork and piping as required to route around these existing installations. Illustrate all such pipe fittings on the as-built drawings submittal. Existing installations include HVAC, plumbing, electrical, and other building systems components including, but not limited to, ductwork, diffusers, hydronic piping, drain/vent piping, plumbing piping, fire protection piping, fire protection heads, electrical conduits, lights, etc. Coordinate installation of above ceiling components and devices such that maintenance access is achieved at the completion of the project when all ceiling mounted components are installed. Coordinate with all trades. Ultimate responsibility for any rework required to achieve maintenance access is the responsibility of the Contractor responsible for coordination as noted in Division 1 Sections. The required maintenance access is defined here for this contract:

1. A person with a 24" arm length can stand on a folding ladder which rests on the finished floor and which does not extend through the ceiling grid. All lights and diffusers remain in the grid when defining maintenance access. Ceiling tiles with sprinkler heads, smoke detectors, fire alarm devices and other system devices remain in the grid when defining maintenance access. Light fixtures and diffusers/grilles remain in the ceiling grid when defining maintenance access.
2. While standing on a step of this ladder which is rated for standing upon and while not leaning against the ceiling grid, this person can touch and visually monitor the following items with both hands at the same time:

    a. Sanitary piping cleanouts.
    b. Shutoff valves, balance valves and flow control valves.
    c. Pressure gauges and thermometers.

F. Locate buried utility and distribution services within the project area.

G. Provide temporary connections to maintain existing systems in service during the construction. This may include piping, power, controls and water, as well as other connections as required.

H. Provide the Owner a schedule prior to the start of demolition with phased selected demolition identified by system and by floor. Identify required outages on the schedule and any temporary measures required to maintain existing systems in service.

I. Coordinate the plumbing demolition with all aspects of demolition and temporary construction (including dust barriers) by other trades.

PART 2 - PRODUCTS

NOT APPLICABLE

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer, his employees, or subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 EXCAVATION, FILL, BACKFILL, COMPACTION

A. General:

1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found by calling 811.

2. The Contractor shall do all excavating, filling, backfilling and compacting associated with his work.

B. Excavation:

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.

2. Where excavations are made in error below foundations, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer, shall be placed in such excess excavations. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.

3. Trim bottom and sides of excavations to grades required for foundations.


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4. Protect excavations against frost and freezing.

5. Take care in excavating not to damage surrounding structures, equipment or buried pipe. Do not undermine footing or foundation.

6. Perform all trenching in a manner to prevent cave-ins and risk to workmen.

7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.

8. Where satisfactory bearing soil for foundations is not found at the indicated levels, the Architect/Engineer or their representative shall be notified immediately, and no further work shall be done until further instructions are given by the Architect/Engineer or their representative.

C. Dewatering:

1. Contractor shall furnish, install, operate and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.

D. Underground Obstructions:

1. Known underground piping, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Use great care in making installations near underground obstruction.

2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.

E. Fill and Backfilling:

1. No rubbish or waste material is permitted for fill or backfill.

2. Provide all necessary sand for backfilling.

3. Dispose of the excess excavated earth as directed.

4. Backfill materials shall be suitable for required compaction, clean and free of perishable materials and stones greater than 4 inches in diameter. Water shall not be permitted to rise in unbackfilled trenches. No material shall be used for backfilling that contains frozen earth, debris or earth with a high void content.

5. Backfill all trenches and excavations immediately after installing pipes, or removal of forms, unless other protection is provided.

6. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Fill and backfill materials shall be spread in 6 inch uniform horizontal layers with each layer compacted separately to required density.

7. Lay all piping on a compacted bed of sand at least 3 inches deep. Backfill around pipes with sand, 6 inch layers, and compact each layer.

8. Use sand for backfill up to grade for all piping under slabs or paved areas. All other piping shall have sand backfill to 6 inches above the top of the pipe.

9. Place all backfill above the sand in uniform layers not exceeding 6 inches deep. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement.

10. Where the fill and backfill will ultimately be under a building, floor or paving, each layer of fill shall be compacted to 95% of the maximum density determined by AASHTO Designation T-99 or ASTM Designation D-698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content determined by AASHTO T-99 or ASTM D-698 test.

F. Surface Restoration:

1. Where trenches are cut through graded, planted or landscaped areas, the areas shall be restored to the original condition. Replace all planting removed or damaged to its original condition. A minimum of 6 inches of topsoil shall be applied where disturbed areas are to be seeded or sodded.

2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition.

3.3 ARCHITECT/ENGINEER OBSERVATION OF WORK

A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Placing fill over underground and underslab utilities.
2. Covering exterior walls, interior partitions and chases.
3. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:

a. Pipe insulation is installed and fully sealed.
b. Pipe wall penetrations are sealed.
c. Pipe identification and valve tags are installed.

2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.


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3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

3.4 PROJECT CLOSEOUT

A. The following paragraphs supplement the requirements of Division 1.

B. Final Jobsite Observation:

1. The Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.

2. The Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.

3. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

C. Before final payment is authorized, this Contractor must submit the following:

1. Operation and maintenance manuals with copies of reviewed shop drawings.

2. Record documents including reproducible drawings and specifications.

3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.

4. Start-up reports on all equipment requiring a factory installation inspection or start-up.

5. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed; receipt by Owner to Architect/Engineer required prior to final payment approval.

3.5 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.


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2. Reviewed O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.

2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.

3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.

   a. O&M file name: O&M.div22.contractor.YYYYMMDD

   b. Transmittal file name: O&Mtransmittal.div22.contractor.YYYYMMDD

5. File Size: Electronic file size shall be limited to a maximum of 4MB. Larger files shall be divided into files that are clearly labeled as “1 of 2”, “2 of 2”, etc.

6. Provide the Owner with a reviewed copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title “Operation and Maintenance Instructions”, title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.

7. All text shall be searchable.

8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Paper Copy Submittal Procedures:

1. Once the electronic version of the manuals has been reviewed by the Architect/Engineer, three (3) paper copies of the O&M manual shall be provided to the Owner. The content of the paper copies shall be identical to the corrected electronic copy.

2. Binder Requirements: The Contractor shall submit three sets of O&M manuals in heavy duty, locking three ring binders. Incorporate clear vinyl sheet sleeves on

the front cover and spine for slip-in labeling. “Peel and stick” labels are **not** acceptable. Sheet lifters shall be supplied at the front of each notebook. The three-ring binders shall be 1/2" thicker than initial material to allow for future inserts. If more than one notebook is required, label in consecutive order. For example; 1 of 2, 2 of 2. No other form of binding is acceptable.

3. Binder Labels: Label the front and spine of each binder with “Operation and Maintenance Instructions”, title of project, and subject matter.

4. Index Tabs: Divide information by specification section, major equipment, or systems using index tabs. All tab titling shall be clearly printed under reinforced plastic tabs. All equipment shall be labeled to match the identification in the construction documents.

D. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.

2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.

3. Copies of all final reviewed shop drawings and submittals. Include Architect’s/Engineer’s shop drawing review comments and change orders. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.

4. Copy of final reviewed test and balance reports.

5. Copies of all factory inspections and/or equipment startup reports.

6. Copies of warranties.

7. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.

8. Dimensional drawings of equipment.

9. Capacities and utility consumption of equipment.

10. Detailed parts lists with lists of suppliers.

11. Operating procedures for each system.

12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.

13. Repair procedures for major components.

14. List of lubricants in all equipment and recommended frequency of lubrication.


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15. Instruction books, cards, and manuals furnished with the equipment.

3.6 INSTRUCTING THE OWNER'S REPRESENTATIVES

A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.

B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.

D. The instructions shall include:

1. Explanation of all system flow diagrams.
2. Maintenance of equipment.
3. Start-up procedures for all major equipment.
4. Explanation of seasonal system changes.

E. The Architect/Engineer shall be notified of the time and place instructions will be given to the Owner's representatives so he or his representative can attend if desired.

F. Refer to the respective specification sections for minimum hours of instruction for each system.

G. The Contractor shall prepare a detailed, written training agenda and submit it to the Architect/Engineer a minimum of two weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shutdown, seasonal changes, draining, venting, changing filters, changing belts, etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.

H. Operating Instructions:

1. Contractor is responsible for all instructions to the Owner's representatives for the mechanical and control systems.

2. If the Contractor does not have staff that can adequately provide the required instructions he shall include in his bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.7 SYSTEM COMMISSIONING

A. The plumbing systems shall be complete and operating. System start-up, testing, balancing, and satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final adjustments as required.


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B. Contractor shall adjust the plumbing systems and controls at season changes during the one year warranty period, as required, to provide satisfactory operation and to prove performance of all systems in all seasons.

C. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.

D. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

## 3.8 RECORD DOCUMENTS

A. The following paragraph supplements Division 1 requirements:

1. Contractor shall maintain at the job site a separate and complete set of plumbing coordination drawings and specifications on which he shall clearly and permanently mark in complete detail all changes made to the plumbing systems.

2. Mark drawings to:

   a. Indicate revisions to piping size and location, both exterior and interior. Note changes specifically due to Change Orders or RFI’s by name and number

   b. Identify devices, requiring periodic maintenance or repair.

   c. Identify and dimension from column lines actual locations of all equipment, underground piping (including inverts), mains and branches of piping systems, valves, and control system devices.

3. Mark specifications to show formally documented substitutions; Change Orders, and actual equipment and materials used.

4. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.

5. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

## 3.9 PAINTING

A. This Contractor shall paint the following items:


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1. All equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.

2. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, he shall have the equipment and all its supports, hangers, etc., painted to match the room decor.

3. Equipment cabinets, casings, covers, metal jackets, etc., in equipment rooms or concealed spaces, shall be furnished in standard or prime finish, free from scratches, abrasions, chips, etc.

4. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chips, etc. If color option is specified or is standard to the unit, this Contractor shall, before ordering, verify with the Architect/Engineer his color preference and furnish this color.

5. All equipment in unfinished areas such as boiler room, mechanical spaces, storage room, etc., furnished by this Contractor. Equipment furnished with a factory coat of paint and enamel need not be painted, provided the factory applied finish is not marred or spattered. If so, equipment shall be refinished with the same paint as was factory applied.

6. All outdoor uninsulated steel piping the color selected by Owner or Architect/Engineer.

B. After surfaces have been thoroughly cleaned and are free of oil, dirt, and other foreign matter; paint all pipes and equipment with the following:

   a. Bare Metal Surfaces - Apply one coat of primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.

   b. Insulated Surfaces - Paint insulation jackets with two coats of semi-gloss acrylic latex paint.

   c. Color of paint shall be as selected by the Architect.

3.10 ADJUST AND CLEAN

A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.

B. Clean all areas where moisture is present. Immediately report any mold, biological growth, or water damage.

C. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.11 SPECIAL REQUIREMENTS


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A. Contractor shall coordinate the installation of all equipment, valves, dampers, operators, etc., with other trades to maintain clear access area for servicing.

B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.

C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

3.12 IAQ MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

A. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:

1. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:

a. Minimizing the amount of dust generated.

b. Reducing solvent fumes and VOC emissions.

c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.

d. Protect stored on-site and installed absorptive materials from moisture damage.

2. Request that the Owner designate an IAQ representative.

3. Review and receive approval from the Owner's IAQ representative for all IAQ related construction activities and negative pressure containment plans.

4. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.

5. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.

6. Request copies of and follow all of the Owner's IAQ and infection control policies.

7. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.

8. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.

9. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings Under Construction".

END OF SECTION 22 05 00

# SECTION 22 05 16 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Flexible-hose packless expansion joints.
2. Metal-bellows packless expansion joints.
3. Rubber packless expansion joints.
4. Grooved-joint expansion joints.
5. Pipe loops and swing connections.
6. Alignment guides and anchors.

### 1.3 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

C. Delegated-Design: The contractor shall engage a qualified professional engineer to analyze and design the required expansion fittings, loops, anchors and alignment guides in each plumbing system. The engineer shall sign and seal the prepared analysis data and design documents.

1. Design Calculations: Calculate the requirements for thermal expansion of each piping system in conditioned and non-conditioned environments, accounting for the presence and absence of the system’s anticipated fluid properties. Select and design expansion joints, loops, and swing connections based on the calculations.
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.

D. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

1.4 SUBMITTALS

A. Submittals shall not be prepared for the Architect/Engineer's review. Project specific product data, sealed design documentation, and maintenance requirements shall be included with the O&M Manuals.

B. Products provided under this specification will be inspected during job site observations. Failure to comply with these specifications will require remedial action at the expense of the Contractor, and the construction schedule will not be delayed.

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."
2. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 PACKLESS EXPANSION JOINTS

A. Flexible-Hose Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Flex-Hose Co., Inc.
b. Flexicraft Industries.
c. Flex Pression Ltd.
d. Metraflex, Inc.
e. Unisource Manufacturing, Inc.

2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.

a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70° F and 340 psig at 450° F ratings.

5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded end connections.

a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70° F and 225 psig at 450° F ratings.

6. Expansion Joints for Steel Piping NPS 2 and Smaller: Stainless-steel fittings with threaded end connections.

    a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70° F and 325 psig at 600° F ratings.

7. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Stainless-steel fittings with flanged end connections.

    a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70° F and 145 psig at 600° F ratings.

8. Expansion Joints for Steel Piping NPS 8 to NPS 12: Stainless-steel fittings with flanged end connections.

    a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70° F and 90 psig at 600° F ratings.

B. Metal-Bellows Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Adsco Manufacturing LLC.
    b. American BOA, Inc.
    c. Badger Industries, Inc.
    d. Expansion Joint Systems, Inc.
    e. Flex-Hose Co., Inc.
    f. Flexicraft Industries.
    g. Flex Pression Ltd.
    h. Flex-Weld, Inc.
    i. Flo Fab inc.
    j. Hyspan Precision Products, Inc.
    k. Metraflex, Inc.
    l. Proco Products, Inc.
    m. Senior Flexonics Pathway.
    n. Tozen Corporation.
    o. Unaflex.
    p. Unisource Manufacturing, Inc.
    q. Universal Metal Hose; a subsidiary of Hyspan Precision Products, Inc.
    r. U.S. Bellows, Inc.
    s. WahlcoMetroflex.

2. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
3. Type: Circular, corrugated bellows with external tie rods.
4. Minimum Pressure Rating: 150 psig unless otherwise indicated.
5. Configuration: Single joint with base class(es) unless otherwise indicated.
6. Expansion Joints for Copper Tubing: Single- or multi-ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.

a. End Connections for Copper Tubing NPS 4 and Smaller: Threaded.
b. End Connections for Copper Tubing NPS 5 and Larger: Flanged.

C. Rubber Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Amber/Booth Company, Inc.; a div. of Vibration Isolation Products of Texas, Inc.
b. Flex-Hose Co., Inc.
c. Flexicraft Industries.
d. Flex-Weld, Inc.
e. Garlock Sealing Technologies.
f. General Rubber Corporation.
g. Mason Industries, Inc.; Mercer Rubber Co.
h. Metraflex, Inc.
i. Proco Products, Inc.
j. Red Valve Company, Inc.
k. Tozen Corporation.
l. Unaflex.
m. Unisource Manufacturing, Inc.

2. Standards: ASTM F 1123 and FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."
3. Material: Fabric-reinforced rubber complying with FSA-NMEJ-703.
4. Arch Type: multiple arches with external control rods.
5. Spherical Type: multiple spheres with external control rods.
6. Minimum Pressure Rating for NPS 1-1/2 to NPS 4: 150 psig at 220° F.
7. Minimum Pressure Rating for NPS 5 and NPS 6: 140 psig at 200° F.
8. Minimum Pressure Rating for NPS 8 to NPS 12: 140 psig at 180° F.
9. Material for Fluids Containing Acids, Alkalies, or Chemicals: EPDM.
10. Material for Fluids Containing Gas, Hydrocarbons, or Oil: Buna-N.
11. Material for Water: EPDM.
12. End Connections: Full-faced, integral steel flanges with steel retaining rings.

## 2.2 GROOVED-JOINT EXPANSION JOINTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Anvil International, Inc.
2. Shurjoint Piping Products.
3. Victaulic Company.

B. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.

C. Standard: AWWA C606, for grooved joints.

D. Nipples: Galvanized, ASTM A 53/A 53M, Schedule 40, Type E or S, steel pipe with grooved ends.

E. Couplings: Flexible type for steel-pipe dimensions. Include ferrous housing sections, Buna-N gasket suitable for diluted acid and alkaline fluids or EPDM gasket suitable for cold and hot water, and bolts and nuts.

## 2.3 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Adsco Manufacturing LLC.
   b. Advanced Thermal Systems, Inc.
   c. Flex-Hose Co., Inc.
   d. Flexicraft Industries.
   e. Flex-Weld, Inc.
   f. Hyspan Precision Products, Inc.
   g. Metraflex, Inc.
   h. Senior Flexonics Pathway.
   i. Unisource Manufacturing, Inc.
   j. U.S. Bellows, Inc.

2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

   a. Stud: Threaded, zinc-coated carbon steel.
   b. Expansion Plug: Zinc-coated steel.
   c. Washer and Nut: Zinc-coated steel.

5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
c. Washer and Nut: Zinc-coated steel.

## PART 3 - EXECUTION

### 3.1 EXPANSION-JOINT INSTALLATION

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

C. Install rubber packless expansion joints according to FSA-NMEJ-702.

D. Install grooved-joint expansion joints to grooved-end steel piping

### 3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.

C. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.

D. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

### 3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install one guide on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Black-Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Anchor Attachment to Galvanized-Steel Pipe: Attach with pipe hangers. Use MSS SP-69, Type 42, riser clamp welded to anchor.
3. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 22 05 16

# SECTION 22 05 17 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Grout.

### 1.3 SUBMITTALS

A. Submittals shall not be prepared for the Architect/Engineer's review. Project specific product data shall be included with the O&M Manuals.

B. Products provided under this specification will be inspected during job site observations. Failure to comply with these specifications will require remedial action at the expense of the Contractor, and the construction schedule will not be delayed.

## PART 2 - PRODUCTS

### 2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

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

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

## 2.2 STACK-SLEEVE FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. J. R. Smith.
2. Zurn.

B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

## 2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

## 2.4 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.


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D. Packaging: Premixed and factory packaged.

## PART 3 - EXECUTION

### 3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, fire-rated partitions, roofs, and fire-rated walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

### 3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

## 3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

## 3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves.
   b. Piping NPS 6 and Larger: Cast-iron wall sleeves.

2. Exterior Concrete Walls below Grade:

   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system sleeve-seal fittings.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

   b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:

a. Piping Smaller Than NPS 6: Stack-sleeve fittings.
b. Piping NPS 6 and Larger: Stack-sleeve fittings.

5. Interior Partitions:

a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 22 05 17

# SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

### 1.3 SUBMITTALS

A. Submittals shall not be prepared for the Architect/Engineer's review. Project specific product data shall be included with the O&M Manuals.

B. Products provided under this specification will be inspected during job site observations. Failure to comply with these specifications will require remedial action at the expense of the Contractor, and the construction schedule will not be delayed.

## PART 2 - PRODUCTS

### 2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

## 2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
   c. Insulated Piping: One-piece, stamped-steel type.
   d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
   e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
   f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
   g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.

2. Escutcheons for Existing Piping:

   a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
   b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
   c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
   d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
   e. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated finish.
   f. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with concealed hinge.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION 22 05 18

# SECTION 22 05 19 - METERS AND GAUGES FOR PLUMBING PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Thermowells.
3. Dial-type pressure gauges.
4. Gauge attachments.
5. Test plugs.
6. Test-plug kits.
7. Sight flow indicators.

B. Related Sections:

1. Section 21 11 00 "Facility Fire-Suppression Water-Service Piping" for fire-protection water-service meters outside the building.
2. Section 21 12 00 "Fire-Suppression Standpipes" for fire protection pressure gauges.
3. Section 21 13 13 "Wet-Pipe Sprinkler Systems"
4. Section 21 13 16 "Dry-Pipe Sprinkler Systems" for fire protection pressure gauges.
5. Section 21 13 39 "Foam-Water Systems" for fire protection pressure gauges.
6. Section 22 11 13 "Facility Water Distribution Piping" for domestic water meters and combined domestic and fire-protection water-service meters outside the building.
7. Section 22 11 16 "Domestic Water Piping" for water meters inside the building.

### 1.3 SUBMITTALS

A. Submittals shall not be prepared for the Architect/Engineer’s review. Project specific product data, sealed design documentation, and maintenance requirements shall be included with the O&M Manuals.

B. Products provided under this specification will be inspected during job site observations. Failure to comply with these specifications will require remedial action at the expense of the Contractor, and the construction schedule will not be delayed.

## PART 2 - PRODUCTS

### 2.1 BIMETALLIC-ACTUATED THERMOMETERS

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

1. Ashcroft Inc.
2. Ernst Flow Industries.
3. Marsh Bellofram.
4. Miljoco Corporation.
5. Nanmac Corporation.
6. Noshok.
7. Palmer Wahl Instrumentation Group.
8. REOTEMP Instrument Corporation.
9. Tel-Tru Manufacturing Company.
10. Trerice, H. O. Co.
11. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
12. Weiss Instruments, Inc.
13. WIKA Instrument Corporation - USA.
14. Winters Instruments - U.S.

B. Standard: ASME B40.200.

C. Case: Liquid-filled type(s); stainless steel with 3-inch nominal diameter.

D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in degrees F. Provide scale with system’s normal operation temperature in the middle third of the range

E. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.

F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.

G. Stem: 0.375 inch in diameter; stainless steel.

H. Window: Plain glass.

I. Ring: Stainless steel.

J. Element: Bimetal coil.

K. Pointer: Dark-colored metal.

L. Accuracy: Plus or minus 1 percent of scale range.

### 2.2 THERMOWELLS

A. Thermowells:

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

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

## 2.3 PRESSURE GAUGES

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

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

    a. AMETEK, Inc.; U.S. Gauge.
    b. Ashcroft Inc.
    c. Ernst Flow Industries.
    d. Flo Fab Inc.
    e. Marsh Bellofram.
    f. Miljoco Corporation.
    g. Noshok.
    h. Palmer Wahl Instrumentation Group.
    i. REOTEMP Instrument Corporation.
    j. Tel-Tru Manufacturing Company.
    k. Trerice, H. O. Co.
    l. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
    m. Weiss Instruments, Inc.
    n. WIKA Instrument Corporation - USA.
    o. Winters Instruments - U.S.

2. Standard: ASME B40.100.
3. Case: Liquid-filled type; cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.

10. Ring: Stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of scale range.

## 2.4 GAUGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS ¼, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass with stainless-steel ball, NPS 1/4, ASME B1.20.1 pipe threads.

## 2.5 TEST PLUGS

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

1. Flow Design, Inc.
2. Miljoco Corporation.
3. National Meter, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Company, Inc.
6. Trerice, H. O. Co.
7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
8. Weiss Instruments, Inc.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200° F.

F. Core Inserts: EPDM self-sealing rubber.

## 2.6 TEST-PLUG KITS

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

1. Flow Design, Inc.
2. Miljoco Corporation.
3. National Meter, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Company, Inc.
6. Trerice, H. O. Co.
7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
8. Weiss Instruments, Inc.

B. Furnish one test-plug kit containing two thermometers, one pressure gauge and adapter, and carrying case. Thermometer sensing elements, pressure gauge, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125° F.

D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220° F.

E. Pressure Gauge: Small, Bourdon-tube insertion type with 2- to 3-inch diameter dial and probe. Dial range shall be at least 0 to 200 psig.

F. Carrying Case: Metal or plastic, with formed instrument padding.

## 2.7 SIGHT FLOW INDICATORS

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

1. Archon Industries, Inc.
2. Dwyer Instruments, Inc.
3. Emerson Process Management; Brooks Instrument.
4. Ernst Co., John C., Inc.
5. Ernst Flow Industries.
6. KOBOLD Instruments, Inc. - USA; KOBOLD Messring GmbH.
7. OPW Engineered Systems; a Dover company.
8. Penberthy; A Brand of Tyco Valves & Controls - Prophetstown.

B. Description: Piping inline-installation device for visual verification of flow.

C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.

D. Minimum Pressure Rating: 125 psig.

E. Minimum Temperature Rating: 200° F.

F. End Connections for NPS 2 and Smaller: Threaded.

G. End Connections for NPS 2-1/2 Larger: Flanged.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.

H. Install remote-mounted pressure gauges on panel.

I. Install valve and snubber in piping for each pressure gauge for fluids.

J. Install test plugs in piping tees.

K. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.
2. Inlets and outlets of each domestic water heat exchanger.
3. Inlet and outlet of each domestic hot-water storage tank.
4. Inlets and outlet of each mixing valve (unless an equal gauge is integrated in the valve).
5. Inlet to each hot water circulation pump.
6. Inlet to each reverse osmosis machine.
7. Domestic cold, hot and circulation water mains serving a dedicated floor, suite or zone, installed on the fixture side of the area shutoff valves.
8. Outlet of the building water service backflow preventers.
9. Branch piping serving sterilizers, washers, and disinfectors.
10. Any other location identified on the drawings.

L. Install pressure gauges in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of water meters.
3. Inlet and outlet of backflow preventers.
4. Inlet and outlet of each pressure-reducing/regulating valve.
5. Suction and discharge of each water pump.
6. Inlets and outlet of mixing valves.
7. Domestic cold, hot and circulation water mains serving a dedicated floor, suite or zone, installed on the fixture side of the area shutoff valves.
8. Branch piping serving sterilizers, washers, and disinfectors.
9. Inlet and outlet of each water softener.
10. Inlet and outlet of each carbon filter.

11. Inlet and outlet of reverse osmosis machine
12. Inlet and outlet of each deionization tank.
13. Each circulated return to atmospheric tank.
14. Outlet of each sewage ejector/sump pump.
15. Any other location identified on the drawings.

## 3.2 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow service and maintenance of meters, gauges, machines, and equipment.

## 3.3 ADJUSTING

A. Adjust faces of meters and gauges to proper angle for best visibility.

## 3.4 THERMOMETER SCHEDULE

A. Thermometers shall be the following:

1. Liquid-filled, bimetallic-actuated type.
2. Direct-mounted, metal-case, vapor-actuated type.
3. Industrial-style, liquid-in-glass type.
4. Test plug with EPDM self-sealing rubber inserts.

B. Thermometer stems shall be of length to match thermowell insertion length.

C. Thermometer scale shall be such that the system's normal operating temperature is in the middle third of the range.

## 3.5 PRESSURE-GAUGE SCHEDULE

A. Pressure gauges shall be the following:

1. Liquid-filled, direct-mounted, metal case.
2. Test plug with EPDM self-sealing rubber inserts.

B. Pressure gauge scale shall be such that the system's normal operating temperature is in the middle third of the range.

END OF SECTION 22 05 19

# SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Bronze angle valves.
2. Bronze ball valves.
3. Iron, single-flange butterfly valves.
4. Iron, grooved-end butterfly valves.
5. Bronze swing check valves.
6. Iron swing check valves.
7. Iron swing check valves with closure control.
8. Bronze gate valves.
9. Iron gate valves.
10. Bronze globe valves.
11. Iron globe valves.
12. Chainwheels.

B. Related Sections:

1. Section 22 05 53 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
2. Section 22 11 13 "Facility Water Distribution Piping" for valves applicable only to this piping.
3. Section 22 11 16 "Domestic Water Piping" for valves applicable only to this piping.
4. Section 22 13 19 "Sanitary Waste Piping Specialties" for valves applicable only to this piping.
5. Section 22 14 23 "Storm Drainage Piping Specialties" for valves applicable only to this piping.
6. Section 22 15 13 "General-Service Compressed-Air Piping" for valves applicable only to this piping.
7. Section 22 61 13 "Compressed-Air Piping for Laboratory and Healthcare Facilities" for valves applicable only to this piping.
8. Section 22 62 13 "Vacuum Piping for Laboratory and Healthcare Facilities" for valves applicable only to this piping.
9. Section 22 63 13 "Gas Piping for Laboratory and Healthcare Facilities" for valves applicable only to this piping.
10. Section 33 41 00 "Storm Utility Drainage Piping" for valves applicable only to this piping.

11. Section 33 46 00 "Subdrainage" for valves applicable only to this piping.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. FKM: Fluoroelastomer.

D. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

E. NRS: Nonrising stem.

F. OS&Y: Outside screw and yoke.

G. RS: Rising stem.

H. SWP: Steam working pressure.

I. TFE: Polytetrafluoroethylene.

1.4 SUBMITTALS

A. Submittals shall not be prepared for the Architect/Engineer's review. Project specific product data shall be included with the O&M Manuals.

B. Products provided under this specification will be inspected during job site observations. Failure to comply with these specifications will require remedial action at the expense of the Contractor, and the construction schedule will not be delayed.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug-valve head.
5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.

2. Grooved: With grooves according to AWWA C606.
3. Solder Joint: With sockets according to ASME B16.18.
4. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

## 2.2 ANGLE VALVES

A. Bronze Angle Valves with Bronze Disc:

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

   a. Hammond Valve.
   b. Milwaukee Valve Company.

2. Description:

   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 200 psig.
   c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
   d. Ends: Threaded.
   e. Stem and Disc: Bronze.
   f. Packing: Asbestos free.
   g. Handwheel: Malleable iron, bronze, or aluminum.

## 2.3 BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

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

   a. Apollo Valves.
   b. Crane Valves.
   c. Hammond Valve.
   d. Lance Valves.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Watts.

2. Description:

   a. Standard: MSS SP-110.
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.

g. Seats: TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

## 2.4 BUTTERFLY VALVES

A. Single-Flange Butterfly Valves:

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

a. ABZ Valve and Controls.
b. Apollo Valves.
c. Cooper Cameron Valves.
d. Crane Valve.
e. DeZurik Water Controls.
f. Flo Fab Inc.
g. Hammond Valve.
h. Jenkins Valves.
i. Kitz Corporation.
j. Legend Valve.
k. Milwaukee Valve.
l. NIBCO INC.
m. Norriseal.
n. Red-White Valve Corporation.
o. Stockham
p. Watts.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 536, ductile iron.
e. Seat: FKM or TFE.
f. Stem: One- or two-piece stainless steel.
g. Disc: Stainless Steel.

B. Grooved-End Butterfly Valves:

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

a. Grinnell Mechanical Products.
b. Kennedy Valve.
c. Shurjoint Piping Products.
d. Victaulic Company.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 175 psig.
c. Body Material: ASTM A 536, ductile iron.
d. Seat: FKM or TFE.
e. Stem: One- or two-piece stainless steel.
f. Disc: Stainless Steel.

## 2.5 CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:

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

a. Crane Valves.
b. Hammond Valve.
c. Jenkins Valves.
d. Kitz Corporation.
e. Legend Valve.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Powell Valves.
i. Red-White Valve Corporation.
j. Stockham.
k. Sure Flow.
l. Watts.
m. Zy-Tech Global Industries, Inc.

2. Description:

a. Standard: MSS SP-139, Type 3.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Stainless steel.
g. Seat: Renewable

B. Class 125, Iron Swing Check Valves with Metal Seats:

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

a. Crane Valves.
b. Hammond Valve.
c. Jenkins Valves.
d. Kitz Corporation.
e. Legend Valve.

f. Milwaukee Valve Company.
g. NIBCO INC.
h. Powell Valves.
i. Red-White Valve Corporation.
j. Stockham.
k. Sure Flow.
l. Watts.
m. Zy-Tech Global Industries, Inc.

2. Description:

a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Disc: Stainless steel.
g. Seat: Stainless steel, renewable.
h. Gasket: Asbestos free.

C. Class 125, Iron Swing Check Valves with Lever- and Weight-Closure Control:

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

a. Crane Valves.
b. Hammond Valve.
c. Jenkins Valves
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Stockham Division.
g. Watts.

2. Description:

a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 536, ductile iron.
e. Ends: Flanged.
f. Disc: Stainless steel.
g. Seal: FKM of TFE.
h. Gasket: Asbestos free.
i. Closure Control: Factory-installed, exterior lever and weight.

## 2.6 GATE VALVES

A. Class 125, RS Bronze Gate Valves:

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

    a. American Valve, Inc.
    b. Crane Valves.
    c. Hammond Valve.
    d. Jenkins Valves.
    e. Kitz Corporation.
    f. Milwaukee Valve Company.
    g. NIBCO INC.
    h. Powell Valves.
    i. Red-White Valve Corporation.
    j. Stockham Division.
    k. Watts.
    l. Zy-Tech Global Industries, Inc.

2. Description:

    a. Standard: MSS SP-80, Type 2.
    b. CWP Rating: 200 psig.
    c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
    d. Ends: Threaded.
    e. Stem: Rising, stainless steel.
    f. Disc: Solid wedge; bronze.
    g. Packing: Asbestos free.
    h. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 125, OS&Y, Iron Gate Valves:

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

    a. Crane Valves.
    b. Flo Fab Inc.
    c. Hammond Valve.
    d. Jenkins Valves.
    e. Kitz Corporation.
    f. Legend Valve.
    g. Milwaukee Valve Company.
    h. NIBCO INC.
    i. Powell Valves.
    j. Red-White Valve Corporation.
    k. Stockham Division.
    l. Watts.
    m. Zy-Tech Global Industries, Inc.

2. Description:

    a. Standard: MSS SP-128, Type I.
    b. CWP Rating: 200 psig.
    c. Body Material: ASTM A 536, ductile iron.

d. Ends: Flanged.
e. Trim: 316 Stainless steel.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

## 2.7 GLOBE VALVES

A. Class 125, Bronze Globe Valves:

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

a. Crane Valves.
b. Hammond Valve.
c. Kitz Corporation.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Powell Valves.
g. Red-White Valve Corporation.
h. Stockham Division.
i. Watts.
j. Zy-Tech Global Industries, Inc.

2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded.
e. Stem and Disc: Stainless steel.
f. Seals: FKM of TFE
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 125, Iron Globe Valves:

1. Manufacturers: Subject to compliance with requirements, Provide products by one of the following:

a. Crane Valves.
b. Hammond Valve.
c. Kitz Corporation.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Powell Valves.
g. Red-White Valve Corporation.
h. Stockham Division.
i. Watts.
j. Zy-Tech Global Industries, Inc.

2. Description:

a. Standard: MSS SP-85, Type I.
b. CWP Rating: 200 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Stainless steel.
f. Packing and Gasket: Asbestos free.

## 2.8 CHAINWHEELS

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

1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries.
3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to ball, butterfly, and plug valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. Include zinc coating.
4. Chain: Stainless steel, of size required to fit sprocket rim.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

## 3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for ball, butterfly, gate, globe, and plug valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

## 3.3 ADJUSTING

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

## 3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service:

    a. NPS 3 and Smaller: Ball valve.
    b. NPS 4 and Larger: Butterfly valve.

2. Water Service Entrance: Configuration per Utility requirements, materials per this specification, whichever is more stringent. In the absence of specific Utility requirements, use shutoff service valves.
3. Dead-End Service: Butterfly Valve, single-flange (lug) type.
4. Throttling Service: Globe valve.
5. Pump-Discharge Check Valves:

    a. NPS 2 and Smaller: Bronze swing check valves with stainless steel disc and viton seat.
    b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight, renewable stainless steel seat and disc.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Grooved-End Copper Tubing and Steel Piping: Valve ends may be grooved when permitted per the system's pipe fitting specification.

## 3.5 COMPRESSED-AIR VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Ball Valves.
2. Bronze Swing Check Valves.

B. Pipe NPS 2-1/2 and Larger:

1. Ductile Iron, Butterfly Valves.
2. Ductile Iron Swing Check Valves.

## 3.6 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Ball Valves.
2. Bronze Globe Valves.
3. Bronze Swing Check Valves.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Ductile Iron, Butterfly Valves.
2. Ductile Iron Globe Valves.
3. Ductile Iron Swing Check Valves.

## 3.7 SANITARY-WASTE AND STORM-DRAINAGE VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Swing Check Valves.
2. Bronze Gate Valves.

B. Pipe NPS 2-1/2 and Larger:

1. Ductile Iron Swing Check Valves.
2. Ductile Iron Gate Valves.

END OF SECTION 22 05 23

# SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

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

B. Related Sections:

1. Section 05 50 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 22 05 16 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
3. Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

### 1.3 DEFINITIONS

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

### 1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. For components requiring seismic bracing, design seismic-restraint hangers and supports for piping and equipment.

1.5 SUBMITTALS

A. Submittals shall not be prepared for the Architect/Engineer's review. Project specific product data shall be included with the O&M Manuals.

B. Products provided under this specification will be inspected during job site observations. Failure to comply with these specifications will require remedial action at the expense of the Contractor, and the construction schedule will not be delayed.

1.6 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

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

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

## 2.2 TRAPEZE PIPE HANGERS

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

## 2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

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

    a. Allied Tube & Conduit.
    b. Cooper B-Line, Inc.
    c. Flex-Strut Inc.
    d. GS Metals Corp.
    e. Thomas & Betts Corporation.
    f. Unistrut Corporation; Tyco International, Ltd.
    g. Wesanco, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Hot-dipped galvanized.
8. Paint Coating: None.
9. Plastic Coating: None.
10. Combination Coating: None.

## 2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.

8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of insulated pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of insulated pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

## 2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

## 2.6 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Plastic.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

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

## 2.7 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

## 2.8 EQUIPMENT SUPPORTS

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

## 2.9 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, 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 INSTALLATION

A. Metal 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 the building structure.

B. Metal 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 for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.

F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

G. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

H. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 07 72 00 "Roof Accessories" for curbs.

I. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

J. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

K. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

L. 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.

M. Install lateral bracing with pipe hangers and supports to prevent swaying.

N. 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.

O. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

P. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

Q. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
    e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

## 3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

## 3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

## 3.4 ADJUSTING

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

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

## 3.5 PAINTING

A. Touchup: 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 a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings," respectively.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

## 3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers and attachments for hostile environment applications.

G. Use copper-plated pipe hangers and stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050° F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.

15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. 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.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction. Coordinate load bearing capacity of each area of structure with dead weight requirements of full piping in service.

S. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 22 05 29

# SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Stencils.
5. Valve tags.
6. Warning tags.

### 1.3 SUBMITTALS

A. Submittals shall not be prepared for the Architect/Engineer's review. Project specific product data shall be included with the O&M Manuals along with the following:

1. Equipment-Label Schedule including equipment name, system, description and location.
2. Valve Schedules including valve number, system, description and location.

B. Products provided under this specification will be inspected during job site observations. Failure to comply with these specifications will require remedial action at the expense of the Contractor, and the construction schedule will not be delayed.

### 1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch or Stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

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

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

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

### 2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Black.

D. Maximum Temperature: Able to withstand temperatures up to 160° F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

## 2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

## 2.4 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material: Fiberboard or metal.
2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.

3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

## 2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch or Stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass beaded chain.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

## 2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

# PART 3 - EXECUTION

## 3.1 PREPARATION

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

## 3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

## 3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09.

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

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

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 25 feet along each run. Reduce intervals to 12.5 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. Pipe Label Color Schedule:

1. Low-Pressure, Compressed-Air Piping:

   a. Background Color: Green.
   b. Letter Color: White.

2. Medium-Pressure, Compressed-Air Piping:

   a. Background Color: White.
   b. Letter Color: Green.

3. Domestic Cold Water Piping:

   a. Background Color: Green.
   b. Letter Color: White.

4. Domestic Hot Water and Hot Water Return Piping:

   a. Background Color: Yellow.
   b. Letter Color: Black.

5. Non-potable Water Piping:

   a. Background Color: Purple.
   b. Letter Color: White.

6. Sanitary Waste, Vent, and Storm Drainage Piping:

   a. Background Color: Green.
   b. Letter Color: White.

7. Natural Gas, Propane Gas, and Fuel Oil Piping:

   a. Background Color: Yellow.
   b. Letter Color: Black.

8. Pure Water Piping:

   a. Background Color: Blue.
   b. Letter Color: White.

9. Vacuum Piping:

   a. Background Color: Yellow.
   b. Letter Color: Black.

## 3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

   1. Valve-Tag Size and Shape: 1-1/2 inches, round.
   2. Valve-Tag Color: Natural.
   3. Letter Color: Black

## 3.5 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 22 05 53

# SECTION 22 07 19 - PLUMBING PIPING INSULATION

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic cold water piping.
2. Domestic hot water piping.
3. Domestic recirculating hot water piping.
4. Domestic chilled water piping for drinking fountains.
5. Sanitary waste piping exposed to freezing conditions.
6. Storm water piping exposed to freezing conditions.
7. Roof drains and rainwater leaders.

B. Related Sections:

1. Section 22 71 6 "Plumbing Equipment Insulation."

### 1.3 SUBMITTALS

A. Submittals shall not be prepared for the Architect/Engineer’s review. Project specific product data, sealed design documentation, and maintenance requirements shall be included with the O&M Manuals.

B. Products provided under this specification will be inspected during job site observations. Failure to comply with these specifications will require remedial action at the expense of the Contractor, and the construction schedule will not be delayed.

C. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.
2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that product complies 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."

## 1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Piping Mockups:

   a. One 10 foot section of NPS 2 straight pipe.
   b. One each of a 90-degree threaded, welded, and flanged elbow.
   c. One each of a threaded, welded, and flanged tee fitting.
   d. One NPS 2 or smaller valve, and one NPS 2-1/2 or larger valve.
   e. Four support hangers including hanger shield and insert.
   f. One threaded strainer and one flanged strainer with removable portion of insulation.
   g. One threaded reducer and one welded reducer.
   h. One pressure temperature tap.
   i. One mechanical coupling.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

D. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

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

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Aeroflex USA, Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

G. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000-Degree Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850°F Materials: Mineral or 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 "Factory-Applied Jackets" Article.

## 2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Ramco Insulation, Inc.; Super-Stik.

## 2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.

d. K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Dow Corning Corporation; 739, Dow Silicone.
b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Speedline Corporation; Polyco VP Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
    b. Eagle Bridges - Marathon Industries; 501.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
    d. Mon-Eco Industries, Inc.; 55-10.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
3. Service Temperature Range: 0 to 180° F.
4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
    b. Eagle Bridges - Marathon Industries; 570.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220° F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
    b. Eagle Bridges - Marathon Industries; 550.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
    d. Mon-Eco Industries, Inc.; 55-50.
    e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180° F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

## 2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
    b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
    c. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
4. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
5. Color: White.

## 2.6 SEALANTS

A. Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
    b. Eagle Bridges - Marathon Industries; 405.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
    d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250° F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile

Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250° F.
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Johns Manville; Zeston.
   b. P.I.C. Plastics, Inc.; FG Series.
   c. Proto Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White unless otherwise specified by Architect.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
    b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
    c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

    a. Factory cut and rolled to size.
    b. Finish and thickness are indicated in field-applied jacket schedules.
    c. Moisture Barrier for Outdoor Applications: 3-mil thick, heat-bonded polyethylene and kraft paper.
    d. Factory-Fabricated Fitting Covers:

        1) Same material, finish, and thickness as jacket.
        2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        3) Tee covers.
        4) Flange and union covers.
        5) End caps.
        6) Beveled collars.
        7) Valve covers.
        8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

## 2.8 TAPES

A. 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, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. ABI, Ideal Tape Division; 370 White PVC tape.
    b. Compac Corporation; 130.
    c. 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.

B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. ABI, Ideal Tape Division; 488 AWF.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
c. Compac Corporation; 120.
d. Venture Tape; 3520 CW.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

## 2.9 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping and Seals.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 1/2 inch wide with wing seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

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

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° 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° F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

## 3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

## 3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

## 3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted

tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover

in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

## 3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

## 3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

## 3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. 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.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

## 3.9 FINISHES

A. Insulation with Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum jackets.

## 3.10 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

## 3.11 PIPING INSULATION SCHEDULE, GENERAL

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

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 INDOOR PIPING INSULATION SCHEDULE (NON-FREEZING CONDITION)

A. Domestic Cold Water:

1. NPS 1 and Smaller: Insulation shall be one of the following:

a. Flexible Elastomeric: 1/2 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

2. NPS 1-1/4 and Larger: Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Domestic Hot and Hot Recirculation Water:

1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

2. NPS 1-1/2 and Larger: Insulation shall be one of the following:

a. Flexible Elastomeric: 1-1/2 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inch thick.

C. Domestic Chilled Water (Potable):

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

D. Stormwater and Overflow:

1. All Pipe Sizes (non-acoustically sensitive): Insulation shall be one of the following:

a. Flexible Elastomeric: 1/2 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

2. All Pipe Sizes (acoustically sensitive areas as noted on the Drawings): Insulation shall be one of the following:

a. Mineral-Wool, Preformed Pipe Insulation, Type I: 1-1/2 inch thick.

E. Roof Drain and Overflow Drain Bodies:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

F. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.

G. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60° F:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 1/2 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

## 3.13 OUTDOOR, ABOVEGROUND AND AREAS WITH FREEZING CONDITIONS PIPING INSULATION SCHEDULE

A. Domestic Cold, Hot, and Hot Recirculation Water:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 2 inches thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

B. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

## 3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.

D. Piping, Exposed:

1. PVC: 30 mils thick.

## 3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. Aluminum, Smooth 0.024 inch thick.

D. Piping, Exposed:
1. Painted Aluminum, Smooth 0.024 inch thick.

END OF SECTION 22 07 19

# SECTION 22 11 16 - DOMESTIC WATER PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
2. Encasement for piping.

B. Related Requirements:

1. Section 22 11 13 "Facility Water Distribution Piping" for water-service piping and water meters outside the building from source to the point where water-service piping enters the building.

### 1.3 SUBMITTALS

A. Submittals shall not be prepared for the Architect/Engineer’s review. Project specific product data, sealed design documentation, and maintenance requirements shall be included with the O&M Manuals.

B. Products provided under this specification will be inspected during job site observations. Failure to comply with these specifications will require remedial action at the expense of the Contractor, and the construction schedule will not be delayed.

C. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, 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."

1.4 FIELD 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 Architect/Engineer, Construction Manager, and Owner no fewer than seven days in advance of proposed interruption of water service.
2. Do not interrupt water service without Construction Manager's and Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

F. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

G. Copper Pressure-Seal-Joint Fittings:

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

a. Elkhart Products Corporation.
b. NIBCO Inc.

c. Viega.

2. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
3. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

H. Copper-Tube, Extruded-Tee Connections:

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

a. T-Drill Industries Inc.

2. Description: Tee formed in copper tube according to ASTM F 2014.

I. Appurtenances for Grooved-End Copper Tubing:

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

a. Anvil International.
b. Shurjoint Piping Products.
c. Victaulic Company.

2. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75 copper tube or ASTM B 584 bronze castings.
3. Mechanical Couplings for Grooved-End Copper Tubing:

a. Copper-tube dimensions and design similar to AWWA C606.
b. Ferrous housing sections.
c. EPDM-rubber gaskets suitable for hot and cold water.
d. Bolts and nuts.
e. Minimum Pressure Rating: 300 psig.

## 2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Standard-Pattern, Mechanical-Joint Fittings:

1. AWWA C110/A21.10, ductile or gray iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Compact-Pattern, Mechanical-Joint Fittings:

1. AWWA C153/A21.53, ductile iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

D. Plain-End, Ductile-Iron Pipe: AWWA C151/A21.51.

E. Appurtenances for Grooved-End, Ductile-Iron Pipe:

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

   a. Shurjoint Piping Products.
   b. Star Pipe Products.
   c. Victaulic Company.

2. Fittings for Grooved-End, Ductile-Iron Pipe: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions that match pipe.
3. Mechanical Couplings for Grooved-End, Ductile-Iron-Piping:

   a. AWWA C606 for ductile-iron-pipe dimensions.
   b. Ferrous housing sections.
   c. EPDM-rubber gaskets suitable for hot and cold water.
   d. Bolts and nuts.
   e. Minimum Pressure Rating:

      1) NPS 14 to NPS 18: 250 psig.
      2) NPS 20 to NPS 46: 150 psig.

## 2.4 STAINLESS-STEEL PIPING

A. Potable-water piping and components shall comply with NSF 61.

B. Stainless-Steel Pipe: ASTM A 312/A 312M, Schedule 10.

C. Stainless-Steel Pipe Fittings: ASTM A 815/A 815M.

D. Appurtenances for Grooved-End, Stainless-Steel Pipe:

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

   a. Anvil International.
   b. Grinnell Mechanical Products; Tyco Fire Products LP.
   c. Shurjoint Piping Products.
   d. Victaulic Company.

2. Fittings for Grooved-End, Stainless-Steel Pipe: Stainless-steel casting with dimensions matching stainless-steel pipe.
3. Mechanical Couplings for Grooved-End, Stainless-Steel Pipe:

   a. AWWA C606 for stainless-steel-pipe dimensions.

b. Stainless-steel housing sections.
c. Stainless-steel bolts and nuts.
d. EPDM-rubber gaskets suitable for hot and cold water.
e. Minimum Pressure Rating:

1) NPS 8 and Smaller: 600 psig.
2) NPS 10 and NPS 12: 400 psig.
3) NPS 14 to NPS 24: 250 psig.

## 2.5 CPVC PIPING

A. CPVC Pipe: ASTM F 441/F 441M, Schedule 40 and Schedule 80.

1. CPVC Socket Fittings: ASTM F 438 for Schedule 40 and ASTM F 439 for Schedule 80.
2. CPVC Threaded Fittings: ASTM F 437, Schedule 80.

## 2.6 PEX-a TUBE AND FITTINGS

A. PEX-a Distribution System: ASTM F 877, SDR 9 tubing.

B. Fittings for PEX-a Tube: ASTM F 1960, metal-insert type with expanded PEX-a rings and matching PEX tube dimensions.

C. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F 877; with plastic or corrosion-resistant-metal valve for each outlet.

D. Channel: Provide galvanized channel for all above ground piping. Installation shall comply with ASTM E84 assembly requirements.

## 2.7 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

F. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

G. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.

1. CPVC solvent cement shall have a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.8 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Cascade Waterworks Manufacturing.
b. Dresser, Inc.; Piping Specialties Products.
c. Ford Meter Box Company, Inc. (The).
d. JCM Industries.
e. Romac Industries, Inc.
f. Smith-Blair, Inc.; a Sensus company.
g. Viking Johnson.

D. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Charlotte Pipe and Foundry Company.
b. Harvel Plastics, Inc.
c. Spears Manufacturing Company.

2. Description:

a. CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.

b. One end with threaded brass insert and one solvent-cement-socket or threaded end.

E. Plastic-to-Metal Transition Unions:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Colonial Engineering, Inc.
b. NIBCO Inc.
c. Spears Manufacturing Company.

2. Description:

a. CPVC four-part union.
b. Brass or stainless-steel threaded end.
c. Solvent-cement-joint or threaded plastic end.
d. Rubber O-ring.
e. Union nut.

## 2.9 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
b. Central Plastics Company.
c. Hart Industries International, Inc.
d. Jomar International.
e. Matco-Norca.
f. McDonald, A. Y. Mfg. Co.
g. Watts; a division of Watts Water Technologies, Inc.
h. Wilkins; a Zurn company.

2. Standard: ASSE 1079.
3. Pressure Rating: 125 psig minimum at 180° F.
4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
    b. Central Plastics Company.
    c. Matco-Norca.
    d. Watts; a division of Watts Water Technologies, Inc.
    e. Wilkins; a Zurn company.

2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 125 psig minimum at 180° F.
5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Advance Products & Systems, Inc.
    b. Calpico, Inc.
    c. Central Plastics Company.
    d. Pipeline Seal and Insulator, Inc.

2. Nonconducting materials for field assembly of companion flanges.
3. Pressure Rating: 150 psig.
4. Gasket: Neoprene or phenolic.
5. Bolt Sleeves: Phenolic or polyethylene.
6. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Elster Perfection Corporation.
    b. Grinnell Mechanical Products; Tyco Fire Products LP.
    c. Matco-Norca.
    d. Precision Plumbing Products, Inc.
    e. Victaulic Company.

2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F 1545.
4. Pressure Rating and Temperature: 300 psig at 225° F.
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

## PART 3 - EXECUTION

### 3.1 EARTHWORK

A. Comply with requirements in Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

### 3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. 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.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105/A21.5.

E. Install underground PVC and CPVC pipe according to ASTM D2774-21a.

F. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 22 05 19 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 22 11 19 "Domestic Water Piping Specialties."

G. Install shutoff valve immediately upstream of each dielectric fitting.

H. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 22 11 19 "Domestic Water Piping Specialties."

I. Install domestic water piping level without pitch and plumb.

J. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

K. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

L. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

M. 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.

N. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

O. Install piping to permit valve servicing.

P. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

Q. Install piping free of sags and bends.

R. Install fittings for changes in direction and branch connections.

S. Install PEX piping with loop at each change of direction of more than 90 degrees.

T. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

U. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 22 05 19 "Meters and Gages for Plumbing Piping."

V. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 22 11 23 "Domestic Water Pumps."

W. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 22 05 19 "Meters and Gages for Plumbing Piping."

X. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

Y. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

Z. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

AA. Piping located in plenums shall be installed in materials or a system listed by ASTM E84 to meet flame and smoke spread requirements.

## 3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. 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.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

G. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

H. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

I. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

J. Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. Roll groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

K. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

L. Joint Construction for Solvent-Cemented Plastic Piping: 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. Apply primer.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

M. Joints for PEX-a Piping: Join according to ASTM F 1960.

N. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

## 3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition unions.

## 3.5 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

C. Dielectric Fittings for NPS 2-1/2 and Larger: Use dielectric flange kits.

## 3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger, support products, and installation in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:

   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.
7. NPS 8: 10 feet with 3/4-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Install hangers for steel and stainless 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.
7. NPS 6: 12 feet with 3/4-inch rod.
8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

H. Install supports for vertical steel and stainless steel piping every 15 feet.

I. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
3. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
4. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
5. NPS 6: 48 inches with 3/4-inch rod.
6. NPS 8: 48 inches with 7/8-inch rod.

J. Install supports for vertical CPVC piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.

K. Install PEX-a in galvanized steel channel and support according to the same copper pipe hanger and spacing requirements. Channel shall be installed on the bottom of horizontal piping in to comply with ASTM E84 assembly requirements.

L. Install hangers for vertical PEX piping every 48 inches.

M. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

## 3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

## 3.8 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

## 3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.

d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
b. 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 a separate report for each test, complete with diagram of portion of piping tested.
c. 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.
d. 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 it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

## 3.10 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

## 3.11 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures 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. Repeat procedures if biological examination shows contamination.
    e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. 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. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

## 3.12 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be one of the following:

1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
2. Soft copper tube, ASTM B 88, Type K; copper pressure-seal fittings; and pressure-sealed joints.
3. PEX-a coiled tube, ASTM F 1960; fittings for PEX-a tube; and expanded PEX-a ring joints. Piping under slab must be continuous with no joints.

E. Under-building-slab, domestic water, and building-service piping, NPS 4 and larger, shall be the following:

1. Mechanical-joint, ductile-iron pipe; standard or compact pattern, mechanical-joint fittings; and mechanical joints.

F. Aboveground domestic water piping, NPS 3 and smaller, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; cast or wrought copper, solder-joint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
3. CPVC, Schedule 40 pipe; socket fittings; and solvent-cemented joints.
4. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
5. PEX-a straight tube, ASTM F 1960; fittings for PEX-a tube; and expanded PEX-a ring joints. Install in galvanized steel channel.

    a. PEX-a shall not be allowed in water heater installations from the cold water supply check valve located upstream of the heater(s) to the high-temperature hot water inlet of the thermostatic mixing valve.

G. Aboveground domestic water piping, NPS 4 and larger, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; cast or wrought copper, solder-joint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L; grooved-joint, copper-tube appurtenances; and grooved joints.
3. Stainless-steel Schedule 10 pipe, grooved-joint fittings, and grooved joints.

## 3.13 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball valves for piping NPS 3 and smaller. Use butterfly or gate valves with flanged ends for piping NPS 4 and larger.

2. Throttling Duty: Use ball or globe valves for piping NPS 3 and smaller. Use butterfly or valves with flanged ends for piping NPS 4 and larger.
3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 22 11 16

# SECTION 22 13 16 - SANITARY WASTE, STORM DRAINAGE, AND VENT PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.
3. Encasement for underground metal piping.

B. Related Sections:

1. Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for sanitary waste, storm drainage and vent piping seismic requirements.
2. Section 22 13 13 "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.
3. Section 22 13 29 "Sewage Ejector and Sump Pumps" for effluent, sewage, and storm drainage pumps.
4. Section 22 66 00 "Chemical-Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.
5. Section 33 41 00 "Storm Utility Drainage Piping" for storm drainage piping outside the building.

### 1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.
2. Waste, Force-Main Piping: 100 psig.

### 1.4 SUBMITTALS

A. Submittals shall not be prepared for the Architect/Engineer’s review. Project specific product data, sealed design documentation, and maintenance requirements shall be included with the O&M Manuals.

B. Products provided under this specification will be inspected during job site observations. Failure to comply with these specifications will require remedial action at the expense of the Contractor, and the construction schedule will not be delayed.

C. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, 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."

D. Shop Drawings: For siphonic roof drainage system. Include calculations, plans, and details.

## 1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

## 1.6 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect/Engineer, Construction Manager, and Owner no fewer than seven days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Construction Manager's and Owner's written permission.

# PART 2 - PRODUCTS

## 2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

## 2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class.

B. Gaskets: ASTM C 564, rubber.

## 2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:

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

   a. ANACO-Husky.
   b. Dallas Specialty & Mfg. Co.
   c. Fernco Inc.
   d. Matco-Norca, Inc.
   e. MIFAB, Inc.
   f. Mission Rubber Company; a division of MCP Industries, Inc.
   g. Stant.
   h. Tyler Pipe.

2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:

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

   a. ANACO-Husky.
   b. Clamp-All Corp.
   c. Dallas Specialty & Mfg. Co.
   d. MIFAB, Inc.
   e. Mission Rubber Company; a division of MCP Industries, Inc.
   f. Stant.
   g. Tyler Pipe.

2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

## 2.4 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight class. Include square-cut-grooved or threaded ends matching joining method.

B. Steel Pipe Pressure Fittings:

1. Galvanized Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, 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. Galvanized Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.

C. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:

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

   a. Anvil International; a subsidiary of Mueller Water Products, Inc.
   b. Grinnell Mechanical Products.
   c. Shurjoint Piping Products.
   d. Victaulic Company.

2. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A 536 ductile-iron castings, ASTM A 47/A 47M malleable-iron castings, ASTM A 234/A 234M forged steel fittings, or ASTM A 106/A 106M steel pipes with dimensions matching ASTM A 53/A 53M steel pipe, and complying with AWWA C606 for grooved ends.
3. Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber gasket suitable for hot and cold water; and bolts and nuts.

## 2.5 STAINLESS-STEEL PIPE AND FITTINGS

A. Pipe: 316L austenitic stainless steel.

B. Fittings: 316L austenitic stainless steel with ASME A112.3.1 drainage pattern fittings with push-fit socket ends

C. Internal Sealing Rings: FPM gaskets shaped to fit socket groove rated for 300°F.

## 2.6 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent, Schedule 40 pipe.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.

1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of

Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Solvent Cement: ASTM D 2564.

1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.7 CPVC PIPE AND FITTINGS

A. Solid-Wall CPVC Pipe: ASTM F 441, drain, waste, and vent, Schedule 40 pipe.

B. CPVC Socket Fittings: ASTM D 2846, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.

1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Solvent Cement: ASTM F 493.

1. CPVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.8 SECONDARY-CONTAINMENT PIPE AND FITTINGS

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

1. Ipex.

B. Description: Schedule 40 PVC primary/Schedule 40 PVC secondary double containment piping.

C. Leak Detection:

1. Provide and install at each zone a density sensor station consisting of an external clip-on sensor, drip leg and drain valve with hose connection and/or riser and sensor extension handle.
2. Each sensor shall have an LED testing lamp, adjusting potentiometer and be removable for periodic testing.
3. Sensor shall not penetrate the containment piping jacket.
4. Control console shall be housed in a NEMA IV enclosure, operating on 120 VAC and supplies 24 VDC to zone sensors.
5. Console shall have alarm lamps, pilot lamp, test button and mute switch.
6. Console shall have a common audible alarm and external output switch for accessory alarms.

## 2.9 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:

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

        1) Dallas Specialty & Mfg. Co.
        2) Fernco Inc.
        3) Mission Rubber Company; a division of MCP Industries, Inc.
        4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.

    b. Standard: ASTM C 1173.
    c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
    d. Sleeve Materials:

        1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
        2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
        3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Pressure Transition Couplings:

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

        1) Cascade Waterworks Mfg. Co.
        2) Dresser, Inc.

3) EBAA Iron, Inc.
4) JCM Industries, Inc.
5) Romac Industries, Inc.
6) Smith-Blair, Inc.; a Sensus company.
7) The Ford Meter Box Company, Inc.
8) Viking Johnson.

b. Standard: AWWA C219.
c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
d. Center-Sleeve Material: Stainless steel.
e. Gasket Material: Natural or synthetic rubber.
f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:

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

1) Capitol Manufacturing Company.
2) Central Plastics Company.
3) Hart Industries International, Inc.
4) Jomar International Ltd.
5) Matco-Norca, Inc.
6) McDonald, A. Y. Mfg. Co.
7) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
8) Wilkins; a Zurn company.

b. Description:

1) Standard: ASSE 1079.
2) Pressure Rating: 125 psig minimum at 180° F.
3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

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

1) Capitol Manufacturing Company.
2) Central Plastics Company.
3) Matco-Norca, Inc.
4) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
5) Wilkins; a Zurn company.

b. Description:

1) Standard: ASSE 1079.
2) Factory-fabricated, bolted, companion-flange assembly.
3) Pressure Rating: 125 psig.
4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric Nipples:

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

1) Elster Perfection.
2) Grinnell Mechanical Products.
3) Matco-Norca, Inc.
4) Precision Plumbing Products, Inc.
5) Victaulic Company.

b. Description:

1) Standard: IAPMO PS 66
2) Electroplated steel nipple.
3) Pressure Rating: 300 psig at 225° F.
4) End Connections: Male threaded or grooved.
5) Lining: Inert and noncorrosive, propylene.

## PART 3 - EXECUTION

### 3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 "Earth Moving."

### 3.2 PIPING 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 coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use double wye and 1/8-bend combo fittings if two fixtures are installed back to back or side by side with common vertical drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

L. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

M. Install underground sanitary piping in separate trenches and a minimum of 10’ from adjacent domestic water piping. Where water and sanitary piping is required to cross, maintain 18” elevation difference with the water pipe at the higher elevation. Maintain elevation difference for 10’ on either side of the drain pipe center line.

N. Install soil, waste, and storm drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Sanitary and Storm Drainage Piping: 1/4 inch per foot percent downward in direction of flow for piping NPS 2-1/2 and smaller; 1/8 inch per foot downward in direction of flow for piping NPS 3 and larger.
2. Vent Piping: 1/8 inch per foot down toward vertical fixture vent or toward vent stack.

O. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

P. Install steel piping according to the plumbing code.

Q. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.

R. Install aboveground PVC and CPVC piping according to ASTM D 2665.

S. Install underground PVC and CPVC piping according to ASTM D 2321.

T. Install engineered siphonic drain specialties and storm drainage piping in locations indicated.

U. Install force mains at elevations indicated.

V. Plumbing Specialties:

1. Install backwater valves in sanitary and storm water gravity-flow piping. Comply with requirements for backwater valves specified in Section 22 13 19 "Sanitary Waste and Storm Drainage Piping Specialties."
2. Install cleanouts at grade, 5’ from the building foundation wall and extend to where building sanitary and storm drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Section 22 13 19 "Sanitary Waste and Storm Drainage Piping Specialties."
3. Install drains in sanitary and storm drainage gravity-flow piping. Comply with requirements for drains specified in Section 22 13 19 "Sanitary Waste and Storm Drainage Piping Specialties."

W. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

X. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

Y. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

Z. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

AA. Piping located in plenums shall be installed in materials or a system listed by ASTM E84 to meet flame and smoke spread requirements.

BB. Install leak detection zone alarm panels at 60” above finished floor to the centerline unless noted otherwise in the Drawings.

## 3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

C. 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.

D. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.

E. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

F. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.
3. CPVC Piping: Join according to ASTM D 2855 and ASTM D 2846 Appendixes.

## 3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Unshielded, nonpressure transition couplings.
3. In Aboveground Force Main Piping: Fitting-type transition couplings.
4. In Underground Force Main Piping:

   a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
   b. NPS 2 and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric nipples.
4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

## 3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves:

1. Install shutoff valve on each sewage pump discharge.
2. Install gate or full-port ball valve for piping NPS 2 and smaller.
3. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Comply with requirements for backwater valve specified in Section 22 13 19 "Sanitary Waste and Storm Drainage Piping Specialties."

## 3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron sanitary, storm, and vent piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron sanitary, storm, and vent piping every 15 feet.

H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 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: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
8. NPS 10 and NPS 12: 12 feet with 7/8-inch rod.

I. Install supports for vertical steel piping every 15 feet.

J. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2: 84 inches with 3/8-inch rod.
2. NPS 3: 96 inches with 1/2-inch rod.
3. NPS 4: 108 inches with 1/2-inch rod.
4. NPS 6: 10 feet with 5/8-inch rod.

K. Install supports for vertical stainless-steel piping every 10 feet.

L. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.

M. Install supports for vertical PVC piping every 48 inches.

N. Install hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.

O. Install supports for vertical CPVC piping every 48 inches.

P. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

## 3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Install horizontal backwater valves with cleanout cover flush with floor or in pit with pit cover flush with floor.
6. Comply with requirements for backwater valves, cleanouts, and drains specified in Section 22 13 19 "Sanitary Waste and Storm Drainage Piping Specialties."
7. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To sanitary force main.
2. Storm Sewer: To storm force main
3. Sewage Pump: To sewage pump discharge.
4. Sump Pump: To sump pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

## 3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

## 3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. 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 to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

## 3.10 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed PVC and CPVC Piping: Protect interior and exterior PVC and CPVC piping exposed to sunlight with two coats of water-based latex paint.

## 3.11 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, sanitary, storm, and vent piping shall be any of the following:

1. Hubless, cast-iron soil pipe and fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
3. Solid-wall CPVC pipe, CPVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

C. Aboveground, sanitary piping containment in sensitive areas as indicated on the Drawings shall be the following:

1. Double containment piping with leak detection at low points.
2. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

D. Underground, sanitary, storm, and vent piping shall be any of the following:

1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
2. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
3. Solid-wall CPVC pipe, CPVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

E. Sanitary sewage and storm water force mains shall be the following:

1. Galvanized-steel pipe, pressure fittings, and threaded joints.

F. Grease sewage shall be the following:

1. Stainless-steel pipe, fittings, and push-fit joints.

G. Sanitary piping serving mechanical rooms, central sterile equipment, commercial laundry equipment, applications with high temperature discharge above 140° F, and other locations indicated on the Drawings:

1. (Aboveground) Hubless, cast-iron soil pipe and fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
2. (Underground) Service class, cast-iron soil piping; gaskets; and gasketed joints.
3. Stainless-steel pipe, fittings, and push-fit joints.

END OF SECTION 22 13 16

# SECTION 22 16 13 – FUEL GAS PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.
6. Concrete bases.

B. Related Sections:

1. Division 22 Section “Meters and Gages for Plumbing Systems” for pressure gauges.
2. Division 22 Section “Fuel Gas Equipment” for gas equipment.
3. Division 33 Section “Natural Gas Distribution” for fuel gas service piping, specialties and accessories outside the building.

### 1.3 DEFINITIONS

A. Fuel Gas: Natural gas or LP gas fuels

### 1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.
2. Service Regulators: 100 psig minimum unless otherwise indicated.

B. Natural Gas Information:

1. Pressure: Refer to the Drawings for pressures within the building.
2. Nominal heating value: 960 BTU/cu.ft.
3. Specific gravity: 0.6.

## 1.5 SUBMITTALS

A. Submittals shall be prepare for pressure regulators. Include construction details, material descriptions and dimensions of individual components. Also include rated capacities, operating characteristics, and accessories.

B. Submittals for other item in this section shall not be prepared for the Architect/Engineer's review. Project specific product data, sealed design documentation, and maintenance requirements shall be included with the O&M Manuals.

C. Products provided under this specification will be inspected during job site observations. Failure to comply with these specifications will require remedial action at the expense of the Contractor, and the construction schedule will not be delayed.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel gas piping and specialties to include in emergency, operation, and maintenance manuals.

B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

## 1.7 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. 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.

D. Comply with NFPA 54, the International Fuel Gas Code and local codes for the installation, testing and inspection of the fuel gas system.

## 1.8 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing fuel gas piping according to requirements of authorities having jurisdiction.

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.

## 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. Interruption of Existing Fuel gas Service: Do not interrupt fuel gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of fuel gas supply according to requirements indicated:

1. Notify Architect and Owner no less than five working days in advance of proposed interruption of fuel gas service.
2. Do not proceed with interruption of fuel gas service without Architect’s and Owner's written permission.

## 1.10 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces.

# PART 2 - PRODUCTS

## 2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

    a. Material group: 1.1.
    b. End connections: Butt welding. Weld neck flange.
    c. Facing: Raised face.
    d. Gasket materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
    e. Bolts and holes: Spot faced.
    f. Wall thickness: Same as pipe in which installed.

5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

    a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

B. Corrugated, Stainless-Steel Tubing:

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

   a. OmegaFlex, Inc.

2. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
3. Coating: PE with flame retardant.

   a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

      1) Flame-Spread Index: 25 or less.
      2) Smoke-Developed Index: 50 or less.

4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
5. Striker Plates: Steel, designed to protect tubing from penetrations.
6. Operating-Pressure Rating: 5 psig.

## 2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches.

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

C. Weatherproof Vent Cap: Cast or malleable iron increaser fitting with corrosion resistant wire screw with free area at least equal to cross-sectional area of connecting pipe and threaded end connection.

## 2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for fuel gas.

B. 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.

## 2.4 MANUAL GAS SHUTOFF VALVES

A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

B. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig.
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Tamperproof Feature: Locking feature for valves indicated.
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

C. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110, NPS 2” and Smaller.

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

    a. BrassCraft Manufacturing Company; a Masco company.
    b. Conbraco Industries, Inc.; Apollo Div.
    c. Jomar International, LTD.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Stainless steel.
4. Stem: Stainless steel.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Separate packnut with adjustable-stem packing threaded ends.
7. Ends: Threaded.
8. CWP Rating: 500 psig.

D. Cast-Iron, Non-Lubricated Plug Valves: MSS SP-78, 2-1/2” and larger.

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

a. Mueller Co.; Gas Products Div.
b. Xomox Corporation; a Crane company.

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 fuel gas.
6. Ends: Flanged.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.
9. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.

## 2.5 EARTHQUAKE VALVES

A. Earthquake Valves: Comply with ASCE 25.

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

a. Pacific Seismic Products, Inc.
b. Vanguard Valves, Inc.

2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
3. Cast-aluminum body with stainless-steel internal parts.
4. Nitrile-rubber, reset-stem o-ring seal.
5. Valve position, open or closed, indicator.
6. Composition valve seat with clapper held by spring or magnet locking mechanism.
7. Level indicator.
8. End Connections: Threaded for valves NPS 2 and smaller; flanged for valves NPS 2-1/2 and larger.

## 2.6 PRESSURE REGULATORS

A. Single Line Pressure Regulators Suitable for Fuel Gas Service: Comply with ANSI Z21.80.

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

a. American Meter Company.
b. Fisher Control Valves and Regulators; Division of Emerson Process Management.
c. Maxitrol Company.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.

5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping. Terminate on exterior of building.
12. Inlet Pressure: As indicated on drawings.
13. Outlet Pressure: As indicated on drawings.
14. Connections: Threaded for valves NPS 2 and smaller, flanged for valves NPS 2-1/2 and larger.

## 2.7 MOTORIZED GAS VALVES

A. Electrically Operated Valves: Comply with UL 429.

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

   a. Asco Power Technologies, LP; Division of Emerson.
   b. Watts Regulator Co., Division of Watts Water Technologies, Inc.

2. Body: Brass.
3. Seats and disc: Nitrile rubber.
4. Springs and trim: Stainless steel.
5. 120 VAC, 60 Hz, Class B, continuous duty molded coil and replaceable.
6. NEMA ICS 6, Type 4, coil enclosure.
7. Visual position indicator.
8. Pilot operated.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine roughing-in for fuel gas piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

A. Close equipment shutoff valves before turning off fuel gas to premises or piping section.

B. Inspect fuel gas piping according to NFPA 54, the International Fuel Gas Code and local code requirements to determine that fuel gas utilization devices are turned off in piping section affected.

C. Comply with NFPA 54, the International Fuel Gas Code and local code requirements for prevention of accidental ignition.

## 3.3 PIPING INSTALLATION

A. Comply with NFPA 54, the International Fuel Gas Code and local code requirements for installation and purging of fuel 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. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. 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.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install fuel gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

N. Extend relief vent connections for each regulator, gas train and overpressure protection devices to outdoors. Terminate vents with turned down, reducing elbow fittings with corrosion resistant insect screen in large end.

O. 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.

P. Concealed Location Installations: Except as specified below, install concealed fuel gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Fuel gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
2. In Floor Channels: Install fuel gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
3. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
4. Prohibited Locations:

    a. Do not install fuel gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    b. Do not install fuel gas piping in solid walls or partitions.

Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

R. Connect branch piping from top or side of horizontal piping.

S. Install unions in pipes NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment. Unions are not required at flanged connections.

T. Do not use fuel gas piping as grounding electrode.

U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

V. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Section 22 05 19 “Meters and Gages for Plumbing Systems".

W. Install sleeves for piping penetrations of walls, ceilings, and floors. "

X. Install sleeve seals for piping penetrations of concrete walls and slabs.

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors.

## 3.4 SERVICE-METER ASSEMBLY INSTALLATION

A. Install service-meter assemblies provided by the utility company above ground on concrete bases.

B. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.

C. Install service meters downstream from pressure regulators.

D. Install metal bollards to protect meter assemblies.

E. Coordinate installation of service meter with utility company.

## 3.5 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of final equipment connection.

B. Coordinate pipe size of final equipment connection with equipment. Notify Architect/Engineer of discrepancies prior to installation.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

## 3.6 PIPING 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. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads.
5. 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.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Flanged Joints: Install gasket material, size, type, and thickness appropriate for fuel gas service. Install gasket concentrically positioned.

## 3.7 HANGER AND SUPPORT INSTALLATION

A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hangers and supports specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

C. 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.

## 3.8 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install fuel gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

F. Ground Equipment:

1. Tighten electrical connections and terminals according to manufacturer’s requirements.
2. Do not use gas pipe as grounding electrode.

## 3.9 LABELING AND IDENTIFYING

A. Comply with requirements in Division 22, Section "Identification for Plumbing Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

## 3.10 PAINTING

A. Comply with requirements in Division 09, Section "Exterior Painting" and Section 099123 "Interior Painting" for painting interior and exterior fuel gas piping.

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 (flat).
d. Color: Gray.

## 3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge fuel gas according to NFPA 54 and the International Fuel Gas Code and authorities having jurisdiction.

C. Fuel gas piping will be considered defective if it does not pass tests and inspections.

1. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.

D. Prepare test and inspection reports.

## 3.12 DEMONSTRATION

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

END OF SECTION 22 16 13

# SECTION 22 16 19 – FUEL GAS EQUIPMENT

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes fuel-gas distribution systems and the following:

1. AST and UST systems.
2. Vaporizer/mixer systems
3. LPG-level gage systems

B. Related Sections:

1. Division 22 Section “Meters and Gages for Plumbing Systems” for pressure gauges.
2. Division 22 Section “Fuel Gas Piping” for piping.
3. Division 33 Section “Natural Gas Distribution” for natural gas service piping, specialties and accessories outside the building.

### 1.3 DEFINITIONS

A. AST: Aboveground storage tank.

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. 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.

E. Fuel Gas: Natural gas or LPG fuels

F. LPG: Liquid propane gas.

G. UST: Underground storage tank.

## 1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.
2. Service Regulators: 100 psig minimum unless otherwise indicated.

B. Natural Gas Information:

1. Pressure: Refer to the Drawings for pressures within the building.
2. Nominal heating value: 960 BTU/cu.ft.
3. Specific gravity: 0.6.

C. Seismic Performance: Factory-installed support attachments for AST shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. 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."

## 1.5 SUBMITTALS

A. Product Data: For each type of product indicated in the Plumbing Equipment Schedule on the Drawings. Include materials of construction, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Products provided under this specification will be inspected during job site observations. Failure to comply with these specifications will require remedial action at the expense of the Contractor, and the construction schedule will not be delayed.

## 1.6 CLOSEOUT SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

C. Operation and Maintenance Data: For fuel-gas equipment and accessories to include in emergency, operation, and maintenance manuals.

D. Plans: Drawn to scale on which underground fuel gas piping, tanks, pumps, and evaporators are shown and dimensioned to nearest structure.

E. Photos: Installation photos of buried systems.

## 1.7 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. 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.

D. Comply with NFPA 54, NFPA 58, the International Fuel Gas Code and local codes for the installation, testing and inspection of the fuel gas system.

## 1.8 DELIVERY, STORAGE, AND HANDLING

A. Lift and support fuel-gas storage tanks only at designated lifting or supporting points, as shown on Shop Drawings. Do not move or lift tanks unless empty.

## 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. Interruption of Existing Fuel gas Service: Do not interrupt fuel gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of fuel gas supply according to requirements indicated:

1. Notify Architect and Owner no less than five working days in advance of proposed interruption of fuel gas service.
2. Do not proceed with interruption of fuel gas service without Architect’s and Owner's written permission.

## 1.10 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces.

## 1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-gas storage tanks, evaporators, pumps, and flexible, double-containment piping and related equipment that fail in materials or workmanship within specified warranty period.

1. Storage Tanks:

a. Failures include, but are not limited to, the following when used for storage of fuel gas at temperatures not exceeding 150 deg F:

1) Structural failures including cracking, breakup, and collapse.
2) Corrosion failure including external and internal corrosion of steel tanks.

b. Warranty Period: 30 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for fuel gas.

### 2.2 HORIZONTAL, STEEL, FUEL-GAS AST

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

1. Containment Solutions, Inc.
2. Highland Tank & Manufacturing Company, Inc.
3. Kennedy Tank and Manufacturing Co., Inc.
4. Modern Welding Company, Inc.
5. Steel Tank & Fabricating Co., Inc.

B. Description: ASME “U” stamped, steel horizontal tank with 2:1 elliptical ends; grit blasted with white urethane topcoat, flanged manway, grounding connectors, pre-piped external connections, and lift lugs.

C. Construction: Fabricated with welded SA516-70 high strength carbon steel; suitable for operation at 250 PSI WP at 125° F. Factory tested to 325 PSI at 125° F and RT3 x-ray inspected.

D. Supports: Manufacturer's standard structural steel welded to tank.

### 2.3 HORIZONTAL, STEEL, FUEL-GAS UST

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

1. Containment Solutions, Inc.
2. Highland Tank & Manufacturing Company, Inc.
3. Kennedy Tank and Manufacturing Co., Inc.
4. Modern Welding Company, Inc.
5. Steel Tank & Fabricating Co., Inc.

B. Description: ASME “U” stamped, steel horizontal tank with 2:1 elliptical ends; grit blasted with 75 mil polyurethane coat, flanged manway, grounding connectors, pre-piped external connections, lift lugs, and cofferdam work chamber dimensioned to meet field installation requirements.

C. Construction: Fabricated with welded SA516-70 high strength carbon steel; suitable for operation at 250 PSI WP at 125° F. Factory tested to 325 PSI at 125° F and RT3 x-ray inspected.

## 2.4 SHOP PAINTING OF FUEL GAS TANKS

A. Apply manufacturer's standard prime coat to exterior steel surface of tank and supports.

B. Prepare exterior steel surface of tank and supports.

C. Shop Cleaning: After fabrication, blast clean according to SSPC-SP 6/NACE No. 3 or SSPC-SP 10/NACE No. 2.

D. After cleaning, remove dust or residue from cleaned surfaces.

E. If surface develops rust before prime coat is applied, repeat surface preparation.

F. Apply manufacturer's standard prime coat to shop-cleaned, dry surface same day as surface preparation.

G. Apply finish coats.

## 2.5 FUEL-GAS AST ACCESSORIES

A. Tank Manholes: 22-inch minimum diameter; bolted, flanged, and gasketed; centered on top of tank.

B. Threaded pipe connection fittings on top of tank, for fill, supply, return, vent, sounding, and gaging. Include cast-iron plugs for shipping.

C. Lifting Lugs: For handling and installation.

D. Ladders: Carbon-steel ladder inside tank, anchored to top and bottom, and located as indicated. Include reinforcement of tank at bottom of ladder.

E. Ladders: Carbon-steel ladder outside tank, anchored to top and side wall. Comply with requirements in Section 055000 "Metal Fabrications" for exterior steel ladder.

1. Cage: Include welded steel cage around ladders for tanks 20 feet high or higher.

## 2.6 FUEL-GAS UST ACCESSORIES

A. Tank Manholes: 22-inch minimum diameter; bolted, flanged, and gasketed, with extension collar; for access to inside of tank.

B. Threaded pipe connection fittings on top of tank for fill, supply, return, vent, sounding, and gaging, in locations and of sizes indicated. Include cast-iron plugs for shipping.

C. Lifting Lugs: For handling and installation.

D. Ladders: Carbon-steel ladder inside tank, anchored to top and bottom. Include reinforcement of tank at bottom of ladder.

E. Containment Sumps: Fiberglass or PE with sump base, add-on extension pieces as required, sump top, lid, and gasket-seal joints. Include sump entry boots for pipe penetrations through sidewalls.

F. Sump Entry Boots: Two-part pipe fitting for field assembly and of size required to fit over pipe. Include gaskets shaped to fit sump sidewall, sleeves, seals, and clamps as required for liquid-tight pipe penetrations.

G. Anchor Straps: Storage tank manufacturer's standard anchoring system, with straps, strap-insulating material, cables and turnbuckles, of strength at least one and one-half times maximum uplift force of empty tank without backfill in place.

H. Filter Mat: Geotextile woven or spun filter fabric, in 1 or more layers, for minimum total weight of 3 oz./sq. yd..

I. Overfill Prevention Valves: Factory fabricated or shop or field assembled from manufacturer's standard components. Include drop tube, cap, fill nozzle adaptor, check valve mechanism or other devices, and vent if required to restrict flow at 80 percent of tank capacity and to provide complete shutoff of filling at 80 percent of tank capacity.

## 2.7 VAPORIZER/MIXER SYSTEM

A. Manufacturers: Subject to compliance with requirements, and equal to the following design standard:

1. Algas-SDI International LLC: QM Aquavaire

B. Description: NFPA 58 compliant and FM approved gas fired waterbath vaporizers and LPG/air mixer to provide mixed gas for use as a substitute for, or mixed with, natural gas.

1. The mixed gas will have a heating value of 1,450 Btu/scf and specific gravity of 1.32 at a delivered pressure of 5 psig. The delivered pressure shall be adjustable between 5 to 6 psig at full load. The liquid propane pressure required to operate the mixer shall not exceed 50 psig. The unit must have 100% turndown capacity.

2. The unit shall be a combination gas-fired waterbath LPG vaporizer and atmospheric Venturi LPG/air mixer package completely fabricated, piped, painted, and ready to be placed on the foundation to receive the contractor’s interconnecting piping and wiring.

3. The unit shall be suitable for operation down to -40° F (-40° C.).

4. All wiring, controls, electrical components and their installation shall comply with recognized code standards as defined in NFPA 58 and 70.

5. The vaporizer shall consist of a vertical vessel (waterbath) to hold a water and ethylene glycol or propylene glycol mixture (coolant) appropriate for freeze

protection to the lowest expected ambient temperature. The coolant in the waterbath shall be heated by a forced draft powered burner firing into fire tubes permanently fabricated into the waterbath. The fire tubes shall be single pass with a riser protruding through the top of the shell emitting the products of combustion through the discharge flue. Burner equipment and fire tube design shall be such that an external stack is not required. The waterbath shall be vented to the atmosphere and shall contain an integral expansion chamber.

6. The LPG heat exchanger shall be a single pass tube, and shall be fabricated in accordance with the requirements of the ASME Boiler and Pressure Vessel Code Section VIII, Division 1. Heat exchanger to have a design pressure rating of 250 psig @ 650° F. Heat exchanger shall include an internal vapor outlet header to minimize heat loss. The heat exchanger shall be equipped with a pressure relief valve to prevent unsafe pressure in the heat exchanger. This relief valve shall have a relief pressure of 250 psig and be sized in accordance with NFPA 58 and furnished by ALGAS-SDI International LLC (ASDI).

7. The burner assembly shall be enclosed and properly vented in an integral housing. The combustion equipment shall consist of a forced draft power burner containing its own combustion air fan, automatic ignition, electronic flame safeguard, and controls to provide for pre-purge. The burner shall be controlled to maintain a waterbath temperature of 165° F +/-5°.

8. The unit shall be equipped with a float switch installed in the vapor outlet header to prevent liquid LPG from being passed through the vapor outlet.

9. The unit's PLC shall include a low temperature safety subprogram to prevent the LPG inlet solenoid from opening and filling the heat exchanger with liquid before the waterbath has reached sufficient temperature to vaporize LPG.

10. The waterbath shall have a low water level switch to shut off the system if water level falls below a safe level.

11. The waterbath shall have a high temperature switch that will shut off the system if the water temperature rises to an unsafe temperature.

12. Waterbath shall include a circulation pump to eliminate thermal stratification and increase water side heat transfer.

13. The shell of the waterbath shall be insulated with closed cell foam. Insulation must maintain R value when exposed to moisture.

14. The unit shall have an integrated PLC controlled operating system with user interface and on/off/standby modes. The user interface shall display trouble shooting information. Monitored alarm display points shall be:

    a. Power failure
    b. Flame failure
    c. High waterbath temperature
    d. Low waterbath temperature
    e. LPG high liquid level

f. LPG high pressure
g. High mixed gas pressure
h. Low mixer inlet LPG vapor pressure

15. After occurrence and correction of a safety shutdown situation, manual starting of the unit shall be required.

16. Weatherproof enclosure shall be galvanized and powder coated to ensure maximum rust protection.

17. The contractor shall furnish a concrete foundation sized in accordance with the supplier's standard details for the LPG vaporizer.

18. The contractor shall furnish and install necessary interconnecting electrical wiring and LPG piping in accordance with applicable codes and local regulations.

## 2.8 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine roughing-in for fuel-gas piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 EARTHWORK

A. Comply with requirements in Division 31, Section "Earth Moving" for excavating, trenching, and backfilling.

## 3.3 PREPARATION

A. Close equipment shutoff valves before turning off fuel gas to premises or piping section.

B. Comply with NFPA 58 and 70 requirements for prevention of accidental ignition.

## 3.4 FUEL-GAS AST INSTALLATION

A. Install tank bases and supports.

B. Connect piping and vent fittings.

C. Install ground connections.

D. Install steel ASTs according to STI R912.

E. Fill storage tanks with LPG.

## 3.5 FUEL-GAS UST INSTALLATION

A. Excavate to sufficient depth for a minimum of 3 feet of earth cover from top of tank to finished grade. Allow for cast-in-place, concrete-ballast base plus 6 inches of sand or pea gravel between ballast base and tank. Extend excavation at least 12 inches around perimeter of tank.

B. Set tie-down eyelets for hold-down straps in concrete-ballast base and tie to reinforcing steel.

C. Place 6 inches of clean sand or pea gravel on top of concrete-ballast base.

D. Set tank on fill materials and install hold-down straps.

E. Connect piping.

F. Install tank monitoring devices.

G. Install manways.

H. Backfill excavation with clean sand or pea gravel in 12-inch lifts and tamp backfill lift to consolidate.

I. Install filter mat between top of backfill material and earth fill.

J. Install USTs with hold-down straps, manhole extensions, and manhole risers.

K. Fill storage tanks with LPG.

## 3.6 VAPORIZER/MIXER SYSTEM INSTALLATION

A. Install equipment on level equipment pad raised 6” above the adjacent surfaces.

B. Install ball valves at inlet and outlet of equipment.

C. Install pressure gages at inlet and outlet of equipment as well as on either side of the Venturi, pressure regulator, water pumps, and other major components to aid in

maintenance of the system. Pressure gages are specified in Division 22, Section "Meters and Gages for Plumbing Piping."

D. Connect to power.

## 3.7 LPG-LEVEL GAGE SYSTEM INSTALLATION

A. Install LPG-level gage system. Locate panel inside building where indicated on the drawings.

## 3.8 LABELING AND IDENTIFYING

A. Nameplates, pipe identification, and signs are specified in Division 22, Section "Identification for Plumbing Piping and Equipment."

B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on or near each service regulators, meters, and valves.

1. Text: In addition to identifying unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

C. Install detectable warning tape directly above fuel-gas equipment, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs. Terminate tracer wire in an accessible area, and identify as "tracer wire" for future use with plastic-laminate sign.

1. Fuel-Gas Storage Tanks: Over edges of each UST.

## 3.9 FIELD PAINTING OF AST

A. Prepare and touch up damaged exterior surface of AST and supports as specified in "Shop Painting of AST" Article.

B. Prepare exterior steel surface of AST and tank supports.

## 3.10 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
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. Use 3000-psig, 28-day, compressive-strength concrete and reinforcement.

## 3.11 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.

B. Perform tests and inspections.

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. Tanks: Minimum compressed-air test pressures for fuel-gas storage tanks that have not been factory tested and do not bear the ASME code stamp or a listing mark acceptable to authorities having jurisdiction:

a. Fill tanks to 325 PSI.
b. Maintain the test pressure for one hour.

D. Fuel-gas piping and equipment will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

## 3.12 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain LPG-level gage systems and vaporizer/mixer systems pumps.

END OF SECTION 22 16 19

# SECTION 22 34 00 - FUEL-FIRED, DOMESTIC-WATER HEATERS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Commercial, condensing, gas-fired, storage, domestic-water heaters.
2. Commercial, condensing, gas-fired, semi-instantaneous, domestic-water heaters.
3. Commercial, condensing, gas-fired, instantaneous, domestic-water heaters.
4. Domestic-water heater storage tanks
5. Domestic-water heater accessories.

### 1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. 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."

### 1.4 SUBMITTALS

A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. LEED Submittals:

1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1, Section 7, "Service Water Heating."

### 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.

C. ASME Compliance:

1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including storage tank and supports.
b. Faulty operation of controls.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion.

a. Storage Tank: Five years.
b. Controls and Other Components: Three year(s).

PART 2 - PRODUCTS

2.1 COMMERCIAL, CONDENSING, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

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

1. AERCO International, Inc.
2. Ajax Boiler Inc.
3. Bock Water Heaters, Inc.
4. Bradford White Corporation.
5. Lochinvar Corporation.
6. PVI Industries, LLC.
7. Rheem Manufacturing Company.
8. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
9. State Industries.

B. Standard: ANSI Z21.10.3/CSA 4.3.

C. Storage-Tank

1. Construction (less than 200 MBH): Non-ASME-code steel.
2. Construction (200 MBH and greater): ASME-code steel.
3. Pressure: 150-psig working-pressure rating.
4. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

    a. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
    b. NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

5. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
6. Lining: Glass lined, complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets unless otherwise specified.

D. Factory-Installed Storage-Tank Appurtenances:

1. Anode Rod: Replaceable magnesium.
2. Dip Tube: Required unless cold-water inlet is near bottom of tank.
3. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
4. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
5. Jacket: Steel with enameled finish.
6. Burner: For use with sealed combustion, gas-fired, domestic-water heaters. Fuel compatibility as required on the Drawings.

7. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 199, electric, automatic, gas-ignition system.
8. Temperature Control: Adjustable thermostat.
9. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
10. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

E. Special Requirements: NSF 5 construction.

F. Draft Hood: Draft diverter, complying with ANSI Z21.12.

G. Automatic Damper: ANSI Z21.66/CSA 6.14-M, electrically operated, automatic-vent-damper device with size matching draft hood.

## 2.2 COMMERCIAL, CONDENSING, GAS-FIRED, SEMI-INSTANTANEOUS, DOMESTIC-WATER HEATERS

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

1. AERCO International, Inc.
2. Intellihot Inc.
3. Lochinvar Corporation.
4. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.

B. Standard: ANSI Z21.10.3/CSA 4.3 for gas-fired, semi-instantaneous, domestic-water heaters for indoor application.

C. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.

1. Tappings: ASME B1.20.1 pipe thread.
2. Pressure Rating: 150 psig.
3. Heat Exchanger: Copper or stainless steel tubing.
4. Insulation: Comply with ASHRAE/IESNA 90.1.
5. Jacket: Metal, with enameled finish, or plastic.
6. Burner: For use with semi-instantaneous, domestic-water heaters. Fuel compatibility as required on the Drawings.
1. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 199, electric, automatic, gas-ignition system.
2. Temperature Control: Adjustable thermostat.
3. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
4. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-

pressure rating. Select one relief valve with sensing element that extends into exchange tank.

D. Support: Floor mounted.

E. Capacity and Characteristics: Refer to the Plumbing Equipment Schedule on the Drawings.

F. Packaged Circulator Pump: Water heating systems with distinct tank and heat exchangers components shall include an integral circulation pump as part of the packaged system. The pump shall be sized by the manufacturer to provide the scheduled system capacity and characteristics. The pumps power shall be integrated into the system's controller for a single point electrical connection to the package.

## 2.3 COMMERCIAL, CONDENSING, GAS-FIRED, INSTANTANEOUS, DOMESTIC-WATER HEATERS

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

1. Navien.
2. Rinnai.
3. Takagi.
4. Rheem.

B. Standard: ANSI Z21.10.3/CSA 4.3 for gas-fired, instantaneous, domestic-water heaters for indoor or outdoor applications.

C. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.

1. Tappings: ASME B1.20.1 pipe thread.
2. Pressure Rating: 150 psig.
3. Heat Exchanger: Copper or stainless steel tubing.
4. Insulation: Comply with ASHRAE/IESNA 90.1.
5. Jacket: Metal, with enameled finish, or plastic.
6. Burner: For use with instantaneous, domestic-water heaters. Fuel compatibility as required on the Drawings.
7. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 199, electric, automatic, gas-ignition system. Recognizes hot water usage patterns to intelligently provide continuous hot water and eliminate temperature drops.
8. Temperature Control: Adjustable thermostat.
9. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
10. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into exchange tank.

D. Support: Wall or strut/frame mounted.

E. Capacity and Characteristics: Refer to the Plumbing Equipment Schedule on the Drawings.

F. Packaged Circulator Pump: Water heating systems with distinct tank and heat exchangers components shall include an integral circulation pump as part of the packaged system. The pump shall be sized by the manufacturer to provide the scheduled system capacity and characteristics. The pumps power shall be integrated into the system's controller for a single point electrical connection to the package.

## 2.4 DOMESTIC-WATER HEATER STORAGE TANKS

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

1. AERCO International, Inc.
2. Ajax Boiler Inc.
3. Bock Water Heaters, Inc.
4. Bradford White Corporation.
5. Lochinvar Corporation.
6. PVI Industries, LLC.
7. Rheem Manufacturing Company.
8. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
9. State Industries.

B. Construction:

1. ASME-code steel.
   a. Exception: Non-ASME-code steel shall be allowed when total system is less than 200 MBH.
2. Pressure: 150-psig working-pressure rating.
3. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
4. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
5. NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
6. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
7. Lining: Glass lined, complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets unless otherwise specified.

## 2.5 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic Hot Water Expansion Tanks:

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

    a. AMTROL Inc.
    b. Bell & Gossett Domestic; ITT Corporation.
    c. Flexcon Industries.
    d. Honeywell International Inc.
    e. Pentair Pump Group (The); Myers.
    f. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
    g. State Industries.
    h. Taco, Inc.

2. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
3. Construction:

    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.

4. Capacity and Characteristics:

    a. Working-Pressure Rating: 150 psig.
    b. Capacity Acceptable: Refer to the Plumbing Equipment Schedule on the Drawings; 2 gal. minimum.
    c. Air Precharge Pressure: Contractor to obtain optimal pressure from tank manufacturer based on final operational system pressure.

B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.

D. Heat-Trap Fittings: ASHRAE 90.2.

E. Manifold Kits: Domestic-water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water heater and calibrated balancing valves to provide balanced flow through each domestic-water heater.

1. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."
2. Comply with requirements for balancing valves specified in Section 22 11 19 "Domestic Water Piping Specialties."

F. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

G. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include pressure rating as required to match gas supply.

H. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.

I. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
2. Oil-Fired, Domestic-Water Heaters: ASME rated and stamped.

J. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
2. Oil-Fired, Domestic-Water Heaters: ASME rated and stamped.

K. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

L. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Provide dimension that will support bottom of domestic-water heater a minimum of 18 inches above the floor.

M. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

## 2.6 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled domestic-water heaters and storage tanks specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test domestic-water heaters and storage tanks to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 "Quality Requirements" for retesting and reinspecting requirements and Section 01 73 00 "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Install domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Division 03.

1. Exception: Omit concrete bases for commercial domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
2. Maintain manufacturer's recommended clearances.
3. Arrange units so controls and devices that require servicing are accessible.
4. 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 concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Install anchor bolts to elevations required for proper attachment to supported equipment.
8. Anchor domestic-water heaters to substrate.

B. Install domestic-water heaters 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.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."

C. Install gas-fired, domestic-water heaters according to NFPA 54.

1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 22 16 13 "Fuel Gas Piping."

D. Install commercial domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

E. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water

piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

F. Install combination temperature-and-pressure relief valves in water piping for domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

G. Install water-heater 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 domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 22 11 19 "Domestic Water Piping Specialties."

H. Install air intake and exhaust vent piping to condensing water heaters. Follow the water heater manufacturer's written instructions for sizing, length, and fitting limitations. Materials shall be stainless steel or CPVC DWV piping specified in Section 22 13 16 "Sanitary Waste, Storm Drainage, and Vent Piping."

I. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

J. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet. Comply with requirements for valves specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping," and comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

K. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

L. Fill domestic-water heaters with water.

M. Charge domestic-water compression tanks with air.

## 3.2 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Section 22 11 16 "Domestic Water Piping."

B. Comply with requirements for fuel-oil piping specified in Section 22 17 19 "Fuel Oil Piping"

C. Comply with requirements for gas piping specified in Section 22 16 13 "Fuel Gas Piping."

D. Drawings indicate general arrangement of piping, fittings, and specialties.

E. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

## 3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

## 3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

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.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 "Quality Requirements" for retesting and reinspecting requirements and Section 01 73 00 "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

## 3.5 DEMONSTRATION

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

END OF SECTION 22 34 00

# SECTION 22 42 00 - PLUMBING FIXTURES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section includes the following plumbing fixture components:

1. Bathing Units.
2. Bathing Valves.
3. Drains.
4. Faucets.
5. Flush Valves.
6. Hose Boxes.
7. Hydrants.
8. Lavatories.
9. Sinks.
10. Toilets.
11. Trim.
12. Urinals.
13. Water Fountains.
14. Water Hammer Arrestors.

### 1.3 REFERENCES

A. ANSI A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use.

B. ANSI A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.

C. ANSI A112.19.1M - Enameled Cast Iron Plumbing Fixtures.

D. ANSI A112.19.2M - Vitreous China Plumbing Fixtures.

E. ANSI A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).

F. ANSI A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.

G. ANSI Z358.1 - Emergency Eye Wash and Shower Equipment.FD

H. ANSI/NSF 61 - Drinking Water System Components - Health Effects.

I. ANSI/NSF 372 - Drinking Water System Components - Lead Content.

J. ARI 1010 - Drinking Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers.

K. ASSE 1002 - Water Closet Flush Tank Ball Cocks.

L. ASSE 1016 - Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Showers Combinations.

M. ASSE 1017 - Performance Requirements for Water Temperature Limiting Devices.

N. Americans with Disabilities Act (ADA), Title III.

O. The Energy Policy Act (EPAct) of 2005.

P. USGBC - Leadership in Energy and Environmental Design (LEED) Rating System.

1.4 SUBMITTALS

A. Procedure:

1. Fixture component submittals shall conform to the following procedure requirements. Improperly prepared submittals will not be reviewed but shall be returned to be revised and resubmitted.
2. Refer to the Plumbing Fixture Schedule on the Drawings for plumbing fixture tag and the respective plumbing fixture components associated with each tag. Not all fixture components within this specification may be listed in the Plumbing Fixture Schedule.
3. Submit each plumbing fixture component listed in the Plumbing Fixture Schedule a single time in the order outlined within this specification.
4. Each plumbing fixture component shall be annotated with the fixture component tag in the upper right hand corner of each submittal page.
5. Where multiple fixture component options are listed, annotate the submittal with arrows and strikeouts to clearly indicate applicable options.

B. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fixtures.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. All water faucets shall meet NFS Standard 61, Annex G and NSF-372 for drinking water faucets and shall be certified by Underwriter's Laboratory. Product cartons shall feature the UL logo signifying certification to NSF-61, Annex G.

C. Shop Drawings:

1. Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.

D. Maintenance Data::

1. Include operation and maintenance information for each plumbing fixture component with the maintenance manual in accordance with Division 1

E. LEED Submittals:

1. Product Data: Documentation indicating that flow and water consumption requirements comply with [**Prerequisite WE 1**] [**Prerequisite WE 1 and Credit WE 3**] [**Prerequisite WE 1, Credit WE 2, and Credit WE 3**].
2. Product Data: Documentation indicating that flow and water consumption requirements comply with Prerequisite WE 1[ **and Credit WE 1**].
3. Product Data: Documentation indicating that flow and water consumption requirements comply with Prerequisite WE 1[ **and Credit WE 2**].

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Faucet Washers and O-Rings: Equal to 10 percent of the amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of the amount of each type and size installed.
3. Flush Valve Repair Kits: Equal to 10 percent of amount of each type installed.
4. Toilet Seats: Equal to 5 percent of the amount of each type installed.

PART 2 - PRODUCTS

2.1 BATHING VALVES

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

1. American Standard.
2. Delta Faucet.
3. Grohe Commercial.
4. Kohler.
5. Symmons.
6. T&S Brass.
7. Zurn.

B. Materials (Unless otherwise noted):

1. Valve Body: Brass.
2. Shower Head: Plastic.
3. Hand Spray: Plastic.
4. Tub Spout: Bronze.
5. Finish: Chrome Plated.
6. Hose: Braided Stainless Steel

C. Requirements:

1. ASSE 1016 listed.

D. BV-2 – Shower head with hand spray:

1. Mixing Valve: Pressure balanced with integral stops.
2. Shower Head: 1.5 GPM with wall shower head fitting.
3. Hand spray: 1.5 GPM with 60” hose, inline vacuum breaker, diverter valve, and wall mounted adjustable bar.

E. BV-3 – Shower hand spray:

1. Mixing Valve: Pressure balanced with integral stops.
2. Hand spray: 1.5 GPM with 60” hose, inline vacuum breaker, and wall mounted adjustable bar.

2.2 DRAINS

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

1. Blucher.
2. J. R. Smith.
3. Josam Co.
4. Mifab.
5. Quick-Trench.
6. Sioux Chief.
7. Wade.
8. Watts.
9. Zurn.

B. Materials (unless otherwise noted):

1. Drain body: Cast iron.
2. Drain Head: Nickel bronze.
3. Trap: Deep seal configuration; does not apply to roof drains.
4. Cleanout: Provide 2-way cleanout fitting downstream of trap. Provide floor cleanout in below grade installations.

C. Special Requirements:

1. Install top of grate/strainer flush with adjacent floor at low-point. Refer to Architectural drawings for floor sloping requirements, and coordination with all other contractors to ensure positive sloping toward drain.
2. Nominal size of drain outlet as indicated on the Drawing floor plans.
3. Provide drain trap primer connection per the requirements on the Plumbing Fixture Schedule.

D. D-1 – General Floor Drain with Flush Grate:

1. Body: Bottom outlet with flashing collar and weep holes.
2. Head: Adjustable 5” round grate with 2-way drainage pattern.

E. D-2 – Mechanical Room Floor Drain with Flush Grate:

1. Body: Bottom outlet with flashing collar and weep holes.
2. Head: Adjustable 7” round grate with 2-way drainage pattern.

F. D-3 – Floor Drain with Recessed Grate:

1. Body: Bottom outlet with flashing collar and weep holes.
2. Head: Adjustable 7” round recessed grate with 2-way drainage pattern.

G. D-19 – Trench Drain:

1. Body: High density polypropylene body with 12” wide throat and ductile iron slotted grate. Class C load rating. Provide pre-sloped channel sections as required to accommodate configuration show on drawings.
2. Connections: Drain inlet and outlet sizes, locations, and quantities shall be as required to accommodate the connected equipment and the sanitary drain as shown on the drawings.

H. D-23 –Shower Drain with Flush Grate:

1. Body: Bottom outlet with flashing collar, weep holes, and 2” outlet.
2. Head: Chrome plated bronze or stainless steel with heel-proof strainer and 2” outlet.

## 2.3 FAUCETS

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

1. American Standard.
2. Chicago Faucet.
3. Delta Faucet.
4. Grohe Commercial.
5. Kohler.
6. Moen Commercial.
7. Sloan.
8. Symmons.
9. T&S Brass.
10. Zurn.

B. Materials (Unless otherwise noted):

1. Valve Body: Brass.
2. Finish: Chrome plated.

C. Requirements:

1. All public faucet fixtures shall be ASSE 1070 listed, provided with an ASSE 1070 listed below deck mixing valve on the hot water supply, or supplied from a hot water distribution system which is tempered by an ASSE 1017 master mixer as allowed by local code requirements.

D. F-1 – Manual Gooseneck Faucet: 5-1/4” rigid/swing gooseneck spout with 4” wrist blade handles, 8” on center, and ceramic 1/4 turn cartridges.

1. F-1A: 0.5 GPM laminar spray at end of spout.
2. F-1B: 1.5 GPM laminar flow regulator in base of spout with plain end spout.

E. F-3 – Manual Lavatory Faucet: 4-1/2” spout with single lever handle, 4” on center.

1. F-3A: 0.5 GPM laminar spray at end of spout.

F. F-7 – Kitchen Faucet with Pull-out Spray: 9” combination spout/pull-out spray with single lever handle, single hole, 1.5 GPM flow rate.

G. F-9 – Utility Sink Faucet: 4" centerset faucet with 4" blade handles, 6-3/4" 360° swing spout, aerator and threaded hose spout end.

## 2.4 FLUSH VALVES

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

1. American Standard.
2. Kohler.
3. Sloan.
4. Zurn.

B. Materials (Unless otherwise noted):

1. Valve Body: Brass.
2. Finish: Chrome plated.

C. FV-1 – Manual, Exposed Flush Valve: Quiet operation lever actuated flush valve with chlorine and chloramine resistant diaphragm/piston, and screwdriver stop.

1. FV-1E: 1.6 GPF toilet valve.

## 2.5 FOOD WASTE GRINDER

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

1. In-Sink-Erator.

B. FWG-1 – 1/2 HP, 115 volts, single phase, 9.4 amps, and stainless steel grinding chamber with cast nickel chrome alloy shredding elements.

## 2.6 HOSE BOXES

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

1. Acorn.
2. Elkay
3. Guy Gray.
4. Oatey.
5. Willoughby.

B. HB-1 – Refrigerator/Ice Machine Water Supply Box: 6” x 6” high impact polystyrene box, faceplate, and 1/4 turn brass hammer ball valve with 1/2" sweat inlet connection. Box depth shall allow fully recessed installation in 3-5/8” stud wall.

C. HB-2 – Washing Machine Water Supply and Drain Box: 10” x 8-1/2” hot dipped galvanized 20 gauge steel box and faceplate, hot and cold water 3/4" hose bib supply valves with 1/2" sweat inlet connections, and 2” threaded drain fitting. Box depth shall allow fully recessed installation in 3-5/8” stud wall.

D. HB-5 – Natural Gas Supply Box: 7-1/2” x 5” schedule 20 stainless steel box with faceplate, CSA listed 1/4 turn natural gas valve (3/4” unless supplied by 1/2" gas pipe). Box depth shall allow fully recessed installation in 3-5/8” stud wall.

## 2.7 HOT WATER TAP

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

1. In-Sink-Erator.

B. HWT-1 – Insulated tank, 1/2 gallon capacity with drain plug, chrome plated faucet, instant self-closing lever valve, gooseneck spout, adjustable thermostat, 750 watts, 6.5 amps, 115 volts.

## 2.8 HYDRANTS

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

1. Josam.
2. J. R. Smith.
3. Wade.
4. Woodford.

5. Zurn.

B. H-2 – Non-Freeze, Recessed Wall Hydrant: 7” x 7” type 304 16-gauge stainless steel recessed box with locking door, bronze 1/4 turn non-freeze hydrant with 3/4" hose connection, backer plate, wall clamp, integral vacuum breaker with vandal resistant cap and removable “T” handle key. Stem length shall be 6” beyond the inside face of the exterior wall, unless otherwise exposed.

C. H-3 – Inline Hose Bibb: Rough brass valve body with metal wheel handle, integral vacuum breaker, and 3/4" threaded inlet connection. Anchor directly to adjacent structure or provide standalone strut channel anchored to the floor and/or structure.

D. H-5 – Non-Freeze Roof Hydrant: Epoxy coated cast iron head with 3/4" brass hose connection, integral vacuum breaker, pail hook, and 1” galvanized schedule 40 riser with non-removable deck mounting flanges. Internal piston shall self-drain the water way above to the reservoir every time the hydrant is closed. A flow induced Venturi shall not be used to empty the reservoir. The reservoir and all seals shall be located below the roof. All moving parts shall be maintained from above the deck without removing the hydrant. ASSE 1057 Type 1 compliant.

## 2.9 LAVATORIES

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

1. American Standard.
2. Kohler.
3. Mansfield.
4. Sloan.
5. Zurn.

B. Materials (Unless otherwise noted):

1. Fixture: White vitreous china.

C. L-2 – Wall Mounted Lavatory with Shroud: 21” x 20” sink with rectangular-shaped bowl, front overflow, china rough-in shroud, and self-draining deck with low profile back and side splash shields. Pre-drilled faucet hole configuration as required to match scheduled faucet configuration. Provide suitable floor mounted, concealed arm carrier. ADA compliant; refer to Architectural drawings for mounting height and installation dimensions.

D. L-3 – Drop-in Lavatory: 20” x 17” sink with oval-shaped bowl, front overflow, and self-draining deck. Pre-drilled faucet hole configuration as required to match scheduled faucet configuration. ADA compliant; refer to Architectural drawings for installation dimensions.

2.10 SINKS

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

1. Acorn.
2. American Standard.
3. Elkay.
4. Just.
5. Kohler.
6. Mansfield.
7. Sloan.
8. Steris.
9. Whitehall.
10. Willoughby.
11. Zurn.

B. Materials (Unless otherwise noted):

1. Fixture: 18 gauge stainless steel with satin finish.

C. S-1 – Drop-In Single Bow Sink: 31” x 22” single compartment, self-rimming sink with 5” deep bowl, fully undercoated, and 3-1/2” drain opening. Pre-drilled faucet hole configuration as required to match scheduled faucet configuration. ADA compliant; refer to Architectural drawings for installation dimensions.

D. S-2 – Drop-In Double Bowl Sink: 33” x 21” double compartment, self-rimming sink with 10” deep sized bowls, fully undercoated, and 3-1/2” drain opening. refer to Architectural drawings for installation dimensions.

E. S-7 – Utility Sink: 23” x 21” floor mounted, single bowl heavy duty Molded Stone with white baked enamel angle legs that slip into molded sockets for rigid, friction-fit. Easy leveling devices are provided for fast, even planning. Tub is capable of handling 600 pounds. integral drain and drain plug.

F. S-11 – Undermount Single Bow Sink: 23” x 18” single compartment, self-rimming sink with 4-3/8” deep bowl, fully undercoated, and 3-1/2” drain opening. ADA compliant; refer to Architectural drawings for installation dimensions.

2.11 TOILETS

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

1. Fixtures:

a. American Standard.
b. Kohler.
c. Mansfield.
d. Sloan.

e. Zurn.

2. Seats:

a. Bemis.
b. Beneke.
c. Centoco.
d. Church.
e. Olsonite

3. Carriers:

a. J. R. Smith.
b. Josam.
c. Mifab.
d. Wade.
e. Watts.
f. Zurn.

B. Materials (Unless otherwise noted):

1. Fixture: White vitreous china.
2. Seat: Extra heavy duty antimicrobial fire retardant plastic seat with stainless steel self-sustaining check hinge.

C. T-2 – Floor Outlet Comfort Height Toilet: Elongated bowl, siphon jet, 1.1 – 1.6 GPF compatible, 1,000 gram MaP score rated, 1,000 lb. static load rating on end of bowl, 10” – 12” rough-in range, top spud inlet, 17” – 19” final seat height. ADA compliant; refer to Architectural drawings for installation dimensions.

2.12 TRIM

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

1. Brass Craft.
2. Bridgeport Brass.
3. Chicago Faucet.
4. McGuire.
5. Truebro.

B. Materials (Unless otherwise noted):

1. P-Trap: Chrome plated, 20 gauge cast brass.
2. Ball Stops: Chrome plated brass.
3. Supply Risers: Flexible chrome plated copper or braided stainless steel.
4. Strainer: Chrome plated, 20 gauge brass.

C. TR-1 – Lavatory Trim: Open grid strainer, adjustable p-trap with cleanout and escutcheon, 1/2" X 3/8" angle ball stop with 3/8" supply risers. Provide offset p-trap and

waste piping/water supply insulation kit on fixtures scheduled to meet ADA unless a shroud is provided with the casework or fixture.

D. TR-2 – Sink Trim: Stainless steel basket strainer with removable drain stopper, adjustable p-trap with cleanout and escutcheon, 1/2" X 3/8" angle ball stop with 3/8" supply risers. Provide offset p-trap and waste piping/water supply insulation kit on fixtures scheduled to meet ADA unless a shroud is provided with the casework or fixture.

E. TR-4 – Water Fountain Trim: Adjustable p-trap with cleanout, and escutcheon, 1/2" X 3/8" straight ball stop with 3/8" supply riser.

F. TR-8 – Floor Drain Trap Seal Insert: Waterless, inline drain trap seal. HDPE housing with heavy duty silicone diaphragm and soft EPDM rubber sealing gasket. Size determined by associated drain body. ASSE 1072 compliant.

## 2.13 WATER FOUNTAINS

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

1. Elkay.
2. Halsey Taylor.
3. Haws.
4. Oasis.
5. Sunroc.

B. Materials (Unless otherwise noted):

1. Fountain Basin: Stainless steel.
2. Shroud (wall hung units): Powder coated – light gray.
3. Cover Panels (recessed units): Stainless steel.
4. Bubbler: Pliable anti-microbial polyester elastomer.
5. Waterways: Non-ferrous.
6. Filter: Certified to NSF/ANSI 42 and 53.

C. WF-3 – Single Station Wall Hung Water Cooler with Bottle Filling Station: Self-contained UL listed electric water cooler with front push bar, 3000 gallon capacity filter, built-in pressure regulator; automatically operated, permanently lubricated, air-cooled, hermetically sealed, cooling unit having freeze-up protection, adjustable temperature control; electric rating 115 VAC; minimum cooling capacity 8 GPH (80° F entering to 50° F drinking at 90° F ambient). Sensor activated bottle filling station mounted above fountain with 1.1 GPM laminar flow fill rate and LCD status display, integrated into the common electrical and water cooler systems. ADA compliant; refer to Architectural drawings for mounting height and installation dimensions.

## 2.14 WATER HAMMER ARRESTORS

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

1. J. R. Smith.
2. Josam.
3. Mifab.
4. Precision Plumbing Products.
5. Sioux Chief.

B. Materials (Unless otherwise noted):

1. Body: Copper.
2. Piston: Brass.
3. Seals: Chlorine and chloramine resistant EPDM.
4. Lubricant: FDA approved silicone.

C. Provide water hammer arrestors as required in the Plumbing Fixture Schedule according to the following types and fixture unit ranges:

1. A: 1 – 11 Fixture Units.
2. B: 12 – 32 Fixture Units.
3. C: 33 – 60 Fixture Units.
4. D: 61 – 113 Fixture Units.
5. E: 114 – 154 Fixture Units.
6. F: 155 – 330 Fixture Units.

D. Install water hammer arrestors in an accessible location for inspection, maintenance, and in accordance with the manufacturer's written guidelines. Provide access panels as required; coordinate panel locations and color with the architect.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine roughing-in for water soil and for waste piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated, before plumbing fixture installation. Use manufacturer's roughing-in data if roughing-in data are not indicated.

B. Examine walls, floors, cabinets, and counters for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

A. Install plumbing fixtures level and plumb according to roughing-in drawings and manufacturers' written instructions.

B. Install supports, affixed to building substrate, for wall-mounted fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.

2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-hanging fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounted water closets on bowl-to-drain, connecting fitting attachments to piping or building substrate.

E. Install counter-mounted fixtures in and attached to casework.

F. Install water-supply piping with stop on each supply to each fixture to be connected to water-distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball, gate, or globe valve if supply stops are not specified with fixture. Comply with valve requirements specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."

G. Install flushometer valves on water closets.

H. Install flushometer valves for accessible water closets, with lever handle mounted on wide side of compartment.

I. Install toilet seats on water closets.

J. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts, if faucets are not available with required rates and patterns. Include adapters if required.

K. Install laminar-flow, faucet-spout fittings in faucet spouts where laminar-flow fittings are specified.

L. Install shower flow-control fittings with specified maximum flow rates in shower arms.

M. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.
2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

N. Install disposer in outlet of sinks indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.

O. Install hot-water dispensers in back top surface of sink or in counter with spout over sink.

P. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for escutcheons.

Q. Set bath tubs, showers and mop basins in leveling bed of leveling cement grout.

R. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 22 07 19 "Plumbing Piping Insulation."

S. Seal joints between healthcare plumbing fixtures, counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

T. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

U. Inspect installed fixtures for damage and test after water systems are pressurized for proper operation. Replace damaged or malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

V. Install fresh batteries in sensor-operated mechanisms.

W. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

    a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
    b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
    c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

X. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.

## 3.3 MOUNTING

A. Refer to Architectural Drawings and Plumbing Details for specific mounting heights. Use the following mounting heights if no other dimension is required on the Drawings or by Code.

1. Water closet: 15" floor to rim.
2. Water closet (ADA): 17" floor to seat.
3. Urinal: 24" floor to rim.
4. Urinal (ADA): 17" floor to rim.

5. Lavatory: 31" floor to rim.
6. Lavatory (ADA): 34" floor to rim.
7. Surgeons sink: 36" floor to rim.
8. Clinic sink: 30" floor to rim.
9. Shower mixing valve: 40" floor to centerline.
10. Shower head: 75" floor to lowest point.
11. Mop basin: 36" floor to faucet; 18" floor to hose bracket; 54" floor to mop hanger.
12. Electric water cooler: 40" floor to rim.
13. Electric water cooler (ADA): 36" floor to orifice.
14. Wall hydrant: 16" above finished grade.
15. Emergency eye wash: 40" above finished floor.
16. Emergency shower: 84" floor to rim.

## 3.4 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping sized according to the Drawings and Plumbing Fixture Schedule, whichever is larger. Use reducer fittings as required to match fixture connections.

B. Comply with requirements for water piping specified in Section 22 11 16 "Domestic Water Piping."

C. Comply with requirements for soil and waste drainage piping and vent piping specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

D. Comply with requirements for atmospheric vent piping specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

E. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 22 07 19 "Plumbing Piping Insulation."

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.

## 3.5 ADJUSTING

A. Operate and adjust fixtures, faucets, and controls. Replace damaged and malfunctioning plumbing fixtures, fittings, and controls.

B. Adjust water pressure at faucets, shower valves, and flush valves to produce proper flow.

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

## 3.6 CLEANING AND PROTECTION

A. After installing plumbing fixtures, inspect and repair damaged finishes.

B. Clean plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts. Remove sediment and debris from drains.

C. Provide protective covering for installed fixtures and fittings.

D. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

E. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 00

**SECTION 230500**
**COMMON WORK RESULTS FOR HVAC**

## GENERAL

### RELATED DOCUMENTS

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

### SUMMARY

This Section includes the following:

Piping materials and installation instructions common to most piping systems.
Dielectric fittings.
Mechanical sleeve seals.
Sleeves.
Penetration sealing.
Escutcheons.
Grout.
HVAC demolition.
Equipment installation requirements common to equipment sections.
Painting and finishing.
Concrete bases.
Supports and anchorages.
Roof curbs.
Equipment supports.

### DEFINITIONS

Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above solid ceilings and within chases.

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.

The following are industry abbreviations for plastic materials:

CPVC: Chlorinated polyvinyl chloride plastic.
PE: Polyethylene plastic.
PVC: Polyvinyl chloride plastic.

The following are industry abbreviations for rubber materials:

EPDM: Ethylene-propylene-diene terpolymer rubber.
NBR: Acrylonitrile-butadiene rubber.

SUBMITTALS

Product Data: For the following:

Dielectric fittings.
Mechanical sleeve seals.
Escutcheons.
Supports and anchorages.
Roof curbs.
Equipment supports.

Operations Manual: Include the following:

Final processed submittals of all Division 23 specification sections.
Subcontractor contact list including name, phone number and e-mail contact information.
Valve tag charts.
Field reports, including ductwork leakage testing and piping pressure testing.
Startup reports for all mechanical equipment.
Certifications of piping systems, equipment or systems if specified in the individual specification section.
Testing, adjusting and balancing reports.
ASME Stamp Certification and Reports: “A”, “S”, or “PP” stamp certificates of authorization.
Operations and maintenance information for all equipment.

Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer’s receipt of submittal.

Initial review: Allow 15 days for initial review of each submittal. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. Engineer will advise Contractor when a submittal must be delayed for coordination.
Concurrent review: Where concurrent review of submittals by Architect/Engineer’s Consultants, Owner or other parties is required, allow 21 days for initial review of each submittal.

Submittal Schedule:

Contractor shall submit all submittals to the Engineer for initial review within 30 days of award of contract, or within the first 10% of the duration of the project, whichever is less. Submittals which require processing completion prior to 45 days after award of contract shall be scheduled with the Engineer at least 14 days in advance of their requested due date.

QUALITY ASSURANCE

Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

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.

Roofing Standards: Comply with the following:

SMACNA's "Architectural Sheet Metal Manual" details for fabrication including flanges and cap flashing to coordinate with type of roofing indicated.
NRCA's "Roofing and Waterproof Manual" details for installing units.
Existing roofs: Maintain existing roof warranty.

DELIVERY, STORAGE, AND HANDLING

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 into the pipe.

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

Deliver, store and install materials and equipment (including supports and hangers) such that they are maintaining "as-new" condition (e.g. no rust) upon installation and up through the date of Substantial Completion. Account for environmental conditions of the construction site and schedule work accordingly.

Do not allow any materials nor equipment to be stored in standing water from a rainstorm.

COORDINATION

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

Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

Coordinate requirements with all trades for the location and size of access doors and frames necessary to gain access to HVAC items. Coordinate these requirements for all HVAC items that are concealed behind finished surfaces. See Division 08.

Existing Utilities: Do not interrupt utilities serving facilities occupied or partially occupied by the Owner or others unless specifically allowed under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated.

Notify Owner at least seven days in advance of proposed utility interruptions. Identify extent and duration of utility interruptions.
Indicate method of proposed utility interruptions in detail.
Do not proceed with proposed utility interruptions without Owner's permission.
All air handling units, rooftop units, exhaust fans, pumps, chillers, refrigeration equipment, boilers, heat exchangers, fan coil units, cabinet unit heaters, fin tube radiation, steam system components and unit heaters are to remain disabled and off unless TAB personnel are on-site actively testing that particular piece of equipment.
Utilization of the permanent installed HVAC systems to condition or pressurize the construction area is not allowed without prior specific written authorization from the Owner listing which equipment may be operated and under what limiting conditions along with written agreement to compensate the Owner for utility usage. Limiting conditions shall include specific written listing of all of these features: filtration requirements for all airstreams; fire alarm/smoke detection for all air streams; schedule for preventative maintenance for bearings, seals and other operated equipment features; hours of operation and which hours will be supervised by contractor personnel on site; written confirmation of operability of all equipment control sequences safeties and alarms; and written maintenance recordkeeping at a minimum.

New Equipment:

All air handling units, rooftop units, exhaust fans, pumps, chillers, refrigeration equipment, boilers, heat exchangers, fan coil units, cabinet unit heaters, fin tube radiation, steam system components and unit heaters are to remain disabled and off unless TAB personnel are on-site actively testing that particular piece of equipment.
Utilization of the permanent installed HVAC systems to condition or pressurize the construction area is not allowed without prior specific written authorization from the Owner listing which equipment may be operated and under what limiting conditions along with written agreement to compensate the Owner for utility usage. Limiting conditions shall include specific written listing of all of these features: filtration requirements for all airstreams; fire alarm/smoke detection for all air streams; schedule for preventative maintenance for bearings, seals and other operated equipment features; hours of operation and which hours will be supervised by contractor personnel on site; written confirmation of operability of all equipment control sequences safeties and alarms; and written maintenance recordkeeping at a minimum.

Coordinate new installations with the existing installations which will remain in place and be reutilized or those that are abandoned in place. Provide transitions and fittings in ductwork and piping as well as extra lengths of ductwork and piping as required to route around these existing installations. Illustrate all such ductwork fittings on the sheet metal duct shop drawing submittal. Existing installations include plumbing, piping, electrical and other building systems components including, but not limited to, roof drain piping, sanitary piping, plumbing piping, fire protection piping, fire protection heads, heating and cooling water piping, condensate drains, steam and condensate return piping, conduit, cable tray, electrical pull boxes, projectors, booms, etc. Coordinate installation of above ceiling components and devices such that maintenance access is achieved at the completion of the project when all ceiling mounted components are installed. Coordinate with all trades. Ultimate responsibility for any rework required to achieve maintenance access is the responsibility of the Contractor responsible for coordination as noted in Division 1 Sections. The required maintenance access is defined here for this contract:

A person with a 24" arm length can stand on a folding ladder which rests on the finished floor and which does not extend through the ceiling grid. All lights and diffusers remain in the grid when defining maintenance access. Ceiling tiles with sprinkler heads, smoke detectors, fire alarm devices and other system devices remain in the grid when defining maintenance access. Light fixtures and diffusers/grilles remain in the ceiling grid when defining maintenance access.

While standing on a step of this ladder which is rated for standing upon and while not leaning against the ceiling grid, this person can touch the following items with both hands at the same time:

Terminal unit/terminal box damper actuators.
Terminal unit/terminal box reheat valve actuators.
Terminal unit/terminal box airflow controller.
Terminal unit/terminal box transformers, EP switches, temperature sensor, and all other control components.
Terminal box discharge low pressure volume dampers on diffuser runouts.
Terminal unit/terminal box piped accessories – strainer, PT ports, air vents, drains, shutoff valves, unions and calibrated balance valves.
Piped hydronic system shutoff valves, calibrated balance valves, control valves, vents, and drains.
Steam system traps, control valves, humidifier components and humidifier control components.
Fire damper and fire/smoke damper duct access doors.
Fire damper and fire/smoke damper fusible links.

Locate buried utility and distribution services within the project area.

Provide temporary connections to maintain existing systems in service during the construction. This may include ductwork, piping, power, controls, water, as well as other connections as required.

Provide the Owner a schedule prior to the start of demolition with phased selected demolition identified by system and by floor. Identify required outages on the schedule and any temporary measures required to maintain existing systems in service.

Coordinate the HVAC demolition with all aspects of demolition and temporary construction (including dust barriers) by other trades.

CONTRACT DOCUMENTS

The drawings indicate the general arrangement and scope of the systems and shall be followed insofar as possible. If deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted in writing to the Engineer for approval before proceeding with the Work.

The drawings are not intended to show every vertical offset or horizontal offset that may be necessary to complete the system or clear obstructions and/or the Work of other Contractors and other trades. Contractors shall anticipate during bidding that additional offsets may be required and include same in their proposals.

The Drawings, Schedules and Specifications shall be considered to be cooperative and anything appearing in the Specifications that may not be indicated on the Drawings or vice-versa, shall be considered as part of the Contract and must be executed by the Contractor the same as though indicated by both. Clarify conflicting statements with the Engineer prior to submitting a bid.

Measurements: Contractor shall make all his own measurements in the field and shall be responsible for correct fitting. He shall coordinate this Work with all other branches and trades in such a manner as to cause a minimum of conflict or delay. The Contractor shall coordinate

his work in advance with all other trades and report immediately any difficulty which can be anticipated and propose solutions to resolve the potential difficulty.

Adjustments to Work in the Field:

The Engineer reserves the right to make minor adjustments (maximum of 10'-0") in location of sensors, valving, ductwork, dampers, conduit, drains, piping, hangers and/or equipment at no additional charge if so directed prior to their installation.
Where the Drawings show equipment, casework, structure, fire rated construction, or the like, Contractors shall lay out the work to avoid conflicts.
Where offsets in piping, additional fittings, necessary drains, minor valves, traps and devices are required to complete the installation, to clear obstructions, or for the proper operation of the system (including air vents and drains), these shall be deemed to be included in the Contract and shall be furnished and installed complete by the Contractor at no additional charge.
Where offsets in ductwork, additional fittings, necessary transitions, minor fittings, dampers, accessories and devices are required to complete the installation, to clear obstructions, or for the proper operation of the system, these shall be deemed to be included in the Contract and shall be furnished and installed complete by the Contractor at no additional charge.

Clearances: All installations shall be made to maintain maximum headroom and clearance around equipment. When space and/or headroom appear inadequate, the Contractor shall notify the Engineer prior to proceeding with the installation. No claims for additional compensation will be approved for failure on the part of the Contractor or his Subcontractor to comply with this requirement.

RECORD DRAWINGS

Contractor shall provide owner with a complete set of accurate Record Drawings for all work performed under this contract.

Record Drawings shall include all approved change orders and pertinent RFI responses.
Include actual dimensions of equipment furnished under this contractor where shown on the floor plans.
Record Drawings shall include work performed by all sub-contractors retained.
Record Drawings shall include the words "RECORD DRAWING" on each sheet.
Record Drawings shall be completed using **[AutoCAD] [REVIT]** and in a version as directed by the owner.

Submission:

Submit one set of record Drawings for review by Engineer prior to submission of closeout documents. Record Drawings shall be submitted using the established submittal process.
Upon satisfactory review of the Record Drawing submittals by Engineer, provide three (3) printed sets of the Record Drawings and three (3) copies in electronic format with closeout documents
Paper Record Drawings shall be printed full size using the same sheet size as the construction documents issued to the contractor with the contractor's title block.
Electronic Record Drawings shall include **[AutoCAD] [a REVIT]** compatible **[files] [model]** and **[individual PDF files named by sheet and organized in folders by disciplines] [multi-sheet PDF files combined and named by discipline]**.

## PRODUCTS

### MANUFACTURERS

In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

Provide all materials necessary for demolition work to occur, including cutting, capping, removing walls for access, and repairing finishes.

### PIPE, TUBE, AND FITTINGS

Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

Hex bushings, face bushings, and plugs are not acceptable in any Division 23 piping system.

### JOINING MATERIALS

Refer to individual Division 23 piping Sections for special joining materials not listed below.

Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

Steam service: ASME B16.20, spiral wound gasket with stainless steel metal winding strip, flat, asbestos-free graphite filler, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated. Suitable for pressure class of service and a minimum operating temperature of 600 deg F. Similar to Flexitallic Style CG.
All other services: Thermoseal C-4401, 1/16” thick.
Do not apply compounds, adhesives, or anti-stick lubricants to gasket surface.

Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

Solvent Cements for Joining Plastic Piping:

CPVC Piping: ASTM F 493.
PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

DIELECTRIC FITTINGS

Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

Insulating Material: Suitable for system fluid, pressure, and temperature.

Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 225 deg F. Minimum 400 volts dielectric resistance, insulated against galvanic corrosion, threaded ends, O-ring.

Manufacturers:

Capitol Manufacturing Co.
Central Plastics Company.
Eclipse, Inc.
Epco Sales, Inc.
Hart Industries, International, Inc.
Watts Industries, Inc.; Water Products Div.
Zurn Industries, Inc.; Wilkins Div.

Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

Manufacturers:

Capitol Manufacturing Co.
Central Plastics Company.
Drake Specialties.
Epco Sales, Inc.
Watts Industries, Inc.; Water Products Div.

Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

Manufacturers:

Advance Products & Systems, Inc.
Calpico, Inc.
Central Plastics Company.
Drake Specialties.
Pipeline Seal and Insulator, Inc.

Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.

Dielectric Couplings: Galvanized-steel coupling with inert and non-corrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

Manufacturers:

Calpico, Inc.
Lochinvar Corp.

Dielectric Nipples: Electroplated steel nipple with inert and non-corrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

Manufacturers:

Perfection Corp., Clearflow Dielectric Fittings.
Precision Plumbing Products, Inc.
Sioux Chief Manufacturing Co., Inc.
Victaulic Co. of America.

MECHANICAL SLEEVE SEALS

Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

Manufacturers:

Advance Products & Systems, Inc.
Calpico, Inc.
Metraflex Co.
GPT/Pipeline Seal and Insulator/Link-Seal/Enpro Industries.

Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
Pressure Plates: Glass reinforced nylon polymer or stainless steel. Include two for each sealing element.
Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

SLEEVES

Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40 up to 10” NPS, standard weight for 12” NPS and larger, galvanized, plain ends, fabricated with 2” integral seal welded waterstop. Touch up cut ends of galvanized pipe sleeves with zinc-rich coating prior to installation.

Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

Manufacturers:

Calpico, Inc.

Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

Underdeck Clamp: Clamping ring with set screws.

Stainless Steel Sheet: Fabricated 304L stainless steel, 0.078” minimum thickness, round tube closed with welded longitudinal joint, fabricated with 2” integral seal welded waterstop.

## PENETRATION SEALING

Penetrations in Horizontal Assemblies:

Annular space fill:

Resists the free passage of flame and the products of combustion.
Approved non-combustible material.

Penetration firestopping:

Fill, void or cavity material that is tested and classified for use in through penetration firestop systems.

## ESCUTCHEONS

Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

One-Piece, Cast-Brass Type: With set screw.

Finish: Polished chrome-plated.

Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

Finish: Polished chrome-plated.

One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

## GROUT

Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.

Characteristics: Post-hardening, volume-adjusting, non-staining, non-corrosive, nongaseous, and recommended for interior and exterior applications.
Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
Packaging: Premixed and factory packaged.

## ROOF CURBS

General: If not specified in individual Division 23 specification sections, provide roof curbs capable of supporting superimposed live and dead loads, including equipment loads and other

construction to be supported on roof curbs. Coordinate dimensions with rough-in information or shop drawings of equipment to be supported.

Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified:

Creative Metals, Inc.
Custom Curb, Inc.
Greenheck.
Pate Co. (The).
Thybar Corporation.

Fabrication: Unless otherwise indicated or required for strength, fabricate units from minimum 0.0747 inch (1.9 mm) thick, structural quality, hot dip galvanized or aluminum zinc alloy coated steel sheet, factory primed and prepared for painting with welded or sealed mechanical corner joints.

Provide fire retardant treated wood nailers at tops of curbs and formed flanges at perimeter bottom for mounting to roof.
On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
Provide manufacturer's standard rigid or semi-rigid insulation and metal liners.
Provide formed cants and base profile coordinated with roof insulation thickness.
Fabricate units to minimum height of 16 inches (400 mm) unless otherwise indicated.
Sloping roofs: Where slop of roof deck exceeds 1/4-inch per foot (1:48) fabricate curb units with water diverter or cricket and with height tapered to match slope to level tops of units.
Provide curbs suitable for equipment dead weight, wind loads, seismic lifting, and anchoring forces as required.
Provide anchoring instructions.

EQUIPMENT SUPPORTS

General: If not specified in individual Division 23 specification sections, provide equipment supports capable of supporting superimposed live and dead loads, including equipment loads and other construction to be supported. Coordinate dimensions with rough-in information or shop drawings of equipment to be supported.

Fabricate exterior supports from galvanized or stainless materials which are compatible with the equipment, piping and ductwork being supported.

Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

Custom Curb, Inc.
Pate Co. (The).
ThyCurb, Inc.

Fabrication: Unless otherwise indicated or required for strength, fabricate units from minimum 0.0747 inch (1.9 mm) thick, structural quality, hot dip galvanized or aluminum zinc alloy coated steel sheet; factory primed and prepared for painting with welded or sealed mechanical corner joints.

Provide fire retardant treated wood nailers at tops of curbs and formed flanged at perimeter bottom for mounting to roof.
On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.

Fabricate units to minimum height of 12 inches (300 mm), unless otherwise indicated.
Sloping roofs: Where slope of roof deck exceeds 1/4-inch per foot (1:48), fabricate support units with water diverters and height tapered to match slope to level tops of units.
Provide supports suitable for equipment dead weight, wind loads, seismic lifting, and anchoring forces as required.
Provide anchoring instructions.

EXECUTION

HVAC DEMOLITION

Refer to Division 1 Section "Cutting and Patching" and Division 2 Section "Selective Structure Demolition" for general demolition requirements and procedures.

Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed. No equipment or components shall be abandoned in place unless specifically noted on the drawings.

Piping to Be Removed: Remove portion of piping indicated to be removed and cap remaining piping with same or compatible piping material.
Piping to Be Abandoned in Place: Drain piping and cap piping with same or compatible piping material.
Ducts to Be Removed: Remove portion of ducts indicated to be removed and cap remaining ducts with same or compatible ductwork material. Seal remaining ductwork to seal Class C. Duct tape is not permitted.
Ducts to Be Abandoned in Place: Cap ducts with same or compatible ductwork material.
Equipment to Be Removed: Disconnect and remove services and remove equipment. Cap piping and ductwork as required.
Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, store equipment and protect in a safe location during construction to prevent damage; when appropriate, reinstall, reconnect, and make equipment operational.
Equipment Piping and Ductwork to Be Removed and Salvaged: Disconnect and cap services and remove equipment. Owner shall be given first right of refusal to all items removed from the Owner's facility or property. Deliver salvaged items to Owner at location requested by Owner.
When removing piping and ductwork components, all accessories, hangers, insulation and hanger rods shall be removed also.
Provide temporary hangers for any pipe or duct to remain which has had hangers removed such that hanger spacing does not exceed 10'-0".
Provide temporary hangers for any pipe or duct which was supported by a wall which was removed.
Locate and identify mechanical systems passing through the affected demolition area which serves other areas outside the demolition limits. Provide information to the Engineer directly of any questionable items.
Systems serving areas outside the work limits shall remain uninterrupted unless specifically authorized in writing by the Owner.

If pipe, insulation, or equipment is damaged in appearance or is unserviceable due to demolition work, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

All caps installed shall be installed and located such that the pipe or duct may be reconnected to and extended without relocation of other components while utilizing standard fittings.

Coordinate with all trades such that any existing, temporary or new installations by other trades does not block access to caps.

Confirm with the Owner, which if any, supply, return or exhaust air openings associated with systems which serve the project area may remain in use during construction. Cover all supply, return and exhaust air openings with synthetic air filter media, 1-inch thick, with non-oily tackified surface, with a dust holding capacity of at least 250 grams per square yard, an average dust spot arrestance of at least 85 percent, and a MERV rating of at least 6. Allow in the bid to replace the air filter media at least once per month and more often as required for proper operation of the fan systems.

Removal of portions of systems which are energized or will be energized at any point during the construction project shall be accomplished by skilled trades who will be contractually engaged in connecting new work (piping, ductwork or caps thereof) to these same systems.

PIPING SYSTEMS - COMMON REQUIREMENTS

Install piping according to the following requirements and Division 23 Sections specifying piping systems.

Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

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.

Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

Install piping to permit valve servicing.

Install piping at indicated slopes.

Install piping free of sags and bends.

Install fittings for changes in direction and branch connections. Utilize tee fittings for branch connections that have all three connection sizes of NPS 1-1/2” and larger. It is acceptable to utilize threadolet fittings with dielectric nipples on carbon steel piping of NPS 2-1/2” and larger when the branch connection size is NPS 1” or less and a bronze body ball valve is installed on the other end of the dielectric nipple.

Install piping and ductwork to allow application of insulation.

Select system components with pressure rating equal to or greater than system operating pressure.

Install escutcheons for penetrations of walls, barriers, ceilings, and floors in exposed areas. In Dietary, Kitchen, Cafeteria, Sterile Processing, Sterilizer, Sub-Sterile, Animal Holding,

Operating Rooms, Procedure Rooms and other sterile areas do not install escutcheons, but seal pipe penetrations airtight with clear food grade silicone.

New concrete floors, walls, and roof penetrations are required to have sleeves cast-in-place (no core drilling is allowed unless specifically noted on the drawings).

Core drilling in buildings that are occupied up to two floors above the construction area or two floors below the construction area or are occupied on the same floor within 100 linear feet shall be accomplished with wet core drilling machines with slurry extraction to reduce noise.

Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs. It is the contractors requirement to coordinate fine sleeve placement and size.

Cut sleeves to length for mounting flush with both surfaces.

Exception: Extend top of sleeves installed in all floors (including mechanical equipment areas) and penthouses 2 inches (50 mm) above finished floor level. Waterstop shall be entirely contained within concrete with approximately 1-1/2-inch of concrete cover. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

Install sleeves in new walls and slabs as new walls and slabs are constructed.
Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

Steel pipe sleeves, cast iron pipe sleeves or stainless steel sheet sleeves for all pipes penetrating other than gypsum board partitions or walls.
Galvanized Steel Sheet Sleeves: For pipes and larger, penetrating gypsum-board partitions or walls.
Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.

Aboveground, Exterior-Wall Pipe 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.

Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, barriers, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Firestopping" for materials.

Verify final equipment locations for roughing-in.

Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

Install piping, hangers and equipment so that they do not interfere with fully opening the access panels on any part of the structure, any contractor installed access panels, nor access panels on any equipment (either contract provided or Owner provided or Owner installed equipment).

Install piping, hangers and equipment so that they do not interfere with personnel movement. Components shall be a minimum of 7'-6" above finished floor unless specifically noted to be installed lower. Provide personnel protection on components located less than 6'-6" above finished floor (elastomeric insulation, caution markings).

PIPING JOINT CONSTRUCTION

Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using brazing filler metal complying with AWS A5.8.

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:

Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
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.

Welded Joints:

Construct carbon steel joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
Construct stainless steel joints according to AWS D10.4, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
Construct aluminum joints according to AWS D10.7, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

Utilize AWS D10.11 Guide for Root Pass Welding of Pipe without Backing for all Welding Operations. Purge as required to obtain a smooth root surface.

Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
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.
PVC Non-pressure Piping: Join according to ASTM D 2855.

Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.

PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

Plain-End Pipe and Fittings: Use butt fusion.
Plain-End Pipe and Socket Fittings: Use socket fusion.

Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

## PIPING CONNECTIONS

Make connections according to the following, unless otherwise indicated:

Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
Wet Piping Systems: Install dielectric coupling and dielectric nipple fittings to connect piping materials of dissimilar metals. Do not utilize dielectric unions with O-rings on wet piping systems.

## EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated. Provide a minimum of 7’-2” headroom under all exposed equipment.

Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

Install equipment to allow right of way for piping installed at required slope.

Comply with the equipment manufacturer's written installation instructions.

Provide access platforms on the side of equipment where the access level is more than 30 inches above the roof or floor. Provide handrail guards that extend 42" above the platform in accordance with the International Building Code. Provide a permanent ladder or stairs to access the platform. All platforms, guards and stair/ladder materials shall be non-corrosive. Handrails shall be readily removable for removal of equipment components.

## PAINTING

Painting of HVAC systems, equipment, and components is specified in Division 9 Sections.

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

## CONCRETE BASES

Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project. If concrete bases are not detailed on the drawings, then furnish:

Construct concrete bases of dimensions indicated, not less than 3.5 inches thick and not less than 4 inches (100 mm) larger in both directions than supported unit.
Install bonding agent to connect concrete base to concrete floor. Apply to 100% of the contact area between base and floor.
Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
Install anchor bolts to elevations required for proper attachment to supported equipment.
Install anchor bolts according to anchor-bolt manufacturer's written instructions.
Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section. If not specified, utilize #4 reinforcing at 12" on center each way with #4 around the perimeter.

## ERECTION OF METAL SUPPORTS AND ANCHORAGES

Refer to Division 5 Section "Metal Fabrications" for structural steel.

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

Field Welding: Comply with AWS D1.1.

ERECTION OF WOOD SUPPORTS AND ANCHORAGES

Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.

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.

Attach to substrates as required to support applied loads.

GROUTING

Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.

Clean surfaces that will come into contact with grout.

Provide forms as required for placement of grout.

Avoid air entrapment during placement of grout.

Place grout, completely filling equipment bases. Obtain pump manufacturer's written installation instructions.

Place grout on concrete bases and provide smooth bearing surface for equipment.

Place grout around anchors.

Cure placed grout.

ROOF CURBS AND EQUIPMENT AND PIPE SUPPORTS

General: Comply with manufacturer's written instructions. Coordinate installation of roof accessories with installation of roof deck, roof insulation, flashing, roofing membranes, penetrations, equipment, and other construction involving roof accessories to ensure that each element of the work performs properly and that combined elements are waterproof and weathertight. Anchor roof accessories securely to support structural substrates so they are capable of withstanding lateral and thermal stresses, and inward and outward loading pressures.

All roof repairs shall be completed by a roofing contractor that is certified by the manufacturer of the existing and new roofing systems. All roof repairs shall be completed with materials and workmanship that is fully compatible with the roofing system and in full accordance with the roofing manufacturer's written installation requirements to maintain the roof warranty.

Install roof accessory items according to construction details of NRCA's "Roofing and Waterproofing Manual" unless otherwise indicated.

Separation: Separate metal from incompatible metal or corrosive substrates, including wood, by coating concealed surfaces or at locations of contact, with bituminous coating or providing other permanent separation.

Flange Seals: Unless otherwise indicated, set flanges of accessory units with a thick bed of roofing cement to form a seal.

Cap Flashing: Where required as component of accessory, install cap flashing to provide waterproof overlap with roofing or roof flashing (as counterflashing). Seal overlap with thick bead of mastic sealant.

## CUTTING AND PATCHING

Refer to Division 2 for general cutting and patching requirements and procedures.

Cut, channel and drill floors, walls, partitions, shafts, ceiling sand other surfaces required to permit electrical installations and demolition. Perform cutting by skilled mechanics of trades involved.

Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

## FIRESTOPPING

Apply firestopping to penetrations of fire-rated floor and wall assemblies for all installations to restore original fire-resistance rating of assembly. Apply firestopping to structure where demolition exposes the structure. Firestopping materials and installation requirements are specified in Division 7 Section “Firestopping”.

Apply firestopping as indicated to seal penetrations in Paragraph “Penetration Sealing”.

Apply firestopping to all penetrations of smoke barriers. Provide an approved through penetration firestop system installed and tested in accordance with the requirements of UL 1479 for air leakage. The L rating for each firestop system shall not exceed 5.0 cfm per square foot at 0.30 inches of water in both ambient and elevated temperature tests.

## PENETRATION SEALING

Horizontal assembly penetrations of all floors, floor/ceiling assemblies and ceiling membranes of roof/ceiling assemblies shall be sealed as follows:

Non-fire resistance rated assemblies with non-combustible penetrating items shall utilize annular space fill or penetration firestopping.
Fire resistance rated assemblies shall utilize penetration firestopping.

All Penthouse floor penetrations shall be sealed.

All attic floor penetrations shall be sealed.

All enclosed spaces which house HVAC equipment shall have all penetrations of the horizontal and vertical membranes which separate the space from occupied and unoccupied building spaces sealed.

Penetrations to be sealed shall include, at a minimum, all piping, ductwork, flues, vents, chimneys, conduit and cabling penetrations installed.

CLEANING AND PROTECTION

On completion of installation, inspect exposed finish. Remove burrs, dirt, paint spots and construction debris. This requirement applies for components including piping and ductwork which are located above lay-in and hard ceilings, especially their upper surfaces prone to collect dust and debris.

Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion. Repair all coatings, finishes and cabinets to “as-new” conditions prior to Substantial Completion.

Remove all un-utilized construction materials from the project area.

Trim rod hangers to a maximum exposed threaded length of 1” below the bottom nut.

Protect all Owner provided spare parts. Obtain written receipt of Owner acceptance of spare parts denoting the quantities and storage location.

**END OF SECTION**

**SECTION 230513**
**COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes basic requirements for factory-installed motors.

### 1.3 DEFINITIONS

A. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.

### 1.4 SUBMITTALS

A. Product Data for Installed Motors: For each type and size of motor, provide:

1. Nameplate data and ratings (hp; full load amps; rpm; voltage; power factor; temperature rise class; insulation class; service factor; enclosure type, frame material of construction).
2. Shipping weights.
3. Four pole, nominal 1,800 rpm, full load, nominal efficiency.

### 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.

### 1.6 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices. Provide motors that are:

1. Compatible with the following:

a. Magnetic controllers.
b. Multi-speed controllers.

c. Reduced-voltage controllers.
d. Variable frequency controllers:

1) Cable distance.
2) Operation of the variable frequency controller at up to 90 Hz.

2. Matched to torque, speed and horsepower requirements of the load.
3. Matched to ratings and characteristics of supply circuit and required control sequence.
4. Matched to ambient and environmental conditions at installation location.

B. Motors shall not operate in service factor range.

C. Coordinate motor support with requirements for driven load; access for maintenance and motor replacement; installation of accessories, belts, belt guards; and adjustment of sliding rails for belt tensioning.

D. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section.

## PART 2 - PRODUCTS

### 2.1 MOTOR REQUIREMENTS

A. Motor requirements apply to all motors except when starter requirements, performance or characteristics for a motor are specified in another section or on the drawings.

### 2.2 MOTOR CHARACTERISTICS

A. Motors 3 HP and Larger: Three phase.

B. Motors Smaller Than 3 HP:
1. Single or three phase as identified on the construction documents.
2. Shall utilize an Electrically Commutated Motor

C. Frequency Rating: 60 Hz.

D. Voltage Rating: Matched to voltage of supply circuit.

E. Service Factor: 1.35 for 1/3 HP and below; 1.25 above 1/3 HP to 3/4 HP; 1.15 above 3/4 HP.

F. Duty: Continuous duty at ambient temperature of 105 deg F (40 deg C) and at altitude of 3300 feet (1005 m) above sea level.

G. Capacity and Torque Characteristics: NEMA Standards MG1; 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.

H. Enclosure: Open drip-proof unless noted otherwise in specific equipment specification or on the drawings. Motor enclosures in hazardous areas shall be of the proper UL Class and group for the atmosphere in which they are located.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Nominal Efficiency: Four-pole, full load, minimum nominal efficiency and minimum power factor at nominal 1,800 rpm and nominal 460 VAC:

| HP | MINIMUM EFFICIENCY PERCENT | MINIMUM POWER FACTOR |
|---|---|---|
| 1 | 85.5 | 75 |
| 1.5 | 86.5 | 75 |
| 2 | 86.5 | 75 |
| 3 | 87.5 | 75 |
| 5 | 89.5 | 75 |
| 7.5 | 91.0 | 75 |
| 10 | 91.7 | 80 |
| 15 | 93.0 | 80 |
| 20 | 93.0 | 80 |
| 25 | 93.6 | 85 |
| 30 | 94.1 | 85 |
| 40 | 94.1 | 85 |
| 50 | 94.5 | 85 |
| 60 | 95.0 | 85 |
| 75 | 95.0 | 85 |
| 100 | 95.4 | 85 |
| 125 | 95.4 | 85 |
| 150 | 95.8 | 85 |
| 200 | 95.8 | 85 |

C. Service Factor: Minimum 1.15.

D. Stator: Copper windings, unless otherwise indicated.

1. Multi-speed motors shall have separate winding for each speed.

E. Rotor: Squirrel cage, unless otherwise indicated.

F. Bearings: Double-shielded, prelubricated ball bearings less than 40 HP, regreasable 40 HP and larger, suitable for radial and thrust loading.

G. Temperature Rise: Class B at 1.0 service factor, unless noted otherwise.

H. Insulation: Class F, unless otherwise indicated.

I. Code Letter Designation: NEMA code letters for AC motors normally started on full voltage. NEMA starting code for Code G for motors 15 Hp and larger.

J. Enclosure Material: Cast iron for motors 10 HP and larger; rolled steel for motors smaller than 10 HP.

## 2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals and/or leads 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. Designed and labeled for inverter duty per NEMA MG-1, Part 31 in its entirety and suitable for use throughout 20% to 150% motor base speed range in a variable torque application without overheating.

1. Designed with critical vibration frequencies outside operating range of controller output.
2. Temperature Rise: Class F.
3. Insulation: Class H IEEE Standard 117. Designed to resist transient spikes, high frequencies and short time pulses.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
5. Provide a factory installed, maintenance free, circumferential shaft grounding ring to discharge shaft currents to ground. Grounding ring shall be installed at the motor manufacturer’s factory on the drive end of the motor.

C. Severe-Duty Motors: Totally enclosed, with 1.15 minimum service factor, greased bearings, integral condensate drains, and capped relief vents. Windings insulated with non-hygroscopic material. Comply with IEEE 841.

1. Finish: Chemical-resistant paint over corrosion-resistant primer.

## 2.5 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.
4. Electronically-commutated.

B. Shaded-Pole or Permanent Split Capacitor Motors: For motors 1/20 hp and smaller only.

C. Motors that are 1/12 HP or greater and less than 1 HP shall be electronically commutated motors with a minimum efficiency of 70 percent when rated in accordance with DOE 10 CFR 431.

D. 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.

E. 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.

F. Source Quality Control: Perform the following tests on each motor according to NEMA Standards 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.

G. Electronically Commutated Motor Speed Controller: Integral with the motor, sized and matched for motor by the motor manufacturer, capable of at least a 20% speed adjustment increase and 50% speed decrease via a manual potentiometer. Provide all transformers and wiring factory mounted for a completely functional unit. Furnish controller analog input or two speed input as required to meet the control sequence. Coordinate with Building Automation System submittals.

## 2.6 ELECTRONICALLY COMMMUTATED MOTOR

A. Motor shall be an electronic commutated (EC) motor specifically designed for fan applications.

B. Motor shall be speed controllable down to 20% of full speed. Speed shall be controlled either by a potentionmeter dial mounted on the motor or by a 0-10 VDC signal.

C. Motor shall be 80% efficient at all speeds rated in accordance with NEMA Standard MG 1-2006

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine areas to receive motors for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in of conduit systems to verify actual locations of conduit connections before motor installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. For each electronically commutated motor furnished, provide an electronically commutated motor speed controller.

## 3.2 MOTOR INSTALLATION

A. Anchor each motor assembly to base, adjustable rails, or other support, arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and align with load transfer link.

B. Comply with mounting and anchoring requirements specified in Division 23 Section "HVAC Vibration and Seismic Controls."

## 3.3 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
2. Test interlocks and control features for proper operation.
3. Verify that current in each phase is within nameplate rating.

B. Testing: Perform the following field quality-control testing:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.15.1. 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.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect field-assembled components, equipment installation, and piping and electrical connections for compliance with requirements.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Verify bearing lubrication.
4. Verify proper motor rotation.
5. Test Reports: Prepare a written report to record the following:

    a. Test procedures used.
    b. Test results that comply with requirements.
    c. Test results that do not comply with requirements and corrective action taken to achieve compliance.

## 3.4 ADJUSTING

A. Align motors, bases, shafts, pulleys and belts. Tension belts according to manufacturer's written instructions.

3.5 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 and nameplates, on completion of installation, according to manufacturer's written instructions.

**END OF SECTION**

**SECTION 230529**
**HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

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

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

B. Related Sections include the following:

1. Division 5 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-protection piping.
3. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
4. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
5. Division 23 Section(s) "Metal Ducts" and "Nonmetal Ducts" for duct hangers and supports.

### 1.3 DEFINITIONS

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

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

## 1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Design seismic-restraint hangers and supports for piping and equipment.

## 1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports. Include piping system schedule delineating which piping systems receive roller hangers.
2. Thermal-hanger shield inserts.
3. Powder-actuated fastener systems.
4. Spring hangers utilized at pumps and other locations.

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.

## 1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following as applicable:

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 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Carpenter & Paterson, Inc.
3. ERICO/Michigan Hanger Co.
4. Anvil International, Inc.
5. National Pipe Hanger Corporation.
6. PHD Manufacturing, Inc.
7. PHS Industries, Inc.
8. Piping Technology & Products, Inc.
9. Tolco Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

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

## 2.3 TRAPEZE PIPE HANGERS

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

## 2.4 METAL FRAMING SYSTEMS

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

B. Manufacturers:

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

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

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

## 2.5 THERMAL HANGER SHIELDS

A. Description: Carbon steel, galvanized finish, shield. For use with Clevis hangers with ribs to keep shield centered in hanger. MSS-SP-69 Type 40.

## 2.6 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- (690-kPa-) minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:

1. Carpenter & Paterson, Inc.
2. ERICO/Michigan Hanger Co.
3. PHS Industries, Inc.
4. Pipe Shields, Inc.
5. Rilco Manufacturing Company, Inc.
6. Value Engineered Products, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 552, Type II cellular glass with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.

E. For Trapeze and Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

## 2.7 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated or stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:

a. B-Line Systems, Inc.; a division of Cooper Industries.
b. Empire Industries, Inc.
c. Hilti, Inc.
d. ITW Ramset/Red Head.
e. MKT Fastening, LLC.
f. Powers Fasteners.

## 2.8 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support piping.

B. Compact Pipe Stand: One-piece UV-inhibited plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration, complete with seismic restraints. All metal components shall be hot dipped galvanized in accordance with ASTM A123 after fabrication.

1. Manufacturers:

a. ERICO/Michigan Hanger Co.
b. MIRO Industries.
c. Portable Pipe Hangers.

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

## 2.9 EQUIPMENT SUPPORTS

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

## 2.10 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, non-shrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Non-staining, non-corrosive, and nongaseous.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

# PART 3 - EXECUTION

## 3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will come into direct contact with galvanized piping.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use pre-galvanized (hot dipped galvanized not required) or plain finish for indoor steel pipe hangers unless otherwise indicated.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750). Install second upper locknut on hanger rod and tighten.
2. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 2 (DN 15 to DN 50).

3. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).
4. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36 (DN 100 to DN 900), with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
5. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36 (DN 65 to DN 900), if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
6. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30 (DN 25 to DN 750), from 2 rods if longitudinal movement caused by expansion and contraction might occur.
7. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20 (DN 65 to DN 500), from single rod if horizontal movement caused by expansion and contraction might occur.
8. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42 (DN 50 to DN 1050), if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
9. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30 (DN 50 to DN 750), if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 12.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 14 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
4. C-Clamps (MSS Type 23): For structural shapes.
5. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
6. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
7. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
8. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

9. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
10. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).

11. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

12. For building attachments other than those indicated (such as Z purlins), install appropriate attachments directly to building or install unistrut to structure and hang from the unistrut. Clarify with the Structural Engineer as required

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections. Utilize powder coated channel for all channel exposed to view in occupied spaces and mechanical spaces.

N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction. Do not utilize powder-actuated fasteners.

## 3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricated from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Metal Framing System Installation:

1. Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
2. Provide vinyl frame caps on the ends of framing members which are located less than 8’-0” above finished floor.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. 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.

F. Pipe Stand Installation:

1. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 7 Section "Roof Accessories" for curbs.
2. Insulate pipe stands which come in direct contact with piping or piping system components which operate below 50 deg F.

G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

I. 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.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 4 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.

L. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. 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.

N. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
    b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
    c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.

d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
8. Pipe Spacing: Arrange piping so that a minimum of 2-1/2" of clear space exists between the outer surface of the pipe insulation on parallel piping.
9. Spaces with no ceiling: Attach protective insulation shield to hanger utilizing tack weld such that shield cannot be dislodged from the hanger.

## 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.

D. Paint interior supports with corrosion resistant paint.

E. Insulate supports which come in direct contact with equipment or piping which operates below 50 deg F.

F. Fabricate exterior supports from galvanized or stainless materials which are compatible with the equipment, piping and ductwork being supported.

## 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.

D. Provide brush-on galvanizing touch-up for all bare metal exposed during installation or assembly. Galvanizing touch-up shall be compatible with original galvanized material.

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 (40 mm).

3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

**END OF SECTION**

**SECTION 230549**
**VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT**

## 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 vibration isolation controls for HVAC components. This section includes restraints for equipment, piping, and ductwork.

B. This Section includes the following:

1. Elastomeric isolation pads.
2. Restrained elastomeric isolation mounts.
3. Freestanding and restrained spring isolators.
4. Housed spring mounts.
5. Elastomeric hangers.
6. Spring hangers with vertical-limit stops.
7. Pipe riser resilient supports.
8. Resilient pipe guides.
9. Restrained vibration isolation roof-curb rails.
10. Snubbers.
11. Steel and inertia, vibration isolation equipment bases.
12. Anchor bolts.

### 1.3 DEFINITIONS

A. OSHPD: Office of Statewide Health Planning & Development for the State of California.

B. SMACNA: Sheet Metal and Air Conditioning Contractors National Association, Inc.

C. NFPA: National Fire Protection Association.

D. IBC: International Building Code.

### 1.4 PERFORMANCE REQUIREMENTS

A. Equipment Restraint:

1. Design Spectral Acceleration, Short Period: [**0.XXX.**]

B. Seismic restraint shall be provided in accordance with requirements of the applicable Building Code and Mechanical Code and other locally enforced codes.

C. Wind Restraint Loading:

1. Basic Wind Speed and Building Classification: See structural drawings.
2. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction and 45 degrees either side of normal.

## 1.5 SUBMITTALS

A. Product Data: Include load deflection curves rated load and overload capacity for each vibration isolation device.

B. Equipment Shop Drawings: Signed and sealed by a qualified professional engineer. Include the following:

1. 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. Include equipment and motor location template on concrete inertia base submittals to confirm overall size of inertia base and arrangement of items on top of inertia base.
2. Restraint Details: Detail fabrication and attachment of restraints and snubbers. Show anchorage details and indicate material, strength, finish, quantity, diameter, depth of penetration of anchors, and required anchor edge distances.

C. Wind Restraint Details: Detail fabrication and attachment of restraints. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors. Submit calculations showing wind forces and compliance with all state and local codes.

## 1.6 QUALITY ASSURANCE

A. Restraint devices shall have horizontal and vertical load testing and analysis performed according to OSHPD and shall bear anchorage preapproval "OPA" number, from OSHPD or another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support restraint designs must be signed and sealed by a qualified professional engineer.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel."

C. HVAC equipment mounted outside the building shall be anchored to building structure in compliance with lateral load requirements of the locally enforced building code.

## 1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. 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."

C. Coordinate with all trades the locations of restraints for HVAC piping and equipment with all other systems and equipment in the vicinity.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

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

1. Amber/Booth Company, Inc., A VMC Group Company.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.
4. Vibration Eliminator Company, Inc.
5. Vibro-Acoustics.
6. Vibration Mountings and Controls, Inc.

### 2.2 VIBRATION ISOLATORS

A. Elastomeric Isolator Pads: Oil and water resistant neoprene arranged in single or multiple layers, molded with non-slip 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: Standard neoprene.

B. Spring Isolators: Freestanding, laterally stable, open spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
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- (6-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 100 psig (690 kPa).
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

C. Restrained Spring Isolators: Freestanding, steel, open spring isolators with seismic restraint.

1. 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- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside;

and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
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.
6. Restraint: Snubber and stop as required for equipment and authorities having jurisdiction.

D. Elastomeric Hangers: Double deflection type, with molded, oil resistant rubber or neoprene isolator elements, steel housings with threaded connections for hanger rods. Color coded or otherwise identified to indicate capacity range.

E. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. 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.
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.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame or other method which puts the neoprene in series with the spring.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

F. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

1. 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.
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.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

G. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- (13-mm-) thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both

directions. Design support for a maximum load on the isolation material of 500 psig (3.45 MPa) and for equal resistance in all directions.

H. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes separated by a minimum of 1/2-inch- (13-mm-) thick, neoprene. Factory set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

## 2.3 RESTRAINED VIBRATION ISOLATION ROOF-CURB RAILS

A. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces. Wind forces shall be a minimum of 125-mph (56-m/s) wind impinging laterally against side of equipment.

B. 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 and seismic 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 (50 mm) of rigid, glass-fiber insulation on inside of assembly.

C. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch- (6-mm-) 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.

1. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic and/or wind restraint.

    a. Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
    b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
    c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
    d. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
    e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a non-slip 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.

    a. Material: Standard neoprene.

D. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch (6 mm) thick.

E. 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.

## 2.4 RESTRAINT DEVICES

A. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

B. Resilient Isolation Washers and Bushings: 1-piece, molded, neoprene having a durometer of 40 - 60, plus or minus 5, with a flat washer face.

C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 40 - 60, plus or minus 5.
3. Maximum 1/4-inch air gap and minimum 1/4-inch thick resilient cushion.

D. Hanger Rod Stiffener: Steel tube or steel slotted support system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.

E. Anchor Bolts: Seismic-rated, drill-in, and stud-wedge or female-wedge type suitable for seismic use in accordance with ACI 355. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488/E 488M. Provide adhesive anchor bolts for non-isolated equipment in excess of 10 HP.

F. Channel Support System: MFMA-3 shop or field fabricated support assembly made of slotted steel channels rated in tension, compressor, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end.

## 2.5 VIBRATION ISOLATION EQUIPMENT BASES

A. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor and not more than 1-1/2 inch clearance. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.
2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

B. Inertia Base Factory-fabricated, welded, structural-steel bases and rails ready for field-applied, cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.
2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment. Prime and paint all steel.
3. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. 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.
5. Bottom pan with stiffener supports welded to the steel frame.
6. Cast-in-place anchor templates for supported equipment.
7. Rebar for concrete, sized and located as required.

## 2.6 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 electro-galvanized. Hot-dip galvanized metal components for exterior use.
3. Baked enamel for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and wind control 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 7 Section "Roof Accessories" and in accordance with applicable codes as required by the authorities having jurisdiction.

B. Install thrust limits at centerline of thrust, symmetrical on either side of equipment.

C. Install snubbers or restrained springs on isolated equipment. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

D. Install restraining cables steel angles or channel for hanging equipment as specified herein. Install cables so they do not bend across sharp edges of adjacent equipment or building structure. Do not weld angles to threaded rods.

E. Install resilient bolt isolation washers on equipment anchor bolts.

F. Install hanger rod stiffeners where required to prevent buckling of hanger rods due to forces.

G. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by ICC-ES, OSHPD or another agency acceptable to authorities having jurisdiction.

H. Attachment to Structure: Anchor bracing to structure at flange of beams, at upper chord of truss or at concrete members.

I. Drilled in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage reinforced steel and embedded items. Locate and avoid all items.
2. Do not drill holes until concrete has achieved full design strength.
3. Set anchors to manufacturer’s recommended torque, using a torque wrench.
4. Install zinc coated anchors for interior and stainless steel anchors for exterior applications.

J. Field installed identification means on each actual restraint which is cross-referenced to the submittal drawing.

K. Fill concrete inertia bases, after installing base frame, with 3000-psi (20.7-MPa) concrete; trowel to a smooth finish.

1. Cast-in-place concrete materials and placement requirements as specified in Division 3.

## 3.3 EQUIPMENT BASES

A. Concrete Equipment Bases: Anchor equipment to concrete base according to supported equipment manufacturer's written instructions for seismic codes at Project site.

B. Positively anchor concrete base to concrete floor. Unless otherwise indicated, install #3 with 6" hook dowel rods, 6" from edge of base, minimum four per base, on 18-inch (457-mm) centers around the full perimeter of the base.

1. Place and secure anchorage devices a minimum of 6" from edge of base. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
4. Cast-in-place concrete materials and placement requirements are specified in Division 3.

## 3.4 ACCOMMODATION OF DIFFERENTIAL BUILDING MOTION

A. Install flexible connections in piping where they cross building joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

## 3.5 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 (6-mm) movement during start and stop.

D. Adjust active height of spring isolators.

E. Adjust snubbers according to manufacturer's written recommendations.

F. Adjust restraints to permit free movement of equipment within normal mode of operation.

G. Torque anchor bolts according to equipment manufacturer's written recommendations to resist seismic forces.

## 3.6 CLEANING

A. After completing equipment installation, inspect vibration isolation and seismic-control devices. Remove paint splatters and other spots, dirt, and debris, leaving equipment free to move on isolation supports.

## 3.7 EQUIPMENT VIBRATION ISOLATION AND RESTRAINT

A. Manufacturer shall design and provide vibration isolation and restraints to meet the requirements of this specification and as indicated on the Drawings.

B. Restraints shall be designed and provided for all equipment.

C. All floor mounted equipment whether vibration isolated or not shall be anchored, bolted or welded to the structure to comply with the required design forces.

D. All roof mounted equipment whether vibration isolated or not, shall be anchored, bolted or welded to its equipment support. All equipment supports shall be anchored, bolted or welded to the building structure to comply with required design forces.

E. Suspended equipment shall be two rigid restraint or four point cables independently braced.

**END OF SECTION**

**SECTION 230553**
**IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:

1. Equipment labels.
2. Access panel and door labels.
3. Pipe labels.
4. Duct labels.
5. Stencils.
6. Valve tags.
7. Valve schedules.
8. Ceiling and thermostat labels.
9. Access flooring labels.
10. Raceway identification materials.
11. Control cable identification materials.

### 1.3 SUBMITTALS

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

B. Valve Tag Schedules: For each piping system. Include a listing of all valves to be labeled with proposed content for each label. Include valve numbering scheme. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with proposed content for each label.

### 1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 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.

D. Coordinate identifying devices to be consistent in appearance in all exposed locations.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Labels: Engraved, color-coded, multi-layer, multi-color laminated plastic for mechanical engraving. Include contact-type, permanent adhesive suitable for surface temperature of equipment.

1. Terminology: Match Owner's numbering scheme or drawing schedules with unique equipment number.
2. Size: Length and width vary for required label content, but not less than 4-1/2 by 6 inches (115 by 150 mm) for equipment, 1/8 inch thick.
3. Letters: 1/2 inch minimum.

B. Access Panel and Door Labels: 1/16-inch- (1.6-mm-) thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch (3.2-mm) center hole for attachment.

1. Terminology: Match Owner’s labeling scheme.
2. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Labels, General: Preprinted, color-coded, with lettering indicating service, and an arrow showing direction of flow.

1. Colors: ASME A13.1 or Owner's current color scheme.
2. Lettering:

| | |
|---|---|
| Refrigerant Suction | RS |
| Refrigerant Liquid | RL |
| Refrigerant Hot Gas Bypass | RHGB |
| Condensate Drain | CD |

3. Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): Full-band pipe markers extending 360 degrees around pipe at each location.
4. Pipes with OD, Including Insulation, 6 Inches (150 mm) and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of material flow in piping.

B. Pretensioned Pipe Labels: Precoiled semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

C. Self-Adhesive Plastic Tape Pipe Labels: Continuously printed, vinyl tape at least 3 mils (0.08 mm) thick with pressure-sensitive, permanent-type, self-adhesive back.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations used on drawings and an arrow indicating flow direction. Provide lettering size at least 1-1/2 inches high.

## 2.3 DUCT IDENTIFICATION DEVICES

A. Duct Labels: Preprinted, color-coded with lettering indicating service. Include direction of airflow and duct service (such as supply, return, and exhaust). Include contact-type, permanent adhesive.

## 2.4 DUCT AND ACCESS DOOR STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1; minimum letter height of 1-1/4 inches (32 mm) for ducts; and minimum letter height of 3/4 inch (19 mm) for access panel and door markers and similar operational instructions.

1. Stencil Paint: Exterior, gloss, acrylic enamel black, unless otherwise indicated. Paint may be in pressurized spray-can form.
2. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1, unless otherwise indicated.

## 2.5 VALVE TAGS

A. Valve Tags: Stamped with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers, with numbering scheme approved by Owner. Provide 5/32-inch (4-mm) hole for fastener.

1. Material: 0.032-inch- (0.8-mm-) thick brass.
2. Valve-Tag Fasteners: Brass S-hook.
3. Lettering: Black filled.
4. Size: Minimum 1-1/2”, larger as required for labeling scheme.

## 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: Extruded aluminum.
3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

## 2.7 CEILING LABELS

A. Description: 1/2-inch wide clear extra strength tape with 1/4-inch high black letters. Extra strength adhesive suitable for use on rough, textured, or uneven surfaces, as well as painted and powder coated surfaces.

## 2.8 TEMPERATURE SENSOR LABELS

A. Description: 1/4-inch wide clear extra strength tape with 1/8-inch high black letters. Extra strength adhesive for use on rough textured or uneven surfaces, as well as painted or powder coated surfaces.

## 2.9 ACCESS FLOORING LABELS

A. Description: Minimum 4-inch tall permanent marker lettering on the upper surface of the access floor tile indicating components located below that tile.

## 2.10 RACEWAY (EMT AND CONDUIT) 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. Control circuits:

   a. Temperature controls: Black letters on a white field.
2. Legend: Indicate system or service. Indicate voltage.

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.

## 2.11 CONTROL CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type with circuit identification legend machine printed by thermal transfer or equivalent process.

C. Aluminum Wraparound Marker Labels: Cut from 0.014-inch (0.35-mm) 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 (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking nylon tie fastener.

## PART 3 - EXECUTION

### 3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 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 equipment labels with permanent adhesive on or near each item of mechanical equipment.

1. Letter Size: Minimum 3/4-inch (19 mm) for name of units 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 labels where accessible and visible. Include labels for each piece of mechanical equipment and for the following general categories of equipment:

    a. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
    b. Pumps, compressors, chillers, condensers, and similar motor-driven units.
    c. Heat exchangers, built-up coil banks, evaporators, cooling towers, heat recovery units, and similar equipment.
    d. Fans, blowers, primary balancing dampers, and mixing boxes.
    e. Packaged HVAC central-station and zone-type units.
    f. Tanks and pressure vessels.
    g. Filters, humidifiers and water-treatment systems.
    h. Fire dampers and fire/smoke dampers.
    i. Humidifiers and pressure reducing valves.
    j. Terminal units (supply air terminal boxes, exhaust air valves): For terminal units located above ceiling, locate equipment label on the bottom or side of the terminal unit where it will be visible from the designated ceiling access panel/tile. If utilizing manufacturer’s labels, lettering shall be at least 1” tall. Permanent marker handwritten labels with 2” tall letters are also acceptable. Do not paint over manufacturer provided labels.

B. Install access panel and door labels on equipment and shaft access panels.

## 3.3 PIPING IDENTIFICATION

A. Install manufactured pipe label indicating service on each piping system. Install with flow indication arrows showing direction of material flow in piping.

1. Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): Pretensioned pipe labels. Use size to ensure a tight fit.
2. Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): Self-adhesive pipe labels. Use color-coded, self-adhesive plastic tape, covering full circumference of pipe.
3. Pipes with OD, Including Insulation, 6 Inches (150 mm) and Larger: Self-adhesive pipe labels. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches (38 mm) wide, lapped at least 3 inches (75 mm) at both ends of pipe label, and covering full circumference of pipe.

B. Locate pipe labels as follows:

1. Near (within 24” of) each valve and control device.
2. Near each branch connection, excluding short takeoffs less than ten feet long for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Each side of penetrations through walls, floors, ceilings, and non-accessible 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 15 feet (4.5 m) along each run.
7. At a minimum of once over each room for each piping system present over that room. Center the label in the pipe run over the room. If pipe length over the room is less than 15 feet than install labels at each wall penetration.

## 3.4 DUCT IDENTIFICATION

A. Install duct labels with permanent adhesive on air ducts in the following color codes:

1. Green: For cold-air supply ducts.
2. Yellow: For hot-air supply ducts.
3. Blue: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
4. Red: For bio-hazard and isolation room exhaust ducts.
5. ASME A13.1 Colors and Designs: For hazardous material exhaust.
6. Letter Size: Minimum 1-inch (26 mm) and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

B. Stenciled Duct Option: Stenciled labels, showing service and direction of flow, may be provided instead of laminated-plastic duct labels, if lettering larger than 1 inch (25 mm) high is needed for proper identification because of distance from normal location of required identification.

C. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 15 feet (4.5 m) in each space where ducts are exposed or concealed by removable ceiling system.

D. Duct marker identification shall indicate the associated fan system (e.g., “EF-3 exhaust”).

## 3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; faucets; convenience hose connections; at HVAC terminal devices and at similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

## 3.6 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedules on a wall in an accessible location in each major equipment room.

## 3.7 CEILING LABEL AND TEMPERATURE SENSOR LABEL INSTALLATION

A. Provide ceiling labels to locate items above T-bar type lay-in panel ceilings. Locate at corner of T-Bar grid closest to equipment. Items which are scheduled on the drawings shall have labels which indicate their scheduled tag (e.g. “TB-201”). Items which are not scheduled on the drawings shall have labels which indicate their name (e.g. “Fire damper”). Provide ceiling labels for the following:

1. HVAC terminal units (terminal boxes, fan powered terminal boxes, fan coil units, reheat coils, etc.).
2. Fire dampers and fire/smoke dampers. Utilize ceiling tags “fire damper”, “fire/smoke damper” etc. if not provided individual tag names by the Owner.
3. Steam traps, humidifiers and steam pressure reducing valves. Utilize ceiling tags “steam trap”, “humidifier”, etc.
4. Controls components: Control panels, duct static pressure sensors, humidifier sensors, control valves, control dampers, control air reducing valves, etc. Utilize ceiling tags “control panel”, “pressure sensor”, etc.
5. Duct smoke detectors. Utilize ceiling tag “duct detector”.
6. Each valve which receives a valve tag. Utilize valve tag nomenclature for ceiling tag (e.g. “CHWP-7”).

B. Provide thermostat labels on the inside cover of all thermostats with removable covers. For other sensors, install label on top exterior surface. Label shall indicate equipment tag of controlled device (e.g., TB-311). Clarify location of label with controls submittal.

## 3.8 ACCESS FLOOR TILE LABEL INSTALLATION

A. Provide access floor tile labels to locate items below raised access floor. Locate on upper surface of access tile. Provide access floor labels for the following:

1. HVAC terminal units (terminal boxes, reheat coils, etc.).
2. Fire dampers and fire/smoke dampers.
3. Controls components: Control panels, duct static pressure sensors, humidifier sensors, control valves, control dampers and control air reducing valves, etc.
4. Duct smoke detectors.

5. Each valve which receives a valve tag.

## 3.9 WARNING LABEL INSTALLATION

A. Write required message on and attach warning labels to equipment and other items (e.g., hazardous ductwork systems) where required.

## 3.10 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

## 3.11 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

## 3.12 TEMPERATURE CONTROL LABEL INSTALLATION

A. Control panels shall receive equipment labels where the number of the panel matches that on the controls submittal.

B. All control raceways and junction boxes shall be identified with preprinted self-adhesive vinyl labels.

C. All cables not located within raceways shall be identified at maximum 25 foot intervals.

D. Control raceways shall be identified at maximum 15 foot intervals within rooms with no ceiling and at a minimum once over each room the raceway passes through.

**END OF SECTION**

**SECTION 230593**
**TESTING, ADJUSTING AND BALACING FOR HVAC**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes testing, adjusting and balancing HVAC systems to produce design objectives, including the following:

1. Balancing airflow and water flow within distribution systems, including submains, branches and terminals, to indicated quantities according to specified tolerances.
2. Adjusting total HVAC systems to provide indicated quantities.
3. Measuring electrical performance of HVAC equipment.
4. Setting quantitative performance of HVAC equipment.
5. Verifying that automatic control devices are functioning properly.
6. Reporting results of the activities and procedures specified in this Section.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TAB Specialist: An entity engaged to perform TAB Work.

1.4 SUBMITTALS

A. LEED Submittal:

1. Air-Balance Report for LEED Prerequisite EQ 1: Documentation of work performed for ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."

B. Qualification Data: Within 30 days of Contractor's Notice To Proceed, submit documentation that the TAB Contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article. This documentation shall include the following:

1. A list of the names of all individual on-site Field Supervisors and TAB Technicians who may be assigned to the project.

2. A statement that each of the individual listed on-site Field Supervisors and TAB Technicians has met the experience and certification requirements of the specification.
3. A statement that each of the individual listed on-site Field Supervisors and TAB Technicians has received the required training from the selected Controls Supplier.
4. A statement noting that apprentice labor may be utilized for lesser skilled tasks if under the direct supervision of one of the listed individual on-site Field Supervisors and TAB Technicians who is on-site at all times the apprentice is working.

C. Contract Documents Examination Report: Within 45 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

D. Strategies and Procedures Plan: Within 90 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

E. Pencil-copy initial TAB reports, sent directly to the Engineer, as system TAB progresses.

F. Certified TAB reports.

G. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration. Calibration dates shall be within a period of six months prior to the first recorded measurements on the project site.

H. Additional testing reports with verified conditions noted, description of adjustments made and outstanding corrective action items required by other trades.

## 1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Shall meet the following minimum requirements:

1. TAB Contractor shall be either:

a. A current certified member of AABC, registered in the state of the project site.
b. A current certified member of NEBB, registered in the state of the project site.
c. A registered Professional Engineer licensed in the state of the project site that specialized in the testing, adjusting and balancing of systems with a minimum of ten years of documented experience.

2. Testing, adjusting and balancing shall be completed under the direct field supervision of the TAB Field Supervisor. The TAB Field Supervisor shall be either:

a. A direct employee of the TAB Contractor who is currently certified as an AABC Test and Balance Engineer with at least ten years of demonstrated working experience in the testing, adjusting and balancing of building HVAC systems.
b. A direct employee of the TAB Contractor who is currently certified as NEBB Qualified TAB Supervisor with at least ten years of demonstrated working experience in the testing, adjusting and balancing of building HVAC systems.
c. A registered Professional Engineer that specialized in the testing, adjusting and balancing of systems with a minimum of ten years of documented experience.

3. All testing, adjusting and balancing work shall be completed by a TAB technician. The TAB technician shall be either:

a. An employee of the TAB Contractor and who is certified by AABC as a test and balance technician.
b. An employee of the TAB Contractor and who is certified by NEBB as a qualified TAB technician.
c. A registered Professional Engineer that specialized in the testing, adjusting and balancing of systems with a minimum of ten years of documented experience.

4. In addition to the technical capabilities described herein, the TAB Contractor demonstrates a production capability to plan, control, and integrate manpower and other resources necessary for successful contract completion.
5. TAB Contractor shall have received software training from the selected Controls Supplier applicable to the software and hardware which will be provided for this project.
6. TAB Contractor shall have on the project site all required software and hardware necessary from the selected Controls Supplier to perform testing, adjusting and balancing required tasks.
7. TAB Contractor shall be listed on the Bid Form on bid day.
8. [TAB Contractor shall not be owned by any of the following contractors nor subcontractors on this project:]

a. [General Contractor.]
b. [Mechanical Contractor.]
c. [Electrical Contractor.]
d. [Temperature Controls Contractor.]

9. TAB Contractor shall have at least five years documented experience in the testing, adjusting and balancing of commercial DDC controls. The Owner may ask to verify the qualifications and experience for all field installation technicians assigned to the project prior to the approval of the TAB Contractor.
10. TAB Contractor shall submit a statement acknowledging agreement with the applicable manufacturer's design guidelines covering the installation of controls and the subsequent requirements of the TAB Contractor.
11. TAB Contractor shall attend a one hour familiarization session immediately following the project preconstruction meeting.

B. TAB Conference: Meet with Engineer, Owner, Construction Manager, and Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB

field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items:

    a. The Contract Documents examination report.
    b. The TAB plan.
    c. Coordination and cooperation of trades and subcontractors.
    d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

## 1.6 PROJECT CONDITIONS

A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

## 1.7 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

C. The TAB Agent shall telephone the Engineer while on-site TAB work is being undertaken. Provide pencil copy handwritten data directly to the Engineer via fax while on-site TAB work is being undertaken.

# PART 2 - PRODUCTS (Not Applicable)

# PART 3 - EXECUTION

## 3.1 TAB SPECIALISTS

A. Subject to compliance with requirements, engage one of the following:

1. Central Indiana:

    a. Fulton Air Balance.

b. Midwest Balance and Service.

2. Chicago:

a. Mechanical Test and Balance, Crown Point, Indiana.
b. Independent Testing and Balancing, Wheaton, Illinois.
c. Controlled Environmental Testing and Balancing, Schaumburg, Illinois.
d. International Test and Balance, Inc., Des Plaines, Illinois.

3. Northwest Indiana:

a. Fluid Dynamics, Inc., Fort Wayne, Indiana.
b. Mechanical Test and Balance, Crown Point, Indiana.
c. Independent Testing and Balancing, Wheaton, Illinois.
d. Circle 'R' Mechanical

4. Northeastern/ South Bend

a. Fluid Dynamics, Inc., Fort Wayne, Indiana.

5. Evansville, Indiana:

a. Flo-Tech.
b. Midwest Roofing and Sheet Metal.

6. Charleston, West Virginia:

a. Kahoe Air Balance.

7. Springfield, Illinois:

a. IL Certified Testing, Inc., 500 Juniper Drive, Petersburg, Illinois 62675, (217) 632-3479.
b. Thermodynamic Balance, Inc., 25218 North 2175 East Road, Lexington, Illinois 61753, (309) 365-2520.
c. System Testing and Analysis, 11730 Old Ballas Road, Creve Coeur, Missouri 63141, (314) 567-6011.

8. Central Texas:

a. TAB Technologies
b. Campos Engineering.
c. Engineered Air Balance (EAB).

## 3.2 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the final submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section "Metal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Examine automatic temperature system components to verify the following:

1. Dampers, valves and other controlled devices operate 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 position. This includes dampers in multi-zone units, mixing boxes and variable air volume terminals.
4. Automatic modulating and shutoff valves, including 2-way valves and 3-way mixing and diverting valves, are properly connected.

5. Thermostats and humidistats are located to avoid adverse affects 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 setpoints are set at design values. Observe and record system reactions to changes in conditions. Record default setpoints if different from design values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to design values.

Q. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

## 3.3 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

## 3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance," ASHRAE 111 NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing," and in this Section.

1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

## 3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity. Submit this plan to all contractors to verify phasing and occupancy concerns. Submit plan to the Engineer prior to execution.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers. Communicate concerns about potential stratification directly to the Engineer.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

M. Measure and record for each terminal unit the static air pressure and the damper position (% open) when recording the maximum airflow readings for the space.

## 3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

    a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
b. Measure static pressure directly at the fan outlet or through the flexible connection.
c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

    a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
6. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
8. Replace sheaves and belts as required to deliver the necessary airflow through the system accounting for all system losses. Coordinate final belt and sheave sizes with unit manufacturers. Refer to individual Division 23 specifications for additional information.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.

    a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

## 3.7 PROCEDURES FOR MULTIZONE SYSTEMS

A. Set unit at maximum airflow through the cooling coil.

B. Adjust each zone's balancing damper to achieve indicated airflow within the zone.

## 3.8 PROCEDURES FOR MOTORS

A. Motors: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

## 3.9 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

## 3.10 TEMPERATURE CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between setpoints, controller readings and actual measurements.

D. Verify operation of limiting controllers (i.e., high and low temperature controllers).

E. Verify free travel and proper operation of control devices such as damper and valve operators.

F. Verify sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Confirm interaction of electrically operated switch transducers.

H. Confirm interaction of interlock and lockout systems.

I. Verify main control supply air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine if the system operates on a ground or non-grounded power supply.

K. Note operation of electric actuators using spring return for proper fail safe operations.

L. For each system with airflow measuring station, record the calibration data, actual airflow and measured sensor process variable at minimum airflow, maximum airflow, and halfway between minimum and maximum airflow settings.

M. With each piece of equipment in operation under the fully automatic control of the Building Automation System, perform the following test:

1. Throw the disconnect to the off position. For equipment driven by a variable frequency drive, switch the breaker feeding the drive to the “off” position. Simultaneously remove power from the Building Automation System controller which controls that piece of equipment.
2. Remain in the un-energized condition for eight seconds.
3. Return disconnect and breaker to their normal “on” position. Return power to controls.
4. Document normal operation of the equipment after power interruption (normal speed, normal position, normal pressure, etc.).

N. Measure and record the discharge air temperature from each terminal unit, fan coil unit and induction unit. Cooling and heating systems shall be operational during this test. Report all cooling discharge air temperatures that are above 55 deg. F to the proper contractors for remediation. Report all heating discharge air temperatures that are less than 90 deg. F to the proper contractor for remediation.

O. Report all results in writing for all verification activities.

## 3.11 FULL AIRFLOW TESTING

A. Prior to performing building pressurization testing, perform full airflow testing on each floor, one floor at a time, to be witnessed by the Mechanical Engineer.

B. Adjust diffuser throws prior to full airflow testing.

C. In fully automatic control, reset each supply terminal unit temperature control setpoint to 55 deg F and verify maximum simultaneous flow at all terminal units. Record

percentage open position of the five most hydraulically remote terminal units while simultaneously measuring static pressure at each of the five terminal units and at all the system static pressure sensors. Measure supply air temperature at the DDC sensor and compare to sensor reading. Investigate temperatures which indicate reheat valve is not fully closed. Adjust static pressure sensor setpoint such that the most hydraulically remote terminal box is 85 percent open. Rerecord percentage open position at the five most hydraulically remote terminal units while simultaneously measuring static pressure at each of the five terminal units and at the system static pressure sensors. With the floor still in full airflow and with the final static pressure setpoint in operation, identify acoustic issues for investigation by the Mechanical Engineer. Measure supply air by duct traverse in locations suitable to confirm airflow serving the floor.

D. Report all results in writing.

## 3.12 BUILDING PRESSURIZATION

A. Measure building pressurizations across doors at all existing buildings and exterior doors in full automatic occupied mode.

B. Adjust corridor and other constant volume terminal boxes and exhaust valves as clarified by Engineer.

C. Repeat testing in full automatic unoccupied mode.

D. Remeasure differential pressure across doors and readjust as clarified.

E. Report all results in writing.

## 3.13 SPECIAL SYSTEMS

A. Special systems include isolation rooms, protective environment rooms, operating rooms, clean rooms and pharmacies. Special systems include all spaces equipped with a pressure monitor or pressure indicating device. Special systems also include animal housing spaces.

B. Initial Tests:

1. Measure static pressure differential across all door undercuts with systems operating in full automatic control.
2. Adjust airflows at all exhaust, return and supply boxes as clarified by the Engineer.
3. Remeasure static pressure differential across all door undercuts with systems operating in full automatic control. Record damper positions.
4. Readjust airflows as clarified by Engineer. Adjust system pressure settings as clarified by Engineer.
5. Coordinate with cleanroom certifier for BSC testing and adjusting.

C. Final Tests:

1. After receiving clarification of initial tests and with BSC setup by certifier complete, adjust airflows as clarified by Engineer.

2. Assist TCC in calibrating pressure transmitters. Record all pressures measured with TAB equipment while simultaneously recording the readings at the Owner's operating workstation. Provide a sketch with doors and room numbers, pressures and flows for each special system. Report all results in writing.
3. Measure static pressure differential across all door undercuts. Measure percentage open of each control valve.
4. Re-perform static pressure readings in presence of the Owner and Engineer. Adjust as required. Record all pressures measured with TAB equipment while simultaneously recording the readings at the Owner's operating workstation. Provide a sketch with doors and room numbers, pressures and flows for each special system. Report all results in writing.

## 3.14 KITCHEN EXHAUST HOODS

A. Determine total airflow into the room where the hood is located and balance systems to ensure adequate air supply to all hoods.

1. Energize the exhaust fan and adjust airflow to provide the required air volume.
2. Measure exhaust airflow volume by measuring airflow at hood opening.
3. Measure air velocity using Pitot-tube traverse method.
4. Record each face velocity measurement taken at 4- to 6-inch (100- to 150-mm) increments over the entire hood opening.
5. Calculate the average face velocity by averaging all velocity measurements.
6. Calculate the airflow volume of exhaust hood face velocity by multiplying the calculated average face velocity by the opening area. Compare this quantity with exhaust volume at exhaust fan and report duct leakage.
7. Measure airflow volume supplied by makeup fan. Verify that the makeup system supplies the proper amount of air to keep the space at the indicated pressure with the exhaust systems in all operating conditions.
8. Retest for average face velocity. Adjust fan drives and other parts of the system to provide the indicated average face velocity and the indicated auxiliary air supply percentages.
9. Retest and adjust the systems until hood performance complies with Contract Documents.
10. Report all results in writing.

## 3.15 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Zero to plus 10 percent.
2. Air Outlets and Inlets: Plus or minus 5 percent.
3. Heating-Water Flow Rate: Zero to plus 5 percent.
4. Cooling-Water Flow Rate: Zero 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: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

## 3.17 FINAL REPORT

A. General: Prepare a certified written report, tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.

b. Conditions of filters.
c. Cooling coil, wet- and dry-bulb conditions.
d. Face and bypass damper settings at coils.
e. Fan drive settings including settings and percentage of maximum pitch diameter.
f. Inlet vane settings for variable-air-volume systems.
g. Settings for supply-air, static-pressure controller.
h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches (mm), and bore.
i. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches (mm), and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

3. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm (L/s).
b. Total system static pressure in inches wg (Pa).
c. Fan rpm.
d. Discharge static pressure in inches wg (Pa).
e. Filter static-pressure differential in inches wg (Pa).

f. Preheat-coil static-pressure differential in inches wg (Pa).
g. Cooling-coil static-pressure differential in inches wg (Pa).
h. Heating-coil static-pressure differential in inches wg (Pa).
i. Outdoor airflow in cfm (L/s).
j. Return airflow in cfm (L/s).
k. Outdoor-air damper position.
l. Return-air damper position.
m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch (mm) o.c.
f. Make and model number.
g. Face area in sq. ft. (sq. m).
h. Tube size in NPS (DN).
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm (L/s).
b. Average face velocity in fpm (m/s).
c. Air pressure drop in inches wg (Pa).
d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).
f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
h. Water flow rate in gpm (L/s).
i. Water pressure differential in feet of head or psig (kPa).
j. Entering-water temperature in deg F (deg C).
k. Leaving-water temperature in deg F (deg C).
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig (kPa).
n. Refrigerant suction temperature in deg F (deg C).
o. Inlet steam pressure in psig (kPa).

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h (kW).
h. Ignition type.

i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches (mm), and bore.
n. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

2. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm (L/s).
b. Entering-air temperature in deg F (deg C).
c. Leaving-air temperature in deg F (deg C).
d. Air temperature differential in deg F (deg C).
e. Entering-air static pressure in inches wg (Pa).
f. Leaving-air static pressure in inches wg (Pa).
g. Air static-pressure differential in inches wg (Pa).
h. Low-fire fuel input in Btu/h (kW).
i. High-fire fuel input in Btu/h (kW).
j. Manifold pressure in psig (kPa).
k. High-temperature-limit setting in deg F (deg C).
l. Operating set point in Btu/h (kW).
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h (kW).

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 Btu/h (kW).
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.
h. Air flow rate in cfm (L/s).
i. Face area in sq. ft. (sq. m).
j. Minimum face velocity in fpm (m/s).

2. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h (kW).
b. Air flow rate in cfm (L/s).
c. Air velocity in fpm (m/s).
d. Entering-air temperature in deg F (deg C).
e. Leaving-air temperature in deg F (deg C).
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 (mm), and bore.
h. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches (mm), and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm (L/s).
b. Total system static pressure in inches wg (Pa).
c. Fan rpm.
d. Discharge static pressure in inches wg (Pa).
e. Suction static pressure in inches wg (Pa).
f. System leakage data. Report on system leakage as the difference between the airflows measured at the fan inlet traverse and the summation of airflows measured at the spaces served. Measure fan airflows while the space airflows are all simultaneously at their maximum airflow settings. For leakage rates greater than 3%, perform branch traverse airflow readings to identify locations of leakage.

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 (deg C).
d. Duct static pressure in inches wg (Pa).
e. Duct size in inches (mm).
f. Duct area in sq. ft. (sq. m).
g. Indicated air flow rate in cfm (L/s).
h. Indicated velocity in fpm (m/s).
i. Actual air flow rate in cfm (L/s).
j. Actual average velocity in fpm (m/s).
k. Barometric pressure in psig (Pa).

K. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft. (sq. m).

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm (L/s).
b. Air velocity in fpm (m/s).
c. Preliminary air flow rate as needed in cfm (L/s).
d. Preliminary velocity as needed in fpm (m/s).
e. Final air flow rate in cfm (L/s).
f. Final velocity in fpm (m/s).
g. Space temperature in deg F (deg C).
h. Static pressure at the terminal unit when the terminal is flowing the maximum airflow setting.
i. Damper position (% open) when the terminal is flowing the maximum airflow setting.

L. System-Coil Reports: For terminal heating and cooling hydronic coils at 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. Air flow rate in cfm (L/s).
b. Entering-water temperature in deg F (deg C).
c. Leaving-water temperature in deg F (deg C).
d. Water pressure drop in feet of head or psig (kPa).
e. Entering-air temperature in deg F (deg C).
f. Leaving-air temperature in deg F (deg C).

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: Include the following:

a. Unit identification.
b. Location.
c. Unit make and model number.
d. Manufacturer's compressor serial numbers.
e. Compressor make.

f. Compressor model and serial numbers.
g. Refrigerant weight in lb (kg).
h. Low ambient temperature cutoff in deg F (deg C).

2. Test Data: Include design and actual values for the following:

a. Inlet-duct static pressure in inches wg (Pa).
b. Outlet-duct static pressure in inches wg (Pa).
c. Entering-air, dry-bulb temperature in deg F (deg C).
d. Leaving-air, dry-bulb temperature in deg F (deg C).
e. Condenser entering-water temperature in deg F (deg C).
f. Condenser leaving-water temperature in deg F (deg C).
g. Condenser water temperature differential in deg F (deg C).
h. Condenser entering-water pressure in feet of head or psig (kPa).
i. Condenser leaving-water pressure in feet of head or psig (kPa).
j. Condenser water pressure differential in feet of head or psig (kPa).
k. Control settings.
l. Unloader set points.
m. Low-pressure-cutout set point in psig (kPa).
n. High-pressure-cutout set point in psig (kPa).
o. Suction pressure in psig (kPa).
p. Suction temperature in deg F (deg C).
q. Condenser refrigerant pressure in psig (kPa).
r. Condenser refrigerant temperature in deg F (deg C).
s. Oil pressure in psig (kPa).
t. Oil temperature in deg F (deg C).
u. Voltage at each connection.
v. Amperage for each phase.
w. The kW input.
x. Crankcase heater kW.
y. Number of fans.
z. Condenser fan rpm.
aa. Condenser fan airflow rate in cfm (L/s).
bb. Condenser fan motor make, frame size, rpm, and horsepower.
cc. Condenser fan motor voltage at each connection.
dd. Condenser fan motor amperage for each phase.

N. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

O. System and Functional Test Reports: For each system test, include the following:

1. Condition of controls (fully automatic or not).
2. Variable frequency drive Hertz.
3. All conditions denoted in the Procedures Section.
4. System static pressures at building automation sensors, both physical readings and controller readouts.

## 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. Check the following for each system:

    a. Measure airflow of at least 10 percent of air outlets.
    b. Measure water flow of at least 5 percent of terminals.
    c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
    d. Verify that balancing devices are marked with final balance position.
    e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Engineer.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Engineer of Record.
3. Engineer shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

## 3.19 ADDITIONAL TESTS

A. Within 90 days of completing TAB, at the request of the Engineer, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures for equipment were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions. Additional tests shall be performed as follows:

1. Cooling season: With outdoor air temperature at least 80 deg. F, index the unit to 100% outdoor air and reset space setpoints such that all zones are simultaneously at maximum cooling airflow. Test cooling coil performance both airside (including wet bulb readings) and tube side and record data, including cooling systems equipment operation, overall flow rates and system temperatures.
2. Heating season: With outdoor air temperature no greater than 30 deg. F., reset space setpoints such that all zones are simultaneously at maximum heating. Adjust outdoor air control to load the heating coil at its maximum scheduled capacity. Test heating coil performance both air side and tube side and record data, including heating system equipment in operation, overall flow rates and system temperatures.

**END OF SECTION**

**SECTION 230700**
**HVAC INSULATION**

GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Insulation Materials:

a. Calcium silicate.
b. Cellular glass.
c. Flexible elastomeric.
d. Mineral fiber.

2. Fire-rated insulation systems.
3. Insulating cements.
4. Adhesives.
5. Mastics.
6. Sealants.
7. Factory-applied jackets.
8. Field-applied fabric-reinforcing mesh.
9. Field-applied cloths.
10. Field-applied jackets.
11. Tapes.
12. Securements.
13. Corner angles.

B. Related Sections:

1. Division 22 Section "Plumbing Insulation."
2. Division 23 Section "Metal Ducts" for duct liners.
3. Division 33 Section "Underground Hydronic Energy Distribution" for loose-fill pipe insulation in underground piping outside the building.
4. Division 33 Section "Underground Steam and Condensate Distribution Piping" for loose-fill pipe insulation in underground piping outside the building.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any). Provide a scheduled listing in the submittal of each type of pipe service, duct service or equipment type that insulates with the thickness and jacket noted for each service and type.

B. LEED Submittal (if required):

1. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.

C. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at pipe expansion joints for each type of insulation.
3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
4. Detail removable insulation at piping specialties, equipment connections, and access panels.
5. Detail application of field-applied jackets.
6. Detail application at linkages of control devices.
7. Detail field application for each equipment type.

D. Field quality-control reports.

## 1.4 QUALITY ASSURANCE

A. 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, tapes, 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.

B. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Piping Mockups:

a. One 10-foot (3-m) section of NPS 2 (DN 50) straight pipe.
b. One each of a 90-degree threaded, welded, and flanged elbow.
c. One each of a threaded, welded, and flanged tee fitting.
d. One NPS 2 (DN 50) or smaller valve, and one NPS 2-1/2 (DN 65) or larger valve.
e. Four support hangers including hanger shield and insert.
f. One threaded strainer and one flanged strainer with removable portion of insulation.
g. One pressure temperature tap.
h. One mechanical coupling.

2. Ductwork Mockups:

a. One 10-foot (3-m) section, each of rectangular and round straight duct.
b. One each of a 90-degree mitered round and rectangular elbow, and one each of a 90-degree radius round and rectangular elbow.
c. One rectangular branch takeoff and one round branch takeoff from a rectangular duct. One round tee fitting.
d. Four support hangers for round and rectangular ductwork.

3. Equipment Mockups:

a. One chilled-water pump.
b. One tank or vessel.

4. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
5. Notify Engineer seven days in advance of dates and times when mockups will be constructed.
6. Obtain Engineer's approval of mockups before starting insulation application.
7. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Engineer specifically approves such deviations in writing.
8. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
9. Demolish and remove mockups when directed.

## 1.5 DELIVERY, STORAGE, AND HANDLING

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

B. Storage: Insulation material shall be stored to prevent dirt and moisture contamination.

## 1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

## 1.7 SCHEDULING

A. Schedule insulation application after satisfactory pressure testing systems and, where required, after installing and testing heat tracing.

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Calcium Silicate:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Industrial Insulation Group (The); Thermo-12 Gold.

2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Cell-U-Foam Corporation; Ultra-CUF.
   b. Pittsburgh Corning Corporation; Foamglass Super K.

2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Board Insulation: ASTM C 552, Type IV.
5. Preformed Pipe Insulation with Factory-Applied ASJ or ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
6. Factory fabricated shapes according to ASTM C 450 and ASTM C 585.

H. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

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

   a. Aeroflex USA Inc.; Aerocel and Aerocel (EPDM).
   b. Armacell LLC; AP Armaflex and UT Solaflex (EPDM).
   c. K-Flex USA; Insul-Sheet, K-Flex and Kflex HT (EPDM).

2. Where flexible elastomeric (EPDM) is required, it shall be suitable for continuous operation up to at least 250 deg. F and down to at least -40 deg. F and be U.V. resistant in accordance with ASTM G7/G90.

I. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type [**II with factory-applied vinyl jacket**] [**III with factory-applied FSK jacket**] [**III with factory-applied FSP jacket**]. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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

   a. CertainTeed Corp.; Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Duct Wrap.
   d. Manson Insulation Inc.; Alley Wrap.
   e. Owens Corning; All-Service Duct Wrap.

J. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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

   a. CertainTeed Corp.; Commercial Board.
   b. Fibrex Insulations Inc.; FBX.
   c. Johns Manville; 800 Series Spin-Glas.
   d. Knauf Insulation; Insulation Board.
   e. Manson Insulation Inc.; AK Board.
   f. Owens Corning; Fiberglas 700 Series.

K. Mineral-Fiber, Preformed Pipe Insulation:

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

a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; Earthwool 1000.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ or with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

L. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semi-rigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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

a. CertainTeed Corp.; CrimpWrap.
b. Johns Manville; MicroFlex.
c. Knauf Insulation; Pipe and Tank Insulation.
d. Manson Insulation Inc.; AK Flex.
e. Owens Corning; Fiberglas Pipe and Tank Insulation.

## 2.2 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with fully encased FSK jacket that is tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.

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

a. CertainTeed Corp.; FlameChek.
b. Johns Manville; Firetemp Wrap.
c. Morgan Thermal Ceramics; FireMaster Duct Wrap or Fastwrap XL.
d. 3M; Fire Barrier Wrap Products.
e. Unifrax Corporation; FyreWrap.
f. Vesuvius; PYROSCAT FP FASTR Duct Wrap.

B. Performance:

1. Zero inch clearance required to combustible construction at all points along the ductwork (including insulation joints).
2. Continuous product model and rating markups on foil face for identification.
3. Blanket shall be UL classified non-combustible with a flame spread of 0, smoke development of 0 and fuel construction of 0.

4. Suitable for continuous use to 300 deg F; four hour operation at 500 deg F.
5. Provide UL listed terminations at shaft construction with firestopping details as required by the authority having jurisdiction.
6. Accommodate duct access doors with easily removable sections of insulation.

C. Air Duct Application:

1. Single layer application to achieve required rating.
2. Minimum 1-1/2” thickness.

D. Grease Duct Application:

1. Double layer application to achieve required rating.
2. Minimum 1-1/2” thickness per layer.
3. Installation in compliance with all sections of ASTM E2336. Provide 2” thick layers as required.

## 2.3 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Insulco, Division of MFS, Inc.; Triple I.
b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

## 2.4 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F (10 to 427 deg C).

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products, Division of ITW; CP-97.
b. Foster Products Corporation, H. B. Fuller Company; 81-27/81-93.
c. Marathon Industries, Inc.; 290.
d. Mon-Eco Industries, Inc.; 22-30.
e. Vimasco Corporation; 760.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Cellular-Glass Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F (minus 59 to plus 149 deg C).

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products, Division of ITW; CP-96.
b. Foster Products Corporation, H. B. Fuller Company; 81-33.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Aeroflex USA Inc.; Aeroseal.
b. Armacell LCC; 520 Adhesive.
c. Foster Products Corporation, H. B. Fuller Company; 85-75.
d. K-Flex USA.
e. RBX Corporation; Rubatex Contact Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. 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, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

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. Speedline Corporation; Speedline Vinyl Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.5 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 following:

a. Childers Products, Division of ITW; CP-35.
b. Foster Products Corporation, H. B. Fuller Company; 30-90.
c. ITW TACC, Division of Illinois Tool Works; CB-50.
d. Marathon Industries, Inc.; 590.
e. Mon-Eco Industries, Inc.; 55-40.
f. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
5. Color: White.

## 2.6 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass, Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products, Division of ITW; CP-76.
b. Foster Products Corporation, H. B. Fuller Company; 30-45.
c. Marathon Industries, Inc.; 405.
d. Mon-Eco Industries, Inc.; 44-05.
e. Pittsburgh Corning Corporation; Pittseal 444.
f. Vimasco Corporation; 750.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.

4. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
5. Color: White or gray.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Products, Division of ITW; CP-76-8.
   b. Foster Products Corporation, H. B. Fuller Company; 95-44.
   c. Marathon Industries, Inc.; 405.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Vimasco Corporation; 750.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Products, Division of ITW; 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 (Minus 40 to plus 121 deg C).
5. Color: White.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.7 FACTORY-APPLIED JACKETS

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

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

5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perms) when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

## 2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. (68 g/sq. m) with a thread count of 10 strands by 10 strands/sq. inch (4 strands by 4 strands/sq. mm) for covering pipe and pipe fittings.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Vimasco Corporation; Elastafab 894.

B. Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 6 oz./sq. yd. (203 g/sq. m) with a thread count of 5 strands by 5 strands/sq. inch (2 strands by 2 strands/sq. mm) for covering equipment.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products, Division of ITW; Chil-Glas No. 5.

C. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. inch (4 strands by 4 strands/sq. mm), in a Leno weave, for duct, equipment, and pipe.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Foster Products Corporation, H. B. Fuller Company; Mast-A-Fab.
b. Vimasco Corporation; Elastafab 894.

## 2.9 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

## 2.10 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules. Flame spread of 25 or less and smoke developed rating of 50 or less per ASTM E84.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Johns Manville; Zeston.
    b. P.I.C. Plastics, Inc.; FG Series.
    c. Proto PVC Corporation; LoSmoke.
    d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

    a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

5. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Products, Division of ITW; Metal Jacketing Systems.
    b. PABCO Metals Corporation; Surefit.
    c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005, Temper H-14.

    a. Finish and thickness are indicated in field-applied jacket schedules.
    b. Moisture Barrier for Indoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper or 2.5-mil- (0.063-mm-) thick Polysurlyn.
    c. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper or 2.5-mil- (0.063-mm-) thick Polysurlyn.
    d. Factory-Fabricated Fitting Covers:

        1) Same material, finish, and thickness as jacket.
        2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        3) Tee covers.
        4) Flange and union covers.
        5) End caps.
        6) Beveled collars.
        7) Valve covers.
        8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.

    a. Material, finish, and thickness are indicated in field-applied jacket schedules.
    b. Moisture Barrier for Indoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper or 2.5-mil- (0.063-mm-) thick Polysurlyn.
    c. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper or 2.5-mil- (0.063-mm-) thick Polysurlyn.
    d. Factory-Fabricated Fitting Covers:

        1) Same material, finish, and thickness as jacket.
        2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        3) Tee covers.
        4) Flange and union covers.
        5) End caps.
        6) Beveled collars.
        7) Valve covers.
        8) Field fabricated fitting covers only if factory-fabricated fitting covers are not available.

D. Self-Adhesive Outdoor Jacket: 60-mil- (1.5-mm-) thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with stucco-embossed aluminum-foil facing.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Polyguard; Alumaguard 60.

## 2.11 TAPES

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

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    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. Minimum width: 3 inches (75 mm).
3. Thickness: 11.5 mils (0.29 mm).
4. Adhesion: 45 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile strength: 40 lbf/inch (7.2 N/mm) in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
8. WVTR: 0.02 perms per ASTM E96.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic pressure sensitive adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    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. Minimum width: 3 inches.
3. Minimum thickness: 6.5 mils.
4. Minimum adhesion: 40 ounces force/inch in width.
5. Elongation: 2 percent.
6. Minimum tensile strength: 40 lbf/inch (7.2 N/mm) in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
8. WVTR: 0.02 perms per ASTM E96.

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, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
    b. Compac Corp.; 130.
    c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
    d. Venture Tape; 1506 CW NS.

2. Width: 2 inches (50 mm).
3. Thickness: 6 mils (0.15 mm).
4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    b. Compac Corp.; 120.
    c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
    d. Venture Tape; 3520 CW.

2. Width: 2 inches (50 mm).
3. Thickness: 3.7 mils (0.093 mm).
4. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

E. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products; Bands.
b. PABCO Metals Corporation; Bands.
c. RPR Products, Inc.; Bands.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch (0.38 mm) thick, 3/4 inch (19 mm) wide with wing seal .
3. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 3/4 inch (19 mm) wide with wing seal .

F. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin (or other material as required for stainless or aluminum ductwork), fully annealed for capacitor-discharge welding, 0.135-inch- (3.5-mm-) diameter shank, length to suit depth of insulation indicated.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) 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 (or other material as required for stainless steel or aluminum duct), fully annealed for capacitor-discharge welding, 0.135-inch- (3.5-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) 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, available products that may be incorporated into the Work include, but are not limited to, the following:

1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
2) GEMCO; Perforated Base.
3) Midwest Fasteners, Inc.; Spindle.

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
c. Spindle: Fully annealed, 0.106-inch- (2.6-mm-) 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. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm) thick, sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) AGM Industries, Inc.; RC-150.
2) GEMCO; R-150.
3) Midwest Fasteners, Inc.; WA-150.
4) Nelson Stud Welding; Speed Clips.

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) GEMCO.
2) Midwest Fasteners, Inc.

G. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

H. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. C & F Wire.
b. Childers Products.
c. PABCO Metals Corporation.
d. RPR Products, Inc.

2.12 CORNER ANGLES

A. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

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

B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

C. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Carbon steel: Coat carbon steel operating at a service temperature below 60 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) 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 (50 mm) below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant. Fabricate a cellular glass "box" around the pump which is removable. Utilize flexible elastomeric at penetrations and seal with silicone. Allow for removal of suction diffuser screen if a suction diffuser is installed.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches (50 mm).

1. Comply with requirements in Division 7 Section "Firestopping" and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches (50 mm).
2. Pipe: Install insulation continuously through floor penetrations.
3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 7 Section "Firestopping."

## 3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for minimum 50 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches (75 mm) from insulation end joints, and 16 inches (400 mm) o.c. in both directions.
    d. Do not overcompress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins and attach speed washers.
    g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches (150 mm) from each end. Install wire or cable between two circumferential girdles 12 inches (300 mm) o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional

circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches (1200 mm) o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches (75 mm).
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Fabricate custom fitted insulation pieces. Fit pieces around pumps and coincide joints with splits in pump casings. Fabricate joints with outward bolted flanges. Secure box sections together using a latching mechanism for easy removal of sections to maintain pump.
2. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier. Fabricate a cellular glass “box” around the pump which is removable. Utilize flexible elastomeric at penetrations and seal with silicone. Allow for removal of suction diffuser screen if a suction diffuser is installed.

## 3.6 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 gate valve bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate steam safety relief valves up to the bottom base and provide the minimum clearance to the nuts and bolts to remove the flanged safety relief valve.
6. 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.
7. 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.
8. 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.
9. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
10. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
11. Install insulation at coil connection piping not required to have a continuous vapor barrier such that the maximum length of uninsulated piping does not exceed 3” in length.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with

its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

## 3.7 CALCIUM SILICATE INSULATION INSTALLATION

A. Insulation Installation on Boiler Breechings and Ducts:

1. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation material.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.
3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

C. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
4. Finish flange insulation same as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

## 3.8 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For interior insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant. Seal all insulation terminations with vapor seal mastic. Provide minimum 3” wide ASJ butt strip at joints to maintain the vapor barrier.
5. For exterior insulation, utilize manufacturer’s standard weather barrier mastic under the jacketing.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Factory miter and tar together with a minimum of three segments for elbows. Secure insulation materials with wire or bands.
3. Secure fittings with 1/2” wide filament tape as recommended by the manufacturer.

4. Coat fittings with vapor seal with fab cloth embedded in it.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

## 3.9 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

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

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

## 3.10 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's written recommended coverage rates.
2. 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 exposed ductwork where no ceiling is installed, on all duct sizes greater than 12 inch span, place pins along longitudinal centerline of duct on both duct sides and on the duct bottom. Space pins 3 inches (75 mm) maximum from insulation section joints, and maximum 16 inches (400 mm) on center each way from other pins.
    b. On concealed ductwork, on duct with dimensions larger than 24 inches, place pins at a maximum of 16 inches (400 mm) on center each way from other pins and 3 inches (75 mm) maximum from insulation section joints.

Install pins on any side or the bottom with dimension greater than 24". Install additional pins to hold insulation tightly against the duct surface at structural steel cross bracing.

c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not overcompress insulation during installation.
e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing. Tape shall extend at least 2 inches in all directions from the pin.

3. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples installed at a maximum of 3 inches on center between staples. Install vapor barrier tape at each joint. Vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant may be used at joints, seams, and protrusions in lieu of vapor barrier tape.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches (75 mm).

4. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) o.c.
5. 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.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.
7. Insulate duct mounted coils located within terminal units (terminal boxes, supply air valves, fan coil units) by extending external duct insulation over the terminal unit a minimum of two inches. Insulate over return bends.
8. Insulate the external side of diffusers as noted on the details.

F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for minimum 50 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install 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 (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
    b. On duct sides with dimensions larger than 18 inches (450 mm), space pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches (75 mm).

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

## 3.11 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch-(75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch (50-mm) 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 (300 mm) o.c. and at end joints.

## 3.12 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 7 Section "Firestopping."

## 3.13 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 9 painting Sections.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.14 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.15 DUCT INSULATION SCHEDULE, GENERAL

A. Comply with the requirements in “Indoor Duct and Plenum Insulation Schedule” and “Aboveground, Outdoor Duct and Plenum Insulation Schedule” Articles for where insulating materials shall be applied.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

C. Products shall not contain asbestos, lead, mercury or mercury compounds.

D. Products that come into contact with stainless steel shall be qualified as acceptable according to ASTM C795.

3.16 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, rectangular, round and flat oval, supply air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches minimum thick and 1.0-lb/cu. ft. nominal density to achieve a minimum installed (at 25% compression) R value of 6.0 at 75 deg F. mean temperature.

B. Concealed, rectangular, round and flat oval, return air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches minimum thick and 0.75-lb/cu. ft. nominal density to achieve a minimum installed R value of 3.5 at 75 deg F mean temperature.

C. Concealed, rectangular, round and flat-oval, outdoor-air duct and energy recovery device discharge air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches (50 mm) minimum thick and 1.0-lb/cu. ft. nominal density to achieve a minimum installed R value of 6.0 at 75 deg F mean temperature.
2. Insulate energy recovery device discharge air duct from the outlet of the energy recovery device to the penetration of the building exterior.

D. Concealed and exposed rectangular and round, exhaust-air and relief air duct insulation between isolation damper and penetration of building exterior shall be the following:

1. Mineral-Fiber Blanket: 2 inches (50 mm) thick and 1.0-lb/cu. ft. nominal density.

E. Concealed and Exposed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket insulating system; thickness as required to achieve 2-hour fire rating.

F. Exposed, supply-air duct, relief air duct, return air duct, outdoor air duct and energy recovery device discharge air duct insulation shall be the following:

1. Flexible Elastomeric: 1 inch (25 mm) thick on edges, corners, and flanges of ductwork which are less than 6'-6" above finished floor with space below them for personal access.
2. Mineral-Fiber Blanket: 2 inches (50 mm) thick and 1.0-lb/cu. ft. nominal density on surfaces which are more than 8'-0" above finished floor.
3. Mineral-Fiber Board: 2 inches (50 mm) thick and 6-lb/cu. ft. nominal density for ductwork which is less than 8'-0" above finished floor.

G. Concealed and exposed ductwork with fire rated blanket insulating system: Fire rated blanket insulating system thickness as required to achieve 2-hour fire rating.

H. Concealed and exposed oven and warewash exhaust duct insulation shall be the following: 2 inches minimum thick and 1.0 lb/cu.ft. nominal density to achieve a minimum installed (at 25% compression) R value of 6.0 at 75 deg F mean temperature.

## 3.17 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.

B. Concealed, and exposed, rectangular, round and flat-oval, [**supply-air,**] [**return air**] and [**exhaust air**] duct insulation shall be the following:

1. Mineral-Fiber Board: 4 inches minimum thick, 6-lb/cu. ft. (96-kg/cu. m) nominal density to achieve a minimum R value of 17.0 at 75 deg F. mean temperature.
2. Elastomeric (EPDM): 4 inches minimum thick with additional UV resistant coating furnished by the insulation manufacturer.

3.18 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

C. Fans located on the discharge of heat recovery devices shall be the following:

1. Mineral fiber board: 2-inches thick.

3.19 PIPING INSULATION SCHEDULE, GENERAL

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

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

C. Products shall not contain asbestos, lead, mercury or mercury compounds.

D. Products that come into contact with stainless steel shall be qualified as acceptable according to ASTM C795.

3.20 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 3/4 inch (19 mm) thick.

B. Refrigerant Suction, Liquid, and Hot-Gas Piping and Tubing:

1. NPS 1-1/2 and Smaller: Insulation shall be the following:

a. Cellular glass: 1 inch (25 mm) thick.
b. Flexible elastomeric: 1 inch (25 mm) thick.

2. NPS 1-5/8 and Larger:

a. Cellular glass: 1-1/2 inches thick.
b. Flexible elastomeric: 1-1/2 inches thick.

C. Hot Service Drains (including boiler blowdown):

1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch (25 mm) thick.

D. Hot Service Vents (including steam vents):

1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch (25 mm) thick.

E. Cold Service Vents (including MRI quench vents):

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible elastomeric: 1 inches thick.

3.21 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping and Tubing:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric (EPDM): 2 inches (50 mm) thick.

3.22 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed; within finished occupied spaces; below 8’-0” above finished floor:

1. PVC: 20 mils (0.5 mm) thick.

D. Piping exposed, within mechanical rooms [**and within rooftop pipe enclosures at AHU’s**] [**below 8’-0” above finished floor**][**all chilled water piping within the space][shall be suitably installed for washdown service utilizing a standard water spray nozzle and building water pressure**].

1. PVC: 20 mils (0.5 mm) thick.

## 3.23 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket. Confirm that the vapor barrier of the insulation is 100% intact and repair as necessary prior to applying jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Exposed:

1. Aluminum, Stucco Embossed: 0.024 inch (0.61 mm) thick.
2. Field applied fabric reinforcing mesh with vapor barrier mastic.

D. Piping, Exposed:

1. Aluminum, Stucco Embossed: 0.032 inch (0.81 mm) thick.

**END OF SECTION**

**SECTION 230900**
**ENVIRONMENTAL CONTROL SYSTEM**

## I. WORK DESCRIPTION

### A. Scope of Work:

1. The Environmental Control Contractor (ECC) shall furnish, install complete, program, and place in totally acceptable operation an environmental control system as shown or implied on the Contract Documents.

### B. Work Included:

1. Furnish and install electric, and direct digital control temperature, humidity and pressure controls, and accessories as required to provide a complete operable system to obtain the operational sequence described.
2. All control and interlock wiring by ECC to be in full compliance with all sections of electrical specifications.
3. ECC shall prepare electric wiring diagram on all controls, starters, and mechanical equipment detailing all terminals in each component.
4. Any relays or auxiliary contacts required, but not furnished by suppliers of mechanical equipment or starters shall be furnished by ECC.
5. Note that schematic control diagrams on drawings are presented to show the intent of all control loops and to illustrate the operational sequences described. The electric signals are diagrammatic only and each bidder shall be required to furnish such cabling and air lines as required to meet their specific equipment. ECC is directed to building drawings and all schedules for complete coordination of project requirements.
6. All standards of quality and operation shown, described, and implied are to be fully met. Any questions relative to deviations to be submitted in writing to the Architect/Engineer at least 14 days prior to bid date.
7. The ECC is responsible for coordinating data integration with third party equipment/systems shown on the Contract Documents to be integrated with the ECC's Building Automation System. This coordination includes verifying communication protocol compatibility with each equipment/system manufacturer and/or supplier and verifying the list of available points through the integration/interface. Refer to related specification sections below for project specific integration requirements.

    a) Section 22 11 13 – Facility Fuel Oil System.
    b) Section 22 11 23 – Packaged Booster Pumps.
    c) Section 22 11 24 – Variable Speed Packaged Booster Pumps.
    d) Section 22 13 29 – Sewage Pumps.
    e) Section 22 14 29 – Sump Pumps.
    f) Section 22 15 19 – General Service Compressed Air Equipment.
    g) Section 22 31 16 – Water Softeners.
    h) Section 22 34 00 – Fuel Fired Domestic Water Heaters.
    i) Section 22 67 19 – RO/Deionized Water Equipment.
    j) Section 23 25 00 – HVAC Water Treatment.

k) Section 23 33 00 – Air Duct Acessories
l) Section 23 52 16 – Condensing Boilers.
m) Section 23 52 33 – Water Tube Boilers.
n) Section 23 52 39 – Fire Tube Boilers.
o) Section 23 53 16 – Deaerators, Surge Tanks and Blowdown Separators.
p) Section 23 64 16 – Centrifugal Water Chillers.
q) Section 23 64 26 – Rotary Screw Air-Cooled Water Chillers.
r) Section 23 65 00 – Cooling Towers.
s) Section 23 72 00 – Air-To-Air Energy Recovery Equipment.
t) Section 23 81 19 – Self-Contained Air Conditioners
u) Section 23 81 23 – Computer Room Air Conditioners.
v) Section 23 84 13 – Humidifiers.
w) Section 26 09 13 – Electrical Power Monitoring and Control.
x) Section 26 09 43 – Network Lighting Controls.
y) Section 26 11 16 – Secondary Unit Substations.
z) Section 26 12 00 – Medium Voltage Transformers.
aa) Section 26 23 13 – Paralleling Low Voltage Switchgear.
bb) Section 26 24 13 – Switchboards.
cc) Section 26 24 19 – Motor Control Centers.
dd) Section 26 27 13 – Electricity Metering.
ee) Section 26 29 23 – Variable Frequency Controllers.
ff) Section 26 32 13 – Engine Generators.
gg) Section 26 33 53 – Static Uninterruptible Power Supply.
hh) Section 26 36 00 – Transfer Switches.
ii) Section 26 56 00 – Exterior Lighting.

2. This Contractor/Supplier is directed to all General Conditions of the Contract.

B. Work Not Included:

C. Electrical Contractor shall provide all power wiring to and from all motor starters, variable frequency controllers, and motor control centers.

D. Electrical Contractor to provide 120/60 power to all Direct Digital Controllers.

E. Additional 120 Volt power wiring and conduit that is required beyond that which the Electrical Contractor provides shall be furnished and installed by the Environmental Control Supplier/Engineering Contractor.

F. Sheet Metal Contractor shall install motorized dampers and duct mounted airflow measuring stations furnished by the Environmental Control Contractor.

G. Mechanical Contractor to install all temperature sensing wells and control valves furnished by the Environmental Control Contractor.

H. Related Work Specified Elsewhere:

1. Basic mechanical materials and methods.
2. Hangers and supports.
3. Mechanical identification.
4. Testing, adjusting and balancing.
5. Enclosed switches and circuit breakers.
6. Enclosed controllers.

7. Motor control centers.

II. QUALITY ASSURANCE

A. Acceptable Supervisory Level Control Manufacturer
1. Johnson Controls, Inc.
2. Siemens Building Technologies,
3. Schneider Electric I/A Series,
4. Automated Logic.
5. Tridium – Niagra 4 Framework, Latest Version

B. Acceptable Building Level Control Manufacturer
1. Johnson Controls
2. Siemens Building Technologies
3. Schneider Electric
4. Automated Logic
5. Alerton

C. Acceptable Installation and Service Contractor:
1. Indianapolis
   a) Johnson Controls, Inc.,
   b) Siemens Building Technologies,
   c) Precision Control Systems of Indianapolis,
   d) Automated Logic Indiana.
   e) Open Control Systems
   f) Conserve
2. Chicago
   a) Precision Control System of Chicago
   b) Automated Logic of Chicago
   c) Open Control Systems

D. The entire electric, electronic, and direct digital control system shall be approved and listed by Underwriters Laboratories, Inc. All equipment shall bear the appropriate UL listing marking to insure compliance. In addition to the UL listing requirement, all work shall conform to the following codes and standards as applicable:

1. National Fire Protection Agency (NFPA) Standards.
2. National Electrical Code (NEC) and applicable local electrical codes.
3. UL 268 Smoke Detectors.
4. UL 916 Energy Management.
5. NFPA 70 – National Electrical Code.
6. NFPA 90A – Standard for the Installation of Air Conditioning and Ventilating Systems.
7. American National Standards Institute (ANSI).
8. National Electrical Manufacturer's Association (NEMA).
9. American Society of Mechanical Engineers (ASME).
10. ASHRAE.
11. Air Movement and Control Association (AMCA).
12. American Standard Code for Information Interchange (ASCII).
13. Institute of Electrical and Electronic Engineers (IEEE).
14. Electronic Industries Associates (EIA).
15. Occupational Safety and Health Administration (OSHA).
16. American Society of Testing and Materials (ASTM).
17. Federal Communications Commission (FCC).
18. American Disability Act (ADA).
19. ANSI/EIA 909.1-A-1999 (Lon Works).

20. ANSI/ASHRAE Standard 195-2008 (BACnet).
21. UL 864 UUKL Smoke Control.
22. NFPA 92A and 92B – Smoke Purge/Control Equipment.

E. Except where certain controls are specified by manufacturer and product numbers (and no substitute is permitted in those cases), all products shall be of a common manufacturer and no mixing of manufacturers is permitted. It should be noted that all quality requirements noted in this specification shall be equally met; any variance shall be submitted in writing 14 days prior to bidding and, if approved, notice will be given in writing. Failure to meet the 14-day requirement will negate any consideration of variance.

F. All engineering, project management, system programming, system checkout and project commissioning (if required) shall be performed by experienced full-time professional employees of the Control Supplier/Engineering Contractor. Installation of all electric, electronic, and DDC controls including all electric wiring shall be the responsibility of the ECC. Installation may be subcontracted at the Contractor's discretion, but full and complete responsibility for the quality and workmanship rests with the ECC. Where work is subcontracted, the ECC shall make a complete inspection before the system is placed in operation to insure that all sections of Part 3 - Execution are met and such documentation shall be made a part of the final operation and maintenance manuals.

G. The Control Supplier/Engineering Contractor shall have a minimum of 15 years of experience in the design and installation of Environmental Control Systems equal in scope and size to that herein specified and shall be prepared to provide documented proof of such history. Contractor to be full factory branch or provide written proof that control manufacturer assumes full liability for any product fault or defect.

H. Service and installation personnel to be permanently located within 100 miles of job site and to be available 24 hours each day and respond on-site within 4 hours' notice. Contractors who rely on third party vendors for maintenance/service staff and expertise on any major component are not acceptable.

I. Installer Qualifications:

1. Licensed contractor with at least five years of working experience in the installation of Building Automation Systems.
2. Demonstrated specific experience shall include cabling systems and pathways of electrical and telecommunications systems.
3. Demonstrated expertise in the installation, functional checkout, point to point verification, calibration, troubleshooting and startup of Building Automation Systems.
4. In addition to the technical capabilities described herein, demonstrate a production capability to plan, control and integrate manpower and other resources necessary for successful contract completion.
5. The Owner may ask to verify the qualifications and experience for all field installation technicians and installation contractors assigned to the project prior to the installation work commencing.
6. Installation personnel working this specific project shall attend a one hour familiarization session with the Owner’s control system personnel immediately following the project preconstruction meeting. This meeting shall include the ECC’s assigned Project Manager.

J. SYSTEM PERFORMANCE

1. Comply with the following performance requirements:

a) Graphic display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
b) Graphic refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
c) Object command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
d) Object scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
e) Alarm response time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
f) Program execution frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
g) Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
h) Reporting accuracy and stability of control: Report values and maintain measured variables within tolerances as follows:

(1) Water temperature: Plus or minus 1 deg F.
(2) Water flow: Plus or minus 5 percent of full scale.
(3) Water pressure: Plus or minus 2 percent of full scale.
(4) Space temperature: Plus or minus 1 deg F.
(5) Ducted air temperature: Plus or minus 1 deg F.
(6) Outside air temperature: Plus or minus 2 deg F.
(7) Dew point temperature: Plus or minus 3 deg F.
(8) Temperature differential: Plus or minus 0.25 deg F.
(9) Relative humidity: Plus or minus 5 percent.
(10) Airflow (pressurized spaces): Plus or minus 3 percent of full scale.
(11) Airflow (measuring stations): Plus or minus 5 percent of full scale.
(12) Airflow (terminal): Plus or minus 10 percent of full scale.
(13) Air pressure (space): Plus or minus 0.01-inch wg.
(14) Air pressure (ducts): Plus or minus 0.1-inch wg.
(15) Carbon monoxide: Plus or minus 5 percent of reading.
(16) Carbon dioxide: Plus or minus 50 ppm.
(17) Electrical: Plus or minus 5 percent of reading.

K. PRELIMINARY SUBMITTAL PACKAGE

1. The Environmental Control Contractor (ECC) shall submit, at, or before, the time of bid, a comprehensive Preliminary Submittal Package including all items listed below. Failure to submit the required documentation at the designated time will be grounds for rejection of the Environmental Control Contractor bid. The ECC contract shall be awarded based on a combination of price, completeness of bid (per review of Preliminary Submittal Package), and presentation/interview with the client and their design team.

2. The following documentation shall be provided, at a minimum, as part of the Preliminary Submittal Package:

3. Network diagram(s) showing the correct number of Network Controllers, Operator Interface devices, and Servers as required for the type and size of the BAS system and the communication network connecting all anticipated field level panels/controllers. Clearly identify the responsibilities of connecting the BAS system to the client's IT network (as applicable).
4. Flow diagrams specific for each mechanical system (whether DDC-controlled or locally controlled) schematically showing all control devices intended and required to properly control said system. NOTE: The ECC shall generate the flow diagrams using their standard engineering tool(s). It is not acceptable to directly copy the control schematics included in the bid documents generated by TRC Worldwide to meet this requirement.
5. Sequence of operations written out for each mechanical system (whether DDC-controlled or locally controlled) covering all modes of operation for each piece of equipment. NOTE: The ECC shall generate the sequence of operations using their standard engineering tool(s). It is not acceptable to directly copy the sequence of operation verbiage included in the bid documents to meet this requirement.
6. Point schedules for all equipment that is DDC-controlled. Point nomenclature shall match between the flow diagram and associated point schedule. NOTE: The ECC shall generate the point schedules using their standard engineering tool(s). It is not acceptable to directly copy the point schedules included in the bid documents generated by TRC Worldwide to meet this requirement.
7. Product data sheets for each control device shown on the control schematics.
8. Sample graphic print outs of systems similar to those utilized on this specific project.
9. Resumes of execution/delivery team including project manager(s), field technicians, programmers, engineers, etc.
10. Customer training plan.
11. Detailed drawing, sequence and description of corridor lighting control.

12. Coordinate delivery of the Preliminary Submittal Package per the following scenarios:

14. Direct Bid to Owner as Prime Contractor: Deliver a minimum of two complete hard copies of the Preliminary Submittal Package in appropriately sized 3-ring binders to the designated Owner's representative. All documents should be compiled into the minimum amount of Acrobat pdf files as possible. It is not desired to deliver each document individually. Electronic copies of the entire submittal package shall also be sent to the designated Owner's representative, the General Contractor/Construction Manager, and the Architect/Engineer. *<u>NOTE: All pricing and corresponding proposals are to be sent directly to the designated Owner's representative – not to the HVAC/Mechanical Contractors. See Bid Form for details.</u>

15. Acceptable electronic formats are:

    a) E-mail attachment(s) (beware of size restrictions).

b) On-line file storage service (box.net or equal. Provide applicable access codes, passwords, etc.).
c) FTP file sharing site (provide applicable access codes, passwords, etc.).
d) USB mass storage device(s).
e) CD/DVD media.

16. Prime or direct bid to Construction Manager (CM). Deliver the Preliminary Submittal Package electronically to the designated Construction Manager's representative. All documents should be compiled into the minimum amount of Acrobat pdf files as possible. It is not desired to deliver each separate document. ECC must copy Architect/Engineer indicating the ECC has satisfied the requirement of transmitting the Preliminary Submittal Package. *NOTE: All pricing and corresponding proposals are to be sent to the Construction Manager, not to the Owner's representative.

17. Acceptable electronic formats are:

a) E-mail attachment(s) (beware of size restrictions).
b) On-line file storage service (box.net or equal. Provide applicable access codes, passwords, etc.).
c) FTP file sharing site (provide applicable access codes, passwords, etc.).
d) USB mass storage device(s).
e) CD/DVD media.

18. Bid to General Contractor (GC) as subcontractor. Deliver the Preliminary Submittal Package electronically to each designated General Contractor's Representative. All documents should be compiled into the minimum amount of Acrobat pdf files as possible. It is not desired to deliver each separate document. ECC must copy Architect/Engineer indicating the ECC has satisfied the requirement of transmitting the Preliminary Submittal Package. *NOTE: All pricing and corresponding proposals are to be sent to the General Contractors, not to the Owner's representative.

19. Acceptable electronic formats are:

a) E-mail attachment(s) (beware of size restrictions).
b) On-line file storage service (box.net or equal. Provide applicable access codes, passwords, etc.).
c) FTP file sharing site (provide applicable access codes, passwords, etc.).
d) USB mass storage device(s).
e) CD/DVD media.

20. Bid to Mechanical Contractor (MC) as subcontractor: Deliver the Preliminary Submittal Package electronically to the designated Owner's representative. All documents should be compiled into the minimum amount of Acrobat pdf files as possible. It is not desired to deliver each separate document. ECC must copy each Mechanical Contractor bidding this project indicating the ECC has satisfied the requirement of transmitting the Preliminary Submittal Package. *NOTE: All pricing and corresponding proposals are to be sent to the Mechanical Contractors, not to the Owner's representative.

21. Acceptable electronic formats are:

a) E-mail attachment(s) (beware of size restrictions).
b) On-line file storage service (box.net or equal. Provide applicable access codes, passwords, etc.).
c) FTP file sharing site (provide applicable access codes, passwords, etc.).
d) USB mass storage device(s).
e) CD/DVD media.

L. PRICING AGREEMENT

1. In addition to the Preliminary Submittal Package, the Environmental Control Contractor (ECC) shall submit at or before the time of bid, a Pricing Agreement document for review by the Owner, the Construction Manager and the Project Design Team. The terms and structure of the Pricing Agreement will be considered in the process of selecting and awarding the Environmental Control System Contract.

2. The Pricing Agreement shall include, at a minimum, the following four (4) sections with pricing detailed specifically for this project.

3. Manufacturer's material, equipment and devices: Show total material list price, proposed discount from the list price and final total estimated material price for this project. ECC should be prepared to break this pricing down further per area of building or per system.
4. Third party material, equipment and devices: Show total cost of third party material, proposed overhead and markup structure for the third party material and total estimated price for third party material for this project. Again, the ECC should be prepared to break this pricing down further per area of building or per system.
5. Subcontract labor cost: Show total cost of proposed subcontracted labor (per labor type), proposed overhead and makeup structure for the subcontracted labor and total estimated price for this labor. The ECC should receive competitive bids for each type of subcontracted labor (preferably 3 or more per labor type) and be prepared to share the subcontract quotes with the Owner, Construction Manager and Project Design Team for analysis.
6. Self-performed labor cost: Show cost for each category of self-performed labor, including, but not limited to, project management, project engineering, technician/programming, clerical, training, general conditions, travel and expense. List estimated time (in hours), proposed hourly billing rate and total estimated cost for each category.

M. SUBMITTALS

1. Product:

2. Submit descriptive literature and shop drawings in accordance with Section 01 33 00.
3. Submittals shall include the following data:

4. Dimensions and electrical characteristics.
5. Installation instructions.
6. Product description, operational capacities, and accuracies.

7. For each component located within the occupant's space provide dimensions, colors, and scaled drawings of the faceplate with each feature identified. Provide this information for all space sensors, pressure monitors, carbon dioxide sensors, and humidity sensors.
8. For each terminal controller, floor level controller, network controller and operators workstation (hardware and software) type, provide the following:

a) Date introduced on the market.
b) Expected date which product will cease to be produced.
c) Expected date that successor product is expected to be available.
d) Expected date that support of the product will end.

9. Shop Drawings:

10. Submit shop drawings to the Architect/Engineer which completely illustrate:

a) Full schematic presentation of all systems with location of all sensors, relays, dampers, valves, and actuators. All components to be designated to a code similar to Engineer's design on HPE drawings.
b) Full wiring diagrams with point to point designation. Number, size, and type of wiring with designation as to exact enclosure and support to be clearly noted.
c) All DDC analog and binary points to be cross referenced to the same code designation (AI-X, AO-X, BI-X, and BO-X) shown on Engineer's HPE drawings.
d) All operating systems shall include the sequence of operation that will be employed. This will parallel, as a minimum, the sequence detailed on Engineer's HPE drawings and shall include any virtual points, timers, lookup tables, startup and shutdown sequences, and other control means required. This sequence shall be written in sentence format on the shop drawings similar to that noted on the HPE drawings.
e) All pneumatic sensing and activating air lines to be clearly denoted with sizing and reference to specified installation standards.
f) Hydronic and steam valve schedules with flowrate, design differential pressure at the design flowrate, valve body maximum pressure rating, maximum working differential pressure at which control can be maintained.
g) Damper schedule including design maximum and minimum flowrates, opposed/parallel blade configuration, insulation, and leakage characteristics.
h) Building control system architecture illustrating each DDC controller; the type of communication between each DDC controller; all 120V power requirements; network, phone, fiber and internet connections; and operator's workstations and printer locations.
i) Color graphic samples shall be included in initial submittal package. Floor plan graphics and system graphics depicting mechanical, electrical and plumbing systems similar to those utilized in this project shall be included.
j) Data Communication Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135 (BACNet).

11. ECC to schedule a presubmittal presentation of all proposed formal submittal diagrams and data with A/E prior to said formal submittal. This meeting shall be scheduled and conducted at TRC Worldwide.

12. Maintenance Manuals:

13. Submit maintenance and operating manuals in accordance with Section 01 78 23.
14. Submit software and firmware operating and upgrade manuals.
15. Submit program backup software on compact disc, complete with data files.
16. Device address list.
17. Software license required by and installed for DDC workstations and internet access.

18. Owner Instruction and Training Report:

19. Submit the written "Owner Instruction and Training Report" in accordance with this specification section.

20. Field Quality Control Test Reports:

21. Submit the written "Owner Instruction and Training Report" in accordance with this specification section.

N. PRE-INSTALLATION COORDINATION MEETING

1. A pre-installation coordination meeting shall be held after submittal approval and before installation of the control system beings. The location of this meeting will be determined at a later date and will be appropriate for all parties participating. The following people/roles are required attendees at this meeting:

a) Owner: Director of Facilities/Engineering/Maintenance or equivalent role, key users/operators of the controls/BAS system as designated by the Director of Facilities/Engineer/Maintenance.
b) TRC Worldwide: Project Manager
c) ECC: Project Manager, Lead Field Technician, Design Engineer and Sales Engineer.
d) Construction Manager/General Contractor: Project Manager and MEP Coordinator.

2. The intent of the pre-installation coordination meeting is to address, discuss and resolve controls/BAS items with all key parties in attendance that historically have caused conflict and delays during the closeout/completion phase of projects.

O. DEFINITIONS

1. BAS System: An automatic, programmable building automation system that consists of an open framework Supervisory Level and a system of BACnet compliant Building Level Controllers. The system architecture shall use an IP based Supervisory Level system that connects to the internet and is web based

for ease of access while the Building Level network shall be MSTP, twisted pair network integrating with the Supervisory Level through BACnet protocol and open framework drivers.

a) Supervisory Level: an open framework platform utilizing Tridium Niagara that provides a web based operator graphical interface for supervision, data logging, trending, alarming, scheduling, and network management of all Building Level controllers.

b) Building Level: BACnet compliant, programmable controllers located at terminal devices and systems. The Building Level is connected through a MSTP, twisted pair network.

P. SEQUENCE OF OPERATION

1. Note that all operational sequences are noted on the Drawings.

PRODUCTS

III. FIELD EQUIPMENT

A. Control Instruments:

1. All control instruments, unless otherwise specified, shall be fully proportioning with adjustable sensitivity. Note that P, PI, and PID loops shall be required wherever necessary to afford final stable control within acceptable parameters to satisfaction of Architect/Engineer.

B. Thermostat:

1. Low limit thermostats:

2. Low limit safety thermostats shall be manually reset, line voltage with maximum 23'-0" flexible sensing elements responsible to lowest temperature along entire length. Furnish minimum two (2) wired in series on the discharge side of the first hydronic coils (i.e., a 4-section coil requires eight low limit thermostats wired in series). Contractor to note that the operating head of such instruments shall be shielded from conditions whereby it could be activated by low temperature. Clarify location of low limits with the Engineer during submittal review if HPE Sheets illustrate a location other than the discharge side of the first hydronic coil.
3. All flexible averaging sensors shall be attached by wire ties to a suspended wire or insulated cable to prevent sensor contact with metal or other unit components.
4. Install flexible sensors across all coils at a maximum of 6” from the bottom of the bottom coil and a minimum of 7” diameter to turn the sensor. Install the detector with a maximum free distance of 12” between each pass.
5. Staggered coils shall utilize multiple sensors. Each sensor shall cover one section of the staggered coil. Sensing elements shall be a minimum of 17’ long.
6. All flexible sensors shall be protected at point of penetration of unit via a section of poly tubing to prevent contact of the sensor and the unit.

7. Mount detector within 6” of the face of the coil unless noted otherwise. For staggered coil banks, this requirement applies for each half of the bank
8. ECC to note that when any low limit controls are above an elevation 7'-0" above floor level or otherwise inaccessible, they shall employ automatic reset and shall be wired to an auxiliary control panel of a 5'-0" elevation. The control panel with piano hinged door shall utilize a latching reset relay for each individual low limit control which insures that the fan is de-energized even as the low limit resets automatically. The panel face shall utilize a red alarm pilot light that remains lit until the 10 second time delay reset relay momentary contact switch is activated. An LED inside the panel shall indicate which of low limits has signaled the alarm.

C. Temperature Sensors:

1. Duct sensors for critical spaces shall utilize averaging elements, 1000 OHM platinum Resistance Temperature Detectors (RTD) having an accuracy of ±0.5 deg F.
2. Duct sensors for non-critical spaces may utilize 10,000 OHM or 20,000 OHM thermistor having an accuracy of ±1.0 deg F. 1000 OHM RTDs are also acceptable for non-critical applications.
3. Immersion sensors to be furnished with companion wells separable stainless steel. Well pressure rating shall be consistent with and extend the system pressure it will be immersed in. Wells shall withstand pipe design flow velocities.
4. Outdoor sensors to utilize Vaisala DTR 503A shields.

D. Space Sensors:

1. Space sensors located in private offices, conference rooms, other areas deemed “non-public” and as noted on the drawings shall have exposed external set-point adjustment and digital LCD display capable of displaying setpoint and actual sensed temperature.
2. In areas deemed “public” or where indicated on the drawings, space sensors shall have exposed external setpoint adjustment, but be without LCD displays.
3. Set-point adjustment to be a maximum plus and minus 4 degrees from the null setpoint programmed through the DDC system.
4. Space sensors may be (RTD) 1,000 Ohm platinum with an accuracy of ±0.5 deg F or 10,000 OHM thermistor with accuracy of ±0.5 deg. F for all spaces unless noted otherwise on the HPE Drawings.
5. Space sensor shall be of a neutral color (white, beige or other customer approved color) unless noted otherwise on the HPE Drawings.
6. Provide insulating bases for all sensors located on exterior walls and on exterior column wraps. Foam seal cavity and junction box prior to installing insulating base.
7. Provide locking, ventilated guards where indicated on the HPE Drawings. It is the ECC’s responsibility to coordinate color of all space sensors with the Owner prior to installation of same.
8. Provide washdown resistant sensors where indicated on the HPE Drawings and for all wet locations.
9. Provide occupancy override button on face of space sensor where indicated on the sequence and on the HPE Drawings.
10. Space sensors with occupant set-point adjustment shall be adjustable from the operator’s work station as to the deadband of adjustability allowed to the occupants.

E. Electronic Actuators:

1. Manufactured, brand labeled or distributed by Belimo or Johnson Controls, Inc. or Siemens.
2. Size for torque required for damper seal at load conditions.
3. Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle.
4. Mounting: Actuators shall be direct shaft mount type. Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
5. Overload protected electronically throughout rotation.
6. Fail safe operation: Mechanical, spring return mechanism. [**Electronic fail safe shall incorporate a visual indication of the fail safe status on the face of the actuator. The power fail position shall be field adjustable between 0 to 100% in 10 deg. F increments. The electronic fail safe shall have a 2 second (adjustable) operational delay.**]
7. Power requirements (spring return): 24 VAC, maximum 15 VA at 24 VAC or 8 W at 24 VDC.
8. Proportional actuators shall be fully programmable through an EEPROM without the use of actuator mounted switches.
9. Temperature rating: -22 deg. F to +122 deg. F.
10. Housing: Minimum requirement NEMA Type 2/IP54 mounted in any orientation. NEMA 4/4X (IP67) required for outdoor applications.
11. Agency listings: ISO 9001 or UL.
12. The manufacturer shall warrant all components for a period of 5 years from the date of production with the first two years unconditional.
13. All damper actuators used on equipment introducing outdoor air shall be furnished with mechanical spring return mechanism as indicated in “fail safe operation” above.
14. All actuators shall have external adjustable stops to limit the travel in either direction and a gear release to allow manual positioning.
15. Actuators shall be provided with position feedback signal (2-10 VDC or 4-20 mA) where indicated on HPE drawings. Feedback signal shall be independent of the input signal and shall provide true position indication.

F. Industrial Actuators (Only to be used with Butterfly Valves – Resilient Seat and Butterfly Valves – High Performance):

1. Manufacturer, brand labeled or distributed by Belimo or Johnson Controls, Inc. or Siemens.
2. The combination of valve and actuator shall meet the close-off requirements as specified in the “Butterfly Valves” portion of this Specification.
3. Coupling: ISO 5211 mounting standards.
4. Overload protection: A self-resetting thermal switch embedded in the motor.
5. Manual override: Actuator shall be equipped with a hand wheel or shaft for manual override to permit operation of the actuator in the event of an electrical power failure.
6. Power requirements: [**24 VAC**][**120 VAC**] 1 PH.
7. Auxiliary switches: 2 SPDT rated 3A at 250 VAC.
8. Temperature rating: -22 deg. F to +150 deg. F.
9. Housing: Minimum requirement NEMA Type 4X/IP67 with an industrial quality coating. Actuator shall have an internal heater to prevent condensation within the housing. A visual indication beacon shall indicate position status of the device.
10. Agency listing: ISO, UL.

11. The manufacturer shall warrant for 2 years from the date of production.

G. Control Valves:

1. Manufacturer: Manufactured, brand labeled or distributed by Belimo or Johnson Controls, Inc. or Siemens.
2. Control valve actuators:

a) Size for valve close off at 150 percent of total system (head) pressure for two-way valves and 100 percent of pressure differential across the valve or 100 percent of total system (pump) head differential pressure for three-way valves.
b) Coupling: Directly couple and mount to valve stem and shaft ISO style direct-coupled mounting pad.
c) Shall meet all the requirements of 2.1.E Electronic Actuators.

3. Control valves:

a) Factory fabricated of type, body material and pressure class based on maximum pressure and temperature rating of piping system unless otherwise indicated.
b) Sizing:

(1) Two-position: Line size or size using a pressure differential of 1 psi.
(2) Two-way modulating: 5 psid or twice the load pressure drop, whichever is more.
(3) Three-way modulating: Twice the load pressure drop, but not more than 5 psid.

c) Sizing (steam):

(1) Two-position: Line size or sized using 10% of inlet gauge pressure.

(2) Modulating: 15 psig or less inlet steam pressure, the pressure drop shall be 80% of inlet gauge pressure. Higher than 15 psig inlet steam pressure, the pressure drop shall be 42% of the inlet absolute pressure.

d) Close-off pressure rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system head pressure for two-way valves and 150 percent of the design pressure differential across the three-way valves. Combination of actuator and trim shall provide minimum close-off pressure rating of 100 psid.
e) The control valve assembly shall be provided and delivered from a single manufacturer as a complete assembly.

4. The manufacturer shall warrant all components for a period of 5 years from the date of production with the first two years unconditioned (except as noted).

H. Pressure independent control valves:

1. NPS 2 and smaller: Forged brass body rated at no less than 400 psi, chrome plated brass ball and stem, female NPT union ends, dual EPDM lubricated O-rings and a brass Tefzel characterizing disc.
2. NPS 2-1/2 through 6: GG25 cast iron body according to ANSI Class 125, Standard Class B, stainless steel ball and blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring packing design, PTFE seats and a stainless steel flow characterizing disc.
3. Accuracy: The control valves shall accurately control the flow from 0 to 100% full rated flow with an operating pressure differential range of 5 to 50 psi differential across the valve with a valve body accuracy of ±5% variance due to different pressure fluctuation or ±10% total assembly error incorporating differential pressure fluctuation, manufacturing tolerances and valve hysteresis.
4. Flow characteristics: Equal percentage characteristics.
5. All actuators shall be capable of being electronically programmed in the field by use of external computer software or a dedicated handheld tool for the adjustment of flow. Programming using actuator mounted switches or multi-turn actuators are not acceptable.
6. Coil optimization 2-1/2" through 6" shall be accomplished by utilizing a pressure independent control valve assembly; two temperature sensors providing feedback of coil inlet water temperature and coil outlet water temperature and a magnetic flow meter to provide analog flow feedback. Software shall control the valve to avoid the coil differential temperature from falling below a programmed setpoint. Independent trend logs data shall be available by means of BACnet MS/TP trending data to include, but not be limited to, inlet and outlet coil water temperatures, valve position, absolute flow, absolute valve position, absolute power and heating/cooling energy in BTU/hr.
7. The manufacturer shall provide a published commissioning procedure following the guidelines of the National Environmental Balancing Bureau (NEBB) and the Testing Adjusting Balance Bureau (TABB).
8. The control valve shall require no maintenance and shall not include replaceable cartridges.
9. NPS 2" and smaller pressure independent control valves for individual coil control shall be provided as part of a pipe package supplied by the valve manufacturer. The supply side of the coil shall contain an integrated isolation ball valve/manual air vent [**strainer**/**shut-off valve**/**drain**] with a P/T port. The return side shall contain a union fitting with a P/T port, pressure independent control valve, an integrated isolation ball valve/manual air vent with a P/T port. Shutoff valves as an integrated part of the pressure independent control valve are prohibited.

I. Characterized control valves:

1. NPS 2 and smaller: Nickel plated forged brass body rated at no less than 400 psi, stainless steel ball and blowout proof stem may be female NPT, sweat connection or pressure connect end fittings with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seat or graphite reinforced PTFE seats and a flow characterizing disc.
2. NPS 2-1/2 through 3: GG25 cast iron body according to ANSI Class 125, Standard Class B, stainless steel ball and blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring package design, PTFE seats and a stainless steel flow characterizing disc.
3. For steam applications, NPS 1 and smaller: Nickel plated forged brass body rated at no less than 600 psi, stainless steel ball and blowout proof stem, female NPT end fittings with a dual EPDM O-ring packing design,

fiberglass reinforced PTFE Teflon seats and a PTFE Teflon flow characterizing disc.

4. Flow characteristics: Equal percentage characteristics.

5. Six-way control valves shall have the following characteristics:

6. NPS ½" and ¾": Nickel plated forged brass body rated at no less than 600 psi, dual chrome plated brass ball and blowout proof stems and female NPT end fittings. Each three-way portion of the 6-way valve body shall have EPDM O-ring packing design, fiberglass reinforced Teflon seats and a flow characterizing disc.
7. The six-way control valve shall be controlled by a rotary actuator for managing two media in a switching application. The valve shall be closed to flow at mid-rotation.

8. Globe valves shall have the following characteristics:

   a) NSP 2 and smaller: ANSI Class 250 bronze body, stainless steel stem, brass plug, bronze seat and a TFE packing.
   b) NPS 2-1/2 and larger: ANSI Class [**125**][**250**] cast iron body, stainless steel stem, bronze plug, bronze seat and a TFE V-ring packing.
   c) Flow characteristics: Two-way valves shall have equal percentage characteristics. Three-way valves shall have linear characteristics.
   d) Two and three way globe valves shall be used only if characterized control valves do not fit the sizing criteria or application.

9. Butterfly valves – resilient seat:

   a) NPS 2 and 12: Valve body shall be full lugged cast iron 200 psig body with a 304 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange standards. Disc-to-stem connection shall utilize an internal spine. The shaft shall be supported at four locations by RPTFE bushings.
   b) NPS 14 and larger: Valve body shall be full lugged cast iron 150 psig body with a 304 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange standards. Disc-to-stem connection shall utilize a dual pin method to prevent the disc from settling onto the linear. The shaft shall be supported at four locations by RPTFE bushings.
   c) Sizing:

      (1) Two position: Line size or size using a pressure differential of 1 psi.
      (2) Modulating: 5 psig or twice the load pressure drop, whichever is more. Size for the design flow with the disc in a 60 degree open position and a design velocity not-to-exceed 12 feet per second.

   d) Close off pressure rating:

      (1) NPS 2-12" 200 psi bubble tight shutoff.
      (2) NPS 14 and larger: 150 psi bubble tight shutoff.

J. Butterfly valves – high performance:

1. Valve body shall be full lugged carbon steel ANSI Class [**150**][**300**] body with a 316 stainless steel disc without a nylon coating, RTFE seat and be ANSI Class 150/300 flange standards. Blowout proof shaft shall be 17-4 ph stainless steel and shall be supported at four locations by glass backed TFE bushings. Valve packing shall be Chevron TFE and shall include fully adjustable packing flange and separable packing gland. Valve body shall have long stem design to allow for 2" insulation (minimum). Valve face-to-face dimensions shall comply with API 609 and MSS-SP-68. Valve assembly shall be completely assembled and tested, ready for installation.
2. Sizing:

3. Two position: Line size or size using a pressure differential of 1 psi.
4. Modulating: 5 psig or twice the load pressure drop, whichever is more. Size for the design flow with the disc in a 60 degree open position and a design velocity not-to-exceed 12 feet per second.

5. Flow characteristics: Modified equal percentage, unidirectional.
6. Close off pressure rating: [**150**][**285**] psi bubble tight shutoff.
7. Media temperature range: ANSI Class [**150**][**300**] limitations.
8. Max differential pressure: 285 psi at 100 deg. F for ANSI 150 (725 psi at 100 deg. F. for ANSI 300).

K. Zone valves (on/off two position applications):

1. NPS 1 and smaller: Forged brass body rated at no less than 300 psi, stainless steel stems, female, NPT union or sweat with a stainless steel stem or EPDM seals.
2. The manufacturer shall warrant all components for a period of 2 years from the date of production.

L. Dampers:

1. All automatic dampers furnished by this Contractor for modulating control shall be of the proportioning type with opposed or parallel blades depending on the application or as shown on the drawings. Dampers for two position action shall be of the opposed blade type for all applications except those located immediately at the inlet of fans and as noted otherwise on the drawings. Dampers for generator radiator fan exhaust shall be opposed blade type.
2. All dampers for outdoor air service and exhaust air service to be equal to TAMCO Series 9000 aluminum and have the following features:

    a) Frames shall be 4" deep X 1" and no less than .080" in thickness, mill finish extruded aluminum 6063-T5 with mounting flanges on both sides of the frame. Frame to be assembled using plated steel mounting fasteners.
    b) Entire frame shall be thermally broken by means of two polyurethane resin pockets complete with thermal cuts.
    c) Blades shall be extruded aluminum 6063-T5, mill finish air foil profiles, internally insulated with expanded polyurethane foam and shall be thermally broken.
    d) Blade and frame seals shall be of extruded silicone and shall be secured in an integral slot within the aluminum extrusions. Blade and frame seals are to be mechanically fastened to eliminate

shrinkage and movement over the life of the damper. Adhesive or clip on type blade seals shall not be approved.

e) Maintenance free bearings are to be composed of an inner bearing fixed to a 7/16" aluminum hexagon blade pivot pin, rotating within a polycarbonate outer bearing inserted into the frame. There shall be no metal-to-metal or metal-to-plastic contact.

f) Adjustable 7/16" hexagonal drive rod, U-bolt fastener and hexagonal retaining nuts shall be corrosion resistant, zinc plated steel to provide positive connection to blades and linkage.

g) Linkage hardware shall be installed in the frame side. All linkage crank arm and rod hardware parts shall be constructed of mill finished aluminum, complete with corrosion resistant, zinc plated trunnions and cup point trunnion screws for a slip-proof grip.

h) Dampers are to be designed for operation in temperatures ranging between -40 deg. F (-40 deg. C) and 212 deg. F (100 deg. C).

i) Dampers shall be rated Leakage Class 1A at 1 in. w.g. (0.25 kPa) static pressure differential. Standard air leakage data shall be certified under the AMCA Certified Ratings Program.

j) Dampers shall be made to size required without blanking off free area.

k) Dampers shall be available as "flanged to duct" mounting type.

l) Installation of dampers must be in accordance with manufacturer's installation guidelines provided with each damper shipment.

m) Intermediate or tubular steel structural support is required to resist applied pressure loads for dampers that consist of two or more sections in both height and width. (See manufacturer's installation guidelines).

3. Dampers for all other applications to be equal to TAMCO Series 1500 Ultra Low Leakage Air Foil Aluminum and have the following features:

a) Frames shall be 4" deep X 1" and no less than .080" in thickness, mill finish extruded aluminum 6063-T5 with mounting flanges on both sides of the frame. Frame to be assembled using plated steel mounting fasteners.

b) Entire frame shall be thermally broken by means of two polyurethane resin pockets complete with thermal cuts.

c) Blades shall be extruded aluminum 6063-T5, mill finish air foil profiles, internally insulated with expanded polyurethane foam and shall be thermally broken.

d) Blade and frame seals shall be of extruded silicone and shall be secured in an integral slot within the aluminum extrusions. Blade and frame seals are to be mechanically fastened to eliminate shrinkage and movement over the life of the damper. Adhesive or clip on type blade seals shall not be approved.

e) Maintenance free bearings are to be composed of an inner bearing fixed to a 7/16" aluminum hexagon blade pivot pin, rotating within a polycarbonate outer bearing inserted into the frame. There shall be no metal-to-metal or metal-to-plastic contact.

f) Adjustable 7/16" hexagonal drive rod, U-bolt fastener and hexagonal retaining nuts shall be corrosion resistant, zinc plated steel to provide positive connection to blades and linkage.

g) Linkage hardware shall be installed in the frame side. All linkage crank arm and rod hardware parts shall be constructed of mill finished

aluminum, complete with corrosion resistant, zinc plated trunnions and cup point trunnion screws for a slip-proof grip.

h) Dampers are to be designed for operation in temperatures ranging between -40 deg. F (-40 deg. C) and 212 deg. F (100 deg. C).

i) Dampers shall be rated Leakage Class 1A at 1 in. w.g. (0.25 kPa) static pressure differential. Standard air leakage data shall be certified under the AMCA Certified Ratings Program.

j) Dampers shall be made to size required without blanking off free area.

k) Dampers shall be available with either opposed blade action or parallel blade action.

l) Dampers shall be available as “flanged to duct” mounting type.

m) Installation of dampers must be in accordance with manufacturer’s installation guidelines provided with each damper shipment.

n) Intermediate or tubular steel structural support is required to resist applied pressure loads for dampers that consist of two or more sections in both height and width. (See manufacturer’s installation guidelines).

4. Automatic dampers (modulating) shall be designed for face velocity that varies from 1,200 fpm to 2,000 fpm in most cases as approved by the design engineer. Dampers to be selected by the supplier with blade shaft lengths that prevent torsion that will create a leakage of more than 2 percent of the rated leakage capacity. Beyond that point, the dampers shall be broken into multiple sections. Field supplied mullions are required on large dampers exceeding 200 square feet.
5. Individual damper section actuators are preferred unless access to actuators is difficult and then jack shafting is acceptable. ECC to note that drive shafts between dampers of different air paths (i.e., outdoor air and return air or return air and exhaust air) is not acceptable. Jack shafting between sections is permitted when such shafting is designed to accommodate and eliminate the effects of torsion.
6. ECC to note that free access to all actuators is the responsibility of the ECC.
7. Each damper shall be equipped with an individual damper operator of the size and style required for the service intended.
8. Actuators to be designed for modulating control with spring return to the fail "safe" position. Actuators to be low voltage with 100% surplus torque (submittals to incorporate calculations to prove 100 percent closure under 4.0" wg status pressure differential for modulating service and 2.0" wg for two position application).
9. Terminal box/AFCV damper actuators to be low voltage, non-spring return and incremental control with 200 percent torque. All control actuators to utilize auto zero program to insure total accuracy of damper actuator. The feature to be activated during periods of low or no occupancy.
10. Pneumatic damper actuators to be piston type of the size and style to meet application. All modulating dampers to be equipped with pilot positioners to make the full power of the actuator available as well as to allow the operating range and starting point of the actuator to be field adjusted.
11. Smoke Damper and Combination Fire Smoke Dampers full open and full closed status signal shall be displayed at the operators work station, generate a report of this status and generate an alarm when they are not in the open (normal) position.

M. Humidity Sensors:

1. Space and duct humidity sensors to utilize this film capacitor structure on glass substrate element to operate with an accuracy of ±2% within a range of 20 and 95% RH. Sensitivity to be 0.1% RH, repeatability 0.5% RH with hysteresis less than 1%.
2. Sensors to be Vaisala.

    a) Space sensors: HMW80 Series.
    b) Duct sensors: HMD 60 U.

3. Outdoor sensors (temperature and humidity) to be Vaisala Model HMP 60 Series with DTR500 radiation shield.

N. Carbon Dioxide Sensors:

1. Units to be capable of sensing carbon dioxide from 0 to 2000 ppm with an accuracy of ±2% of range plus 2% of reading. Output to be 4-20 ma.
2. The unit shall be guaranteed to maintain accuracy of ±5% of range for 60 months before requiring recalibration.
3. Sensors:

    a) Space: Vaisala GMW 20 (GMW 21 includes temperature sensor option).
    b) Duct: Vaisala GMD 20 (GMD 21 includes temperature sensor option).

O. Control Panels:

1. Control panels for electric and electronic controls shall be located as detailed on drawings or otherwise adjacent to air handling units, heat exchangers, or other mechanical systems served. Panels shall utilize unistrut support from floor brackets such that the center of the panel is at a 48" height.
2. Panel frames shall be extruded alloy with fluted surfaces. All corners to be securely riveted and supported by an internal angle bracket. The door shall be hinged the entire length of the cabinet with key locking latch. The panels shall contain all thermostats, regulators, relays, etc., with all instruments associated with each unit mounted on a common panel inside panel. All thermometers and gages shall be arranged for flush mounting on panel face. Furnish descriptive nameplates below each item on equipment. All instrument capillaries shall be installed in protective channels. Detailed drawings shall be submitted for each panel before beginning construction.

P. Insertion Turbine Flow Meters for Chilled Water (CHW), Heating Hot Water (HHW) and Closed Loop Condenser Water (CW):

1. Provide dual turbine flow meter complete with all installation hardware necessary to enable insertion and removal of the meter without system shutdown. The flow meter shall be hand insertable up to 400 psi. The flow meter shall have two contra-rotating axial turbines, with electronic impedance-based sensing and an averaging circuit to reduce measurement errors due to swirl and flow profile distortion.

2. The flow meter shall be installed in accordance with the manufacturer's installation guide including meter orientation and straight pipe recommendations.
3. Wetted metal components shall be nickel-plated brass for applications operating below 250 degrees F, 316L SS construction for DW applications, HTHW applications operating over 250 degrees F, and for any application in non-metallic pipe. The maximum operating temperature shall be 280 degrees F, 300 F peak.
4. Each flow meter shall be individually wet-calibrated against a primary volumetric standard that is accurate to within 0.1% and traceable to NIST. The manufacturer's certificate of calibration shall be provided with each flow meter.
5. Accuracy shall be within ± 0.5% of rate at the calibrated velocity, within ± 1% of rate over a 10:1 turndown (3.0 to 30 ft/s) and within ± 2% of rate over a 50:1 turndown (from 0.4 to 20 ft/s).
6. The flow meter shall include integral analog output(s), 4-20 mA, 0-10V, or 0-5V, and a high resolution frequency output for use with peripheral devices (remote display or BTU Meter). FB-1210 for Bi-directional applications shall include an isolated contact closure output for direction.
7. The flow meter shall be covered by the manufacturer's two year warranty.
8. Turbine meter shall be ONICON Incorporated Model F-1210 Dual Turbine, or as approved by the Engineer.

Q. Insertion Electromagnetic Flow Meters for Hydronic Measurements Including CHW, HHW and Open Loop CW:

1. Provide Insertion Electromagnetic Flow Meter complete with all installation hardware necessary to enable insertion and removal of the meter without system shutdown. The flow meter shall be hand-insertable up to 400 psi. The flow meter shall average velocity readings from two sets of diametrically opposed electrodes.
2. The flow meter shall be installed in accordance with the manufacturer's installation guide including meter orientation and straight pipe recommendations.
3. The flow meter shall be installed either in the supply or return pipe of the system to be measured following the manufacturer's instructions. For installations in non-metallic pipe, install grounding rings or grounding probes.
4. Materials of construction for wetted metal components shall be 316 SS. The maximum operating temperature shall be 250 degrees F.
5. Each flow meter shall be individually wet-calibrated against a primary volumetric standard that is accurate to within 0.1% and traceable to NIST. A certificate of calibration shall be provided with each flow meter.
6. Accuracy shall be within ± 1% of rate from 2-20 ft/s. Overall turndown shall exceed 80:1.
7. The flow meter shall be covered by the manufacturer's two year warranty.
8. Insertion electromagnetic flow meter shall be Onicon Incorporated, Model F-3500 or as approved by the Engineer.

R. In-Line Flanged Electromagnetic Flow Meters for Hydronic Measurements including CHW, HHW, CW, DW, Makeup and Blowdown:

1. Provide an In-line flanged Electromagnetic Flow Meter complete with integral or remote electronics module. The electronics module shall

include a backlit graphic display and external keypad. The principle of operation shall be based of Faraday's Law of Electromagnetic Induction.

2. The flow meter shall be installed in accordance with the manufacturer's installation guide including meter orientation and straight pipe recommendations. Connections to the piping shall be ANSI class 150 flanges *(ANSI class 300 where required)*. For installations in non-metallic pipe, install grounding rings between flanges. The installing contractor is responsible for providing suitable mating flanges and any required reducer/expander.
3. The flow tube shall be epoxy coated steel; the sensing electrodes shall be 316SS; the liner shall be polypropylene or ebonite for low temperature service, PFTE for hot water service (266 F maximum).
4. Each flow meter shall be individually wet-calibrated and accurate to within ±0.2% of reading from 1.6 to 33 feet per second velocity. A certificate of calibration shall be provided with each flow meter.
5. Output signals shall be 4-20 mA and programmable pulse. The flow meter shall be capable of measuring bi-directional flow. Each flow meter shall be factory programmed for its specific application, and shall be re-programmable using the integral keypad on the electronics module (no special interface device or computer required).
6. Each flow meter shall be covered by the manufacturer's two-year warranty.
7. In-line flanged Electromagnetic Flow Meter shall be ONICON Incorporated Model F-3200, or as approved by the Engineer.

S. Clamp-On Ultrasonic Flow Meters for Hydronic Measurements:

1. Provide clamp-on transit time ultrasonic flow meter, complete with matched transducers, all necessary installation hardware and coaxial transducer cables. The flow meter shall be installed without making any openings in the pipe wall and shall utilize non-wetted ultrasonic transducers that may be located up to 300 ft from the meter.
2. Installation hardware shall support the transducers independent of the pipe clamping mechanism and provide precise spacing with an integral calibrated scale.
3. The flow meter shall be installed in accordance with the manufacturer's installation guide including meter orientation and straight pipe recommendations.
4. Multiple-frequency axial beam transducers provided must be optimized for the specific pipe & process conditions for each application and the transducer frequency shall be automatically matched to the resonant frequency of the pipe at start-up. The use of single frequency transducer technology or shear mode detection technology shall not be acceptable.
5. An integral auto-zero function shall be provided for zero precision. The flow meter shall be capable of measuring bi-directional flow.
6. Accuracy shall be within ± 1% of rate from 1 to 40 ft/sec and ± 0.01 ft/sec for velocities below 1 ft/sec. Overall turndown shall exceed 400:1.
7. Each flow meter shall be covered by the manufacturer's two-year warranty.
8. Clamp-on ultrasonic flow meter shall be ONICON Incorporated Model F-4200, or as approved by the Engineer.

T. Differential Pressure Transmitter:

1. Liquid: Furnish field mounted differential pressure transmitters as indicated on plans for measuring differential pressure and transmitting an isolated 4 to 20 mA dc output linear with differential pressure. The unit

shall be accurate to ±0.2% of calibrated span. It shall withstand static pressures of 2000 psig with negligible change in output. The flanges shall be made of stainless steel with stainless steel wetted sensing components. A 3-valve bypass manifold shall be utilized for easier on-site equalization and calibration. Unit shall be protected against radio frequency interference and shall have a watertight (NEMA Type 4) electrical enclosure with 1/2" NPT conduit connection. The transmitter shall be a standard process grade transmitter as manufactured by Rosemount.

2. Air: Furnish field mounted differential pressure transmitters using a 4-20 mA (or 0-10 Vdc) output linear with measured differential pressure. Accuracy shall be ±0.8% of calibrated span. Response time shall be 250 milliseconds. Transmitter shall be in a standard grade transmitter manufactured by Ashcroft.

U. Airflow Measuring Stations:

1. All air flow measuring stations to be furnished under this contract as shown on control schematics and as scheduled.

a) Approved manufacturers are Tek-Air Systems, Air Monitor, Paragon, Ebtron, and Farr, providing they have approved representation within 100 miles of job site.

2. Duct-mounted stations shall be installed by the Sheet Metal Contractor while fan inlet station installation responsibility shall be by this Contractor.
3. Sizing and physical location of stations shall be the responsibility of this Contractor. ECC to insure that sufficient distance is available both upstream and downstream such that turbulence is not a factor in the velocity pressure measurement. Sizing shall insure that the minimum velocity across the station affords accuracy of measurement and the design engineer shall be notified within 30 days of contract award if any modifications are required to the field ductwork.
4. ECC to insure that a proper access door upstream of the station is provided in the ductwork such that the inlet face of the unit may be cleaned as necessary.
5. Duct-mounted air flow measuring stations:

a) Furnish and install air flow measuring stations constructed of 16 gage sheet metal casing and a copper velocity pressure traverse section.

b) The velocity pressure traverse section shall consist of air straightening tubes, total pressure sensors and static pressure sensors, all interconnected to form a traverse by copper manifolds which shall equalize and integrate each type sensor measurement into one (1) total pressure and one (1) static pressure metering port. There shall be one static pressure sensor for each total pressure sensor.

c) A minimum of one static and one total pressure sensor shall be used for every 16 square feet in cross section. For larger ducts, a minimum of one static and one total pressure sensor shall be used for every 36" of duct cross sectional area up to a maximum as recommended by ASHRAE guide for traverse measurement.

d) Identification: Each air flow measuring station shall have a nameplate with the following information:

(1) Unit size.

(2) Unit designation.
(3) Design air quantity.
(4) Direction of air flow.
(5) Design air velocity.

6. Fan inlet air flow sensing (non-intrusive piezometer type):

a) Accuracy: Within 2% throughout the velocity range of 600 fpm and over, when installed in accordance with published recommendations
b) Temperature: 350 deg F continuous operation; 400 deg F intermittent operation
c) Humidity: 0-100% continuous operation
d) Corrosion resistance: Good salt air and mild acid resistance, excellent solvent and aromatic hydrocarbon resistance
e) Material: 6063-T5 anodized aluminum, galvanized mounting brackets

V. Thermal Dispersion Air Flow Measurement:

1. Air volume measurement system to consist of multiple sensors designed to average velocity using thermal dispersion principles. System to be designed to be totally independent of temperature, density, and humidity. Tek-Air or Ebtron.
2. The quantity of sensing tubes shall conform to manufacturer's requirements for spacing based on the specified accuracy and the actual inlet and outlet conditions.
3. Unit to be accurate to 1.5% between 50 fpm and 6000 fpm. Output to be 4-20 mA.
4. All software by ECC.

W. Carbon Monoxide Alarm: Single or multichannel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of 32 to 104 deg F with 2 factory-calibrated alarm levels at 50 and 100 ppm.

X. Refrigerant Alarm:

1. The unit shall meet or exceed all requirements of ANSI/ASHRAE 15 plus all local, state, and national codes.
2. The refrigerant monitor shall be housed in a NEMA-4 wall mount enclosure as assembled by manufacturer. Detection of refrigerant vapor concentration shall be refrigerant specific and include circulation of ambient air through a non-dispersing infrared energy cell. Electro-chemical sensing technology employing depletion sensors or short term life sensors, which deplete as a normal part of their operation or storage shelf life, shall not be acceptable.
3. Unit range of sensing shall be 0-100 parts per million (ppm) for refrigerant R-123 and/or 0-1000 ppm for all other refrigerants. Concentrations of refrigerant in the ambient air space will be displayed as PPM on the face of the monitor. The monitoring device shall indicate threshold violation via a status panel readout and remote alarm signaling.
4. Sequential sampling and multi-point monitoring shall be employed where airflow currents and/or room size prohibit a representative sample from one sensing point. The system shall have add-on sample point expansion modules available for present configuration and future expansion.

5. Unit to utilize three levels of dry contact alarms to afford the following:

6. Level 1: 25 percent contamination (to energize local strobe light and audible alarm).
7. Level 2: 50 percent contamination (to energize remote alarms and area ventilating process).
8. Level 3: 100 percent contamination (to shut down all chillers in Chiller Room).

9. The monitor shall incorporate dry contact relays for each alarm level and a malfunction relay. An analog 4-20ma signal, and an RS-485 digital output shall also be standard equipment. The specifier is to determine the desirable output mode.
10. Unit to be SAM-I from General Analysis Corp. or approved equal. (The Chill Co., Inc. – Indianapolis, Indiana).

Y. Status Sensors:

1. Status inputs for pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig (55 to 414 kPa), piped across pump.
2. Voltage transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.
3. Power monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.
4. Water-flow switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

Z. Miscellaneous Controls and Relays:

1. High and low limit static pressure safety pressure differential switches to be equal to elevated AFS-460 (0.5 – 12.0 in wc field adjustable) with manual reset. All devices to be mounted so as to allow full access to reset mechanism while standing on the floor.
2. Current sensing controls to be equal to Hawkeye H708 to operate between -15 and 85□C. Trip set point to be adjustable ±1% of scale, amperage 1-135A, N.O. solid state, output rating 0.5A at 30VDC.
3. Liquid level alarm switch to be equal to Dwyer Flotect Model L6 with stainless steel flow lever arm and float. Switch to be sensitive to level change of 0.5".
4. Damper end switches: End switches for dampers to be MicroSwitch BZ-2RW863-A2 with a 3PAI enclosure unit to be totally field adjustable.
5. Water sensors to be equal to Ademco No. 470.
6. Occupancy sensors to be equal to Watt Stopper CI-24 passive infrared model having N.O. and N.C. contacts and having proper power pack. Units to incorporate field adjustable time delay (adjustable from 30 seconds to 30 minutes) that allows the area being monitored to remain on Occupied Mode. Unit to also allow the sensitivity to be field adjusted.

AA. Room Pressure Monitor:

1. General:

a) The room pressure monitor shall be CRC-RPM model as manufactured by Critical Room Control (CRC), Setra Model SCRM or TSI Pressura Model RPM20.

b) The room pressure monitor shall be capable of monitoring up to two (2) differential pressure relationships. Each monitor shall have its own controller capable of standalone operation. Each monitor is capable of both visual and audible alarms. Each monitor will use direct pressure measurement utilizing industrial quality differential pressure transducer technology. Pressure sensing technology shall be a dead ended non-metallic silicon diaphragm that does not allow air/gas to pass from controlled space to reference. The monitor shall be capable of displaying pressure to 0.0001" WC.

c) Each monitor shall have an easy to navigate microprocessor based controller with full color touch screen interface. Minimum touch screen size to be 4.0". Screen shall be capable of displaying multiple colors at the same time. Monitor shall not be limited to single screen size and shall be available in multiple sizes depending on application. All settings and programming shall be made via simple touch screen or communication network. The monitor shall have a full color LED TFT/WQVGA touch screen with a minimum resolution of 480 X 272 (WQVGA), 16 bit (65,535) color depth and sunlight viewable. Panel shall have a minimum brightness rating of 350 cdm for clear indication in all lighting environments. Each monitor shall incorporate a high speed microprocessor based controller, designed for critical environment control applications.

d) The monitor shall have easy to navigate screens that clearly give the user description of any changes that are being made.

(1) Displays that simply change the back lighting for color or use LED indicators are not acceptable.

(2) Monitors that use keypads and layered menus are not acceptable.

e) Display shall be user programmable with graphics and verbiage included with monitor. Monitor shall store all settings in a non-volatile memory. Monitor will allow user to continually display or hide room differential pressure. Main screen shall be solely reserved for critical information and not display programming or menu information. Monitor settings shall be accessed via dual password protected touch screen. Main display shall allow user to select from at least three (3) colors. Monitor shall include automated room changeover including timed clearing and cleaning modes. The monitor shall display the values and setpoints of at least eight (8) auxiliary points in addition to differential pressure. The monitor shall include both visual and audible alarming of both differential pressure and auxiliary points. The monitor shall be field configurable to allow or not allow user to make adjustments setpoints.

f) The monitor shall include at least five (5) modes. Modes shall allow for user to enter customizable naming. Monitor shall display user defined precautions. Precautions shall be field customizable.

g) Monitor shall be recess or surface mounted. Supply voltage shall be 24 VDC.

(1) Monitors using single or multiple line LCD alphanumeric character displays, LED indicators or backlit screens are not acceptable. Touch pads and layered programming menus are not acceptable.

h) Screen is capable of wipe down cleaning and water spray and dust resistant meeting (IP-54).

2. Mounting:

a) Monitors shall be mounted outside of controlled space at locations shown on the prints. The monitors shall be mounted in locations that are easily visible and accessible by staff.
b) The room monitor shall be available in both recessed and surface mounting configurations.
c) The monitors shall not require penetration into the wall for mounting. The monitor shall not extend more than 0.75" from the wall.
d) Monitors that require differential pressure lines to be run down the wall to monitor must be copper or stainless steel to eliminate kinking.

3. Room monitor:

a) The monitor shall use clear unambiguous screen and verbiage to indicate monitor modes and alarms. The main display shall clearly indicate the current status of up to two (2) pressure relationships. The main screen shall allow user to display or not display actual differential pressure. The ability to show and hide actual differential pressure readout shall be accessed from the main screen without having to reconfigure monitor. The monitor shall display the current user defined precautions without having to reconfigure monitor. The monitor shall display current user defined precautions for entering the space. All pressure relationships and associated differential pressure relationships must be clearly displayed at all times.
b) Monitor shall allow the user to select the background color for the main screen.

c) The monitors that change main screen or scroll to display additional relationships are not acceptable. Actual pressure readout must be able to be accessed from the main screen without having to reconfigure monitor.

4. Modes:

a) The monitor shall have a minimum of five (5) user defined modes. Each mode shall be capable of field configuration and naming. The monitor shall include automated sequences and timing features for procedures and room changeover.
b) Naming of the modes shall be field configurable through the touch screen interface. The modes shall include functionality associated with:

(1) Isolation/pressure controlled.

(2) Isolation alarming.
(3) Occupied non-isolation.
(4) Clearing of space.
(5) And cleaning.

c) Mode change shall include optional password protection.
d) All modes shall be capable of automating proper procedures. The modes shall include user selectable timed procedures and staff interaction functions.

(1) Monitors that allow users to select from fixed verbiage or banners that are not coupled to proper sequencing or logic are not acceptable. All mode changes shall be able to be password protected. Each mode will have unique parameters and screen graphics clearly indicating changed status. Mode and condition of space shall be made with single user change and not require user to make changes to multiple parameters.
(2) Monitors that do not offer automated function of clearing, cleaning and room changeover are not acceptable.

5. Precautions:

a) The monitor/controller shall include precautions that can be displayed during occupied modes. Precautions shall be selected and automated with modes. The user selected precaution shall be clearly shown on the main screen. The monitor shall be capable of not showing any precautions if current conditions do not require any special safety requirements. Precautions shall be automated with current mode selected.
b) Changes to precautions shall include optional password protection.

(1) Monitors that do not integrate and/or automate displaying precautions with mode selection or require user to reconfigure or manual key in verbiage are not acceptable.

6. More information:

a) Each monitor shall have a dedicated screen capable of displaying up to eight (8) network points. The “more information” screen shall be accessible from the main screen.
b) Each point shall be field configurable for type/name i.e. “temperature, humidity, air change rate, etc.” Each point shall be field configurable to engineering units i.e. ℉, ℃, WC, etc.”
c) Each point shall allow user to select the appropriate resolution to be displayed. Each point shall:

(1) Display status of point.
(2) Include audible and visual alarming of point.
(3) Display or not display set point.
(4) Allow or not allow user to make set point change.

7. Pressure sensing:

a) The room pressure monitor shall be capable of monitoring up to two (2) differential pressure relationships. The monitor pressure

sensing shall continuously monitor bi-directional room pressure and the associated referenced space. Each monitor will use direct pressure measurement utilizing industrial quality differential pressure transducer technology. Pressure sensing technology shall be a dead ended non-metallic diaphragm that does not allow air/gas to pass from controlled space to reference space. Pressure measurement shall use a variable capacitance sensor. Each sensor shall be digitally compensated using an application specific integrated circuit (ASIC).

b) Pressure sensor shall not be limited to monitor and field removable. The pressure sensor shall be capable of replacement without removing monitor. The pressure sensor shall be capable of changing ranges without removing monitor. Pressure sensing operation shall be indicated by integral LED power/status light.

c) Pressure sensor shall be individually calibrated for installed and scheduled range.

d) The room pressure sensing shall be factory calibrated with NIST traceable standards.

(1) Implied pressure measurement systems utilizing thermal hot wire, thermal mass air velocity measurement, metallic diaphragm or non-dead ended are not acceptable.
(2) Pressure sensors that catalogue accuracy based on larger transducer ranges will not be accepted.
(3) Monitor suppliers with pressure sensing integral to monitor shall include one (1) monitor/sensor for every five (5) monitors required for project.

8. Accuracy:

a) Sensing accuracy shall be ±0.4% full scale including the effects of non-linearity, non-repeatability, and hysteresis, zero offset and span setting errors.

(1) All monitors must supply differential pressure sensor accuracy statements that include the effects of non-linearity, hysteresis, non-repeatability, zero offset and span setting errors.
(2) Accuracy statement sand claims that use the (RSS) root sum squares of non-linearity (BFSL), non-repeatability and hysteresis or exclude zero offset and span setting errors are not acceptable.

b) Stability: Stability per year shall ≤0.25% per year.
c) Overpressure limits: Minimum proof pressure of 15 psi and minimum.
d) Burst pressure limits: Minimum burst pressure of 25 psi.
e) Available pressure ranges: The monitor shall support the following pressure ranges:

(1) 0/0.1, 0/0.25, 0/0.5, 0/0.75, 0/1.0, 0/2.0, 0/2.5, 0/3.0, 0/5.0, 0/10.0, 25.0.
(2) Compound: ±0.1, ±0.25, ±0.5, ±1.0, ±2.0, ±5.0, ±10.0.

9. Pressure sensor setup:

a) The monitor shall be field configurable to accept multiple signal inputs. The monitor shall accept a hardwired analog signal or network signal.
b) The monitor shall be field configurable to accept multiple pressure ranges. The monitor shall be capable of accepting multiple input signals of (4-20mA, 0-5V or 0-10V). The monitor shall allow the users to zero calibrate pressure without removing monitor or accessing pressure transducer. Zero function shall be accomplished via room monitor touch screen. The monitor shall display offset of zero calibration. The offset shall be directly field configurable without calibration function.
c) The monitor shall be able to display in inches of water (“WC) or Pascal’s (pa).

10. Alarms (audible and visual0:

a) Audible alarms:

(1) The monitor shall include at least three (3) distinct alarm sounds. Alarms shall include:

(a) Pressure alarm.
(b) Remote alarm.
(c) More info auxiliary alarm.

(2) Pressure: The monitor shall include both high and low alarms. Both high and low alarms shall be individually configurable. The monitor shall allow for disabling the audible alarm. The monitor shall allow for programmable audible alarm time delay. The monitor shall be capable of locally and remotely acknowledging the audible alarm. The monitor shall include an acknowledgement time out feature. The acknowledgement time out features silences the audible alarm for user defined time, if alarm condition is not cleared after acknowledgement time period has expired the audible alarm will rest. The acknowledge time out feature shall allow for field configurable time delay or can be disabled. Audible alarm shall be indicated with unique icon appearing on the screen. The alarm icon shall also indicate when alarm has been acknowledged.
(3) More information: Audible alarms shall be configurable for each of the eight (8) “more info” points. Alarms shall be able to be locally and remotely silenced. When silenced, the monitor shall visually indicate that the alarm has been silenced. When point being displayed does not have any alarm parameters, the indicator shall be grey. When audible alarm has been acknowledged, the indicator will show that alarm has been acknowledged.

b) Visual alarms:

c) Pressure: The monitor shall at all times display current condition and alarm status of all pressure relationships being monitored. If monitor is configured for two pressure relationships, both relationships must be clearly displayed at all times. All pressure alarms must be clearly displayed whenever in pressurized mode. When pressure is not

being maintained and inside the timed audible delay period, the monitor screen shall display “loss of pressure” and change indication to amber. The monitor shall include a unique “loss of pressure” icon and verbiage indicating that the differential pressure is outside of designated pressure ranges. When pressure is outside of alarm pressure range and audible delay is not active or delay has elapsed, the monitor shall display “pressure alarm” and change indication to red. The monitor shall include a unique alarm icon and verbiage indicating that the differential pressure is outside of designated pressure ranges. Whenever “loss of pressure” or “pressure alarm” conditions are present, the monitor shall also prompt user to check door.

(1) Monitors that change main screen or scroll to display additional relationships and alarms are not acceptable.
(2) Monitor/controllers that do not specifically indicate status or rely on ambiguous verbiage similar to “caution” are not acceptable.

d) More information: Each point shown on the “More Info” screen shall have individual indication for current point status. When no alarm is present, the status indicator shall be green. When in alarm status, indicator shall be red. When point being displayed does not have any alarm parameters, the indicator shall be grey. When audible alarm has been acknowledged, the indicator shall show that alarm has been acknowledged.

11. Door contact (optional):

a) The monitor shall be capable of supporting multiple door contacts. The door contact shall be stand alone or integral to pressure control logic and sequencing.
b) The monitor shall support surface mount, recessed mount, overhead door, plunger, disconnect and magnet style door contacts.
c) Door contact shall be field configurable to allow the user option to “freeze” the monitor pressure control PI loop.
d) Door control logic to include:

(1) Door closed and pressure is lost: Monitor to bypass “loss of pressure” mode and go directly “pressure alarm” mode.
(2) Door open and pressure is lost: Monitor indicates “loss of pressure” mode for alarm delay period. When alarm delay has timed out the monitor will go to “pressure alarm” mode.

12. Monitor inputs and outputs:

a) The monitor shall have minimum of the following inputs and outputs:

(1) Analog inputs: Four (4) analog inputs.
(2) Analog outputs: Four (4) analog outputs.
(3) Digital inputs: Four (4) digital inputs.
(4) Digital contacts: Four (4) digital contacts (relay).

b) The monitor shall include onboard power isolation.

c) The monitor shall include LED light indicators that monitor is powered and working properly.
d) The monitor shall include on board power supply including:

(1) 10 VDC.
(2) 5 VDC.
(3) Power circuit for 4-20mA.

13. Power isolation:

a) The monitor shall be powered by 24 VAC. The pressure monitor shall be internally isolated and not require external isolation transformers.

b) Monitors that require isolated power supplies shall be responsible for providing proper isolation transformers with hinged enclosure and manual disconnect. The cost for installing isolated power supplies shall be included in monitor price.

14. Network communication:

a) The monitor shall have an RS-485 serial network interface that supports native BACnet MS/TP. The monitor shall also support Modbus, N2 and Lon with optional card.
b) All network configurations shall be made without removing monitor from the wall or mounting location.
c) All network parameters shall be digitally set via touch screen interface. The monitor network shall be field configurable from the touch screen administrative menu.
d) The monitor shall support baud rates of 9600, 19200, 38400, 56200, 76800 and 115200.
e) The monitor shall support instance ID's of a minimum 1-4,000,000.

BB. Analog communication:

1. The monitor shall be capable of communicating via non-network analog points.
2. A minimum of four (4) relays shall be available for pressure alarm indication.
3. The monitor shall be able to send analog signal of mode change between multiple monitors without the use of a communication network.
4. The monitor shall be able to send and receive analog differential pressures between unlimited monitor/controllers in a daisy chain configuration without the use of a communication network.
5. The monitor shall be able to send analog signal and/or relay contacts for communication with remote monitoring station without the use of a communication network.

6. Monitors that require differential pressure and alarms to be passed to remote monitor and between multiple monitors shall be required to run redundant independent communication networks.

CC. Password protection:

1. Monitor shall have at least two layers of passwords:

    a) Staff password shall allow access to daily functions and mode selection.
    b) Administrative password shall allow access to engineering and monitor configuration screens.

2. The staff password shall be able to be deactivated.
3. Staff password shall be able to be changed from the administrative menu.
4. The monitor shall have a unique password for staff use and a separate unique password for the accessing the administrative menu.

    a) Monitors that give access to menus while unit is in operation or do not offer separate passwords for staff and administrative functions will not be accepted.
    b) All menus shall be hidden from view and only appear when screen is touched. Monitors that only use a single level of password protection are not acceptable.

5. Time out feature:

    a) The monitor shall have a time out feature. This feature shall return the monitor to the main screen after inactivity (field configurable).

6. Watchdog function:

    a) The monitor shall continuously monitor its own operation to ensure that it is operating properly. The monitor shall be capable of resetting itself to clear any errors before notification.

DD. Diagnostic screen:

1. The monitor shall graphically show all analog and digital inputs and outputs.
2. Analog inputs shall be shown on a bar indicating 0-100% of full signal.
3. The diagnostic screen shall allow for testing of parameters and system checkout without removal of monitor.
4. Digital inputs shall be indicated as red or green as follows:

    a) Open verbiage with green indication.
    b) Shut verbiage with red indication.

5. Analog outputs shall be able to be controlled from this screen. The user shall be able to move the outputs from 0-100% signal. The monitor shall send same signal of field components.
6. Allows the user to open and close controller relays as follows:

    a) Open verbiage with gray indication.
    b) Shut verbiage with red indication.
    c) Monitors that do not have I/O diagnostics shall include costs for factory representative on site for any troubleshooting that may be related to I/O for installed locations.

EE. User Interface Touch Screen Display:

1. General:

   a) The room user interface shall be CRC-Multi-view Model as manufactured by Critical Room Control (CRC).
   b) The Multi-view shall be capable of displaying up to six (6) fully configurable environmental point values, room status or mode selection graphical ions. Graphical icons shall be displayed in up to seven (7) different arrangements. Each icon shall be configurable to include the point's title, current value, set point, status and/or mode. Multi-view shall be able to display any combination of graphical icons on the same screen.
   c) The multi-view points shall include individual alarm parameters for each point. The Multi-view shall be capable of displaying current point values, set points, point status, mode and alarm parameters. Multi-view shall allow for user to make set point, status or mode changes. Each monitor is capable of both visual and audible alarms. Each Multi-view monitor will support direct and network capabilities. The Multi-view graphical icons shall be individually color configurable.
   d) Each Multi-view shall have an easy to navigate microprocessor based controller with full color touch screen interface. Minimum touch screen size to be 7.0". Screen shall be capable of displaying multiple colors at the same time. Monitor/controller shall not be limited to single screen size and shall be available in multiple sizes depending on application. All settings and programming shall be made via simple touch screen or communication network. All settings and programming shall be made via simple touch screen or communication network. The monitor shall have a full color LED TFT / WQVGA touch display with a minimum resolution of 800 X 480 (WVGA), 18 bit (262,144) color depth, and sunlight viewable. Panel shall have a minimum brightness rating of 400cdm for clear indication in all lighting environments. Each Monitor shall incorporate a high speed microprocessor based controller, designed for critical environment control applications.
   e) Each monitor shall be capable of accepting point information via direct analog signal or from network communication.
   f) The monitor shall have easy to navigate screens that clearly give the user description of any changes that are being made:

      (1) Displays that simply change the back lighting for color or use LED indicators are not acceptable.
      (2) Monitors that use keypads and layered menus are not acceptable.

2. Display shall be user programmable with graphics and verbiage included with monitor. The Multi-view shall store all settings in non volatile memory. The Multi-view shall allow the user to continually display up to six (6) user configurable point values, point status or modes. Main screen shall be solely reserved for critical information and not display programming or menu information. Multi-view shall be accessed via optional password protected touch screen. The Multi-view shall include both visual and audible alarming. The Multi-view shall be field configurable to allow or not allow user to make adjustments set points, current status and mode change.
3. Monitor shall be recess or surface mounted. Supply voltage shall be 24 VAC/DC.

4. Monitor shall be recess or surface mounted. Supply voltage shall be 24 VAC/DC.

FF. Mounting:

1. The Multi-view shall be mounted at locations shown on the prints. The Multi-view shall be mounted in locations that are easily visible and accessible by staff.
2. The Multi-view shall be available in both recessed and surface mounting configurations.
3. The Multi-view shall not require penetration into the wall for mounting. The monitor shall not extend more than 0.75" from the wall.
4. Controller shall be mounted remote from the monitor. All control wiring shall be connected to the controller located remote from monitor.

GG. Multi-view value points:

1. The Multi-view shall use clear unambiguous screen and verbiage to indicate current values and alarms. The main screen shall display up to six (6) graphical icons. The monitor shall be field configurable to support between 1-6 graphical icons. Each point on the main screen shall display points and associated set points. Each point shall be configurable to allow or not allow user to adjust set point. Each point's status shall be indicated by color background. If a room goes into alarm, its background will turn red, an audible alarm will sound, and a alarm icon will appear. A user can silence the audible alarm by via a "Silence Alarm" button located on each graphical icon. If a user acknowledges / silences a room's audible alarm, that room's background will remain red until the alarm condition changes to normal. Each value point shall be configurable as an analog or network input/output.

HH. Multi-view list/status points:

1. The Multi-view shall use clear and unambiguous screen and verbiage to indicate a list of user selectable status points. The main screen shall display up to six (6) graphical icons. The monitor shall be field configurable to support between 1-6 graphical icons. Points shall be fully configurable to change modes, indicate alarms, perform control sequencing etc. The Multi-view shall be configurable for up to thirty (30) status points. Each graphical icon list shall allow the user to indicate visual and audible alarms based on selection. A user can silence the audible alarm by via a "Silence Alarm" button located on each graphical icon. Each list point shall color configurable. Each value point shall be configurable as an analog or network input/output.

II. Multi-view mode points:

1. The Multi-view shall use clear and unambiguous screen and verbiage to indicate a list of user selectable status points. Each graphical icon shall be field configurable to allow up to 1-5 user defined modes. The Multi-view shall be configurable for up to thirty (30) modes. Points shall indicate alarms, perform control sequencing etc. Each graphical icon list shall allow the user to indicate visual and audible alarms based on selection. A user can silence the audible alarm via a "Silence Alarm" button located on each graphical icon. Each mode shall be color coded and field configurable. Each mode point shall be configurable as an analog or network input/output.

JJ. Alarms:

1. The Multi-view shall have both audible and visual alarm thresholds:

    a) Alarm range high and low shall be active when point values exceed the alarm parameters. The background color of the point shall change and indicate alarm condition. A user can silence the audible alarm by via a “silence alarm” button located on each graphical icon.

2. The Multi-view shall include both high and low alarms. Both high and low alarms shall be individually configurable.
3. The Multi-view shall allow for disabling the audible alarm. The Multi-view shall allow for programmable audible alarm time delay. The Multi-view shall be capable of locally and remotely acknowledging the audible alarm. Audible alarm shall be indicated with unique icon appearing on the main screen graphical icon. The alarm Icon shall also indicate when alarm has been acknowledged.
4. The Multi-view shall allow user to set up both audible and visual alarms based on point status. Status alarms shall be field configurable for both color and alarm.
5. The Multi-view shall allow user to set up both audible and visual alarms based on point mode. Status alarms shall be field configurable for both color and alarm.

KK. Multi-view set point change:

1. The Multi-view shall be field configurable to display current set point and allow access to make local changes to set point. Set point change shall be accessed from the main screen graphical icon.

LL. Multi-view status change:

1. The Multi-view shall be field configurable to display current status and allow access to make local changes to status point. Status change shall be accessed from the main screen graphical icon.

MM. Multi-view mode change:

1. The Multi-view shall be field configurable to display current mode and allow access to make local changes to modes. Mode change shall be accessed from the main screen graphical icon.

NN. Controller inputs and outputs:

1. The monitor/controller shall have minimum of the following inputs and outputs:

    a) Analog inputs: Four (4) analog inputs.
    b) Analog outputs: Four (4) analog outputs.
    c) Digital inputs: Four (4) digital inputs.
    d) Digital outputs: Four (4) digital outputs.

2. The controller shall include on board power isolation.
3. The controller shall include LED light indicators that controller is powered and working properly.

4. The controller shall include on board power supply including:

   a) 10 VDC.
   b) 5 VDC.
   c) Power circuit for 4-20 mA.

OO. Power isolation:

1. The monitor shall be powered by 24VAC/DC. The pressure monitor/controller shall be internally isolated and not require external isolation transformers.

2. Monitors that require isolated power supplies shall be responsible for providing proper isolation transformers with hinged enclosure and manual disconnect. The cost for installing isolated power supplies shall be included in monitor price.

PP. Network communication:

1. The Multi-view shall have an RS-485 serial network interface that supports native BACnet MS/TP. The monitor/controller shall also support Modbus, N2 and Lon with optional card.
2. All network configurations shall be made without removing controller from the wall or mounting location.
3. All network parameters shall be digitally set via touch screen interface. The monitor/controller network shall be field configurable from the touch screen administrative menu.
4. The controller/monitor shall support baud rates of 9600, 19200, 38400, 56200 76800 and 115200. The controller/monitor shall support instance ID's of a minimum of 1-4,000,000.

QQ. Analog communication:

1. The monitor/controller shall be capable of communicating via non-network analog points. The monitor/controller shall send analog signals mirroring associated analog inputs.
2. A minimum of four (4) relays shall be available for alarm, status or mode indication.
3. A minimum of four (4) analog outputs shall be configurable for relaying inputs, communicating set point, status or modes.
4. A minimum of four (4) configurable analog inputs. Inputs shall support analog signals from remote sensors and controllers. Inputs can be configured as a value, mode or status input. The inputs shall be configurable to accept multiple voltage inputs.
5. A minimum of four (4) digital inputs shall be available for alarms, status and mode changes from other monitors, relays or controllers.
6. The monitor/controller shall be able send analog signal and/or relay contacts for communication with remote monitoring station without the use of a communication network.

RR. Password protection:

1. Monitor/Controller shall have at least one (1) password. The password shall be field configurable. User shall be able to activate or deactivate password protection.

2. The monitor shall have a time out feature. This feature shall return the monitor to the main screen after inactivity (field configurable). After timeout screen will require user to re-enter password to make changes.

3. Monitors that give access to menus while unit is in operation or do not offer separate passwords for staff and administrative functions will not be accepted.

4. All menus shall be hidden from view and only appear when screen is touched.

SS. Watchdog function:

1. The Monitor/controller shall continuously monitor its own operation to ensure that it is operating properly. The monitor/controller shall be capable of resetting itself to clear any errors before notification.

TT. Diagnostic screen:

1. The monitor/controller shall graphically show all analog and digital inputs and outputs.
2. Analog inputs shall be shown on a bar indicating 0-100% of full signal.
3. The diagnostic screen shall allow for testing of parameters and system checkout without removal of monitor/controller.
4. Digital inputs shall be indicated as red or green as follows:

    a) Open verbiage with green indication.
    b) Shut verbiage with red indication.

5. Analog outputs shall be able to be controlled from this screen. The user shall be able to move the outputs from 0-100% signal. The controller shall send same signal to field components.
6. Allows the user to open and close controller relays as follows:

    a) Open verbiage with gray indication.
    b) Shut verbiage with red indication.

UU. Differential Pressure Monitor:

1. Differential pressure monitor for space pressure differentials in Surgeries, Isolation Rooms, etc., to be TSI Pressura Model #8630-PM with adjustable update to negate rapid alarm change.
2. Unit to include alphanumeric digital display of room pressure differential in inches water gage.
3. Alarm to be initiated with an adjustable 20-600 second delay any time the room pressure differential is less than 0.01" wg.
4. The monitor system shall include sensor, digital interface module, transformer, cables, and a Mute menu key to manually deactivate the audible alarm for 5-minute intervals and then require reset for additional deactivation period.
5. Differential Pressure Room Pressure Switch equal to TSI Model #8694-7 with Negative-Neutral key switch and alarm status lights. The key switch will deactivate all alarms when in the Neutral position. All alarms will be active when the key switch is in the Negative position.

VV. Pneumatic Tubing:

1. Pneumatic tubing:

2. Polyethylene tubing shall be manufactured from virgin stock and shall meet the following specifications:

a) Density: 0.92 grams/cc.
b) Melt index: 0.30 decigrams/min.
c) Stress check resistance: 2000 hours minimum per ASTM-D 1693.
d) Tensile strength: 2200 psi.
e) Fire resistancy: “FR” type.

3. Fitting connections for low pressure tubing (25 psig or less) may be made with barbed push-on fittings. For high pressure tubing (more than 25 psig), the connections shall be made with compression fittings.
4. Polyethylene tubing shall be installed using the following rules:

a) Single polyethylene tubing may be run exposed for lengths 18” or less. For lengths which exceed 18”, the lines shall be run concealed in EMT, ¾” size and this tube carrier system shall be installed in a workmanlike manner, parallel to building lines, adequately supported, etc. All connections, except for terminal connections to valves, damper operators, etc. shall be made inside trough junction boxes or control cabinets. Support entry 6 feet to building structure. Accessible ceiling tubing may be bundled neatly and mechanically attached to and parallel with building structure.
b) No fitting connections shall be made within the inaccessible area.
c) All connections shall be tight and secure.
d) 25 psig lines shall be 3/8” minimum poly, 80 psig lines shall be in copper.

## IV. NETWORK EQUIPMENT

### A. General:

1. The controls systems shall consist of multiple network supervisory controllers and associated equipment connected by industry standard digital and communication network arrangements.
2. The operator user interface devices, servers, and principal network computer equipment shall be standard products of recognized major manufacturers available through normal PC and computer vendor channels. ("Clones" assembled by a third-party subcontractor are not acceptable.)
3. Provide licenses for all software residing on and used by the controls systems and transfer these licenses to the Owner prior to completion.
4. The networks shall, at minimum, comprise, as necessary, the following:

a) Data servers: Where network capacity, concurrent users and data storage requirements deem necessary.
b) Operator’s user interface devices: Fixed and portable as required by the specifications.
c) Network computer processing, data storage, and communication equipment including servers and digital data processors.
d) Routers, bridges, switches, hubs, modems, interfaces and the like communication equipment. Verify hardware and configuration requirements with Owner’s IT/IS Department.

e) Network supervisory controllers including programmable field panels and controllers together with their power supplies and associated equipment.
f) Configurable and application specific field-level controllers including power supplies, enclosures and associated equipment.
g) Local display devices.
h) Addressable elements, sensors, transducers, and end devices.
i) Third-party equipment interfaces as required by the Contract Documents.
j) Other components required for a complete and working control systems as specified.

5. The specifications for the individual elements and component subsystems shall be minimum requirements and shall be augmented as necessary by the Contractor to achieve both compliance with all applicable codes, standards, the requirements of the authority having jurisdiction (AHJ) at the site and to meet all requirements of the Contract Documents.
6. The system shall be modular in nature and shall permit expansion of both capacity and functionality through addition of sensors, actuators, controllers and operator devices while reusing existing controls equipment.
7. The system shall comply with the following NFPA Codes and Standards as applicable:

a) NFPA 70 National Electrical Code.
b) NFPA 72 National Fire Alarm Code.
c) NFPA 101 Life Safety Code.
d) NFPA 90A Standard for the Installation of Air Conditioning and Ventilation Systems.
e) NFPA 92B Guide for Smoke Management Systems in Malls, Atria and Large Areas.
f) UL 864 (UUKL) Ninth Edition Smoke Control Listing including the UL 864 Ninth Edition Standard for Controls Units and Accessories for Fire Alarm Systems.

8. The system shall comply with the following International Code Council (ICC) Codes:

a) Building Officials and Code Administrators International (BOMA) Model Code.
b) Southern Building Code Congress International (SBCCI) Regulations.

B. SUPERVISORY LEVEL
1. Open framework Tridium Niagara 4 system consisting of JACE 8000 controllers.
a) Niagara Software Licenses for the Supervisory Level shall be open to the owner to allow access from any provider and any associated programming tool set and manufacturer specific devices and controllers.
2. JACE 8000 controllers:
a) TI AM3352; 1000MHZ ARM Cortex-A8, 1GB DDR3 SDRAM, Wi-Fi capable, real time clock, battery less.
b) Provide expansion modules for each JACE 8000 as required to provide necessary networks or IO modules.
3. DEVICE/POINT CAPACITY:

a) Provide JACE 8000 with device and point license capacity as required for each installation
b) OR
c) Provide JACE 8000 with a minimum license capacity of:
d) --- Devices, --- Points
e) MAINTENANCE AGREEMENT:
f) Provide JACE 8000 with a standard 18 month service agreement
g) OR
h) Provide JACE 8000 with a **(3year)(5year)** service agreement
i) Niagara 4 Supervisor:
j) Provide a Supervisor license for installations with more than one JACE

4. MAINTENANCE AGREEMENT:
   a) Provide Niagara Supervisor with a standard 18 month service agreement
   b) OR
   c) Provide Niagara Supervisor with a **(3year)(5year)** service agreement
   d) Provide a Supervisor license with Niagara Network connections as required
   e) OR
   f) Provide a Supervisor license with **(1)(2)(3)(10)(100)(UNL)** Niagara Network connections
   g) Provide Niagara Supervisor license with add on to allow for running Niagara AX (3.8 & up) in addition to the Niagara 4 platform

C. Automation Network:

1. The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard “off the shelf” products available through normal PC vendor channels.
2. The BMS shall network multiple user interface clients, automation engines, system controllers and application specific controllers. Provide application and data server(s) as required for systems operation, data storage and required number of concurrent users.
3. All BMS devices on the automation network shall be capable of operating at a communication speed of 100 Mbps with full peer-to-peer network communication.
4. Network supervisory controllers and operator user interfaces.
5. The automation network will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.

D. Control Network:

1. Network supervisory controllers (NSC) shall provide supervisory control over the control network and shall support all three (3) of the following communication protocols:

   a) BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9.

(1) The NSC shall be BACnet Testing Labs (BTL) certified and carry the BTL label.
(2) The NSC shall be tested and certified as BACnet Building Controller (B-BC).

b) LonWorks enabled devices using the Free Topology Transceiver (FTT-10a).
c) Legacy manufacturer's proprietary field bus [**Johnson Control N2.**][**Siemens P1.**]

2. Control networks shall provide either "peer-to-peer", master slave or supervised token passing communications and shall operate at a minimum communication speed of 9600 baud.
3. DDC controllers shall reside on the control network.
4. Control network communication protocol shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135.
5. A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.
6. The PICS shall be submitted 10 days prior to bidding.

E. Integration:

1. Hardwired:

a) Analog and digital signal values shall be passed from one system to another via hardwired connections.
b) There will be one separate physical point on each system for each point to be integrated between the systems.

2. Direct protocol (integrator panel):

a) The BAS system shall include appropriate hardware equipment and software to allow bi-directional data communications between the system and the third party manufacturer's control panels. The BAS shall receive, react to and return information from multiple building systems, including, but not limited to, chillers, boilers, variable frequency drives, power monitoring system and medical gas.
b) All data required by the application shall be mapped into the automation engine's database and shall be transparent to the operator.
c) Point inputs and outputs from the third party controllers shall have real-time interoperability with BAS software features such as control software, energy management, custom process programming, alarm management, historical data and trend analysis, totalization and local area network communications.

3. BACnet Protocol Integration – BACnet:

a) The neutral protocol used between systems will be BACnet over Ethernet and comply with the ASHRAE BACnet Standard 135-2008.
b) A complete Protocol Implementation Conformance Statement (PICS) shall be provided for all BACnet system devices.
c) The ability to command, share point object data, change of state (COS) data and schedules between the host and BACnet systems shall be provided.

F. Dedicated Web Based User Interface:

1. Where indicated on plans, the ECC Contractor shall provide and install a personal computer for command entry, information management, network alarm management and database management functions. All real-time control functions, including scheduling, history collection and alarming, shall be resident in the network supervisory controllers to facilitate greater fault tolerance and reliability.
2. Dedicated user interface architecture: The architecture of the computer shall be implemented to conform to industry standards so that it can accommodate applications provided by the ECC Contractor and by other third party applications suppliers, including but not limited to, Microsoft Office applications. Specifically, it must be implemented to conform to the following interface standards.

a) Microsoft Internet Explorer for user interface functions.
b) Microsoft Office Professional for creation, modification and maintenance of reports and sequences of other necessary building management functions.
c) Microsoft Outlook or other e-mail program for supplemental alarm functionality and communication of system events and reports.
d) Required network operating system for exchange of data and network functions such as printing of reports, trends and specific system summaries.

3. PC hardware: The personal computer(s) shall be configured as follows:

a) Memory: 1 GB (minimum).
b) CPU: Pentium 4 processor, 2.8 GHz clock speed (minimum).
c) Hard drive: 100 GB free hard drive space (minimum).
d) Hard drive backup system: CD/RW, DVD/RW or network backup software provided by IT Department.
e) CD ROM Drive: 32X performance.
f) Ports: Two (2) serial, one (1) parallel and two (2) USB ports.
g) Keyboard: 101 keyboard and 2 button mouse.
h) CRT configuration: 1-2 CRTs as follows:

(1) Each display: 19” flat panel monitor (minimum), 1280 X 1024 resolution minimum.
(2) Display card with multiple monitor support.

i) LAN communications: Ethernet communications boards; 3Comm or equal.

4. Operating system software:

a) Windows Windows 7 (32 bit) or 10.
b) Where user interface is not provided via browser, provide complete operator workstation software package, including any hardware or software keys. Include the original installation disks and licenses for all included software, device drivers and peripherals.
c) Provide software registration cards to the Owner for all included software.

G. Distributed Web Based User Interface:

1. All features and functions of the dedicated user interface previously defined in this document shall be available on any computer connected directly or via a wide area or virtual private network (WAN/VPN) to the automation network and conforming to the following specifications.
2. The software shall run on the Microsoft Internet Explorer (10.0 or higher) browser supporting the following functions:

    a) Configuration.
    b) Commissioning.
    c) Data archiving.
    d) Monitoring.
    e) Commanding.
    f) System diagnostics.

3. Minimum hardware requirements:

    a) 1GB RAM.
    b) 2.8 GHz clock speed, Pentium 4 microprocessor.
    c) 500 GB hard drive.
    d) 1 keyboard with 83 keys (minimum).
    e) SVGA 1280 X 1024 resolution display with 64K colors and 16 bit color depth.
    f) Mouse or other pointing device.

V. DDC SYSTEMS EQUIPMENT

A. Tier 1 – Network Supervisory Controller (NSC):

1. The NSC shall be designed, packaged, installed, programmed, and commissioned in consideration of their specific service and prevailing operating conditions. They shall be proven standard product of their original manufacturer and not a custom product for this project.
2. The NSC shall support a minimum of 200% of the project's installed field points together for fully functional distributed processing operations.
3. The controls systems shall be designed and implemented entirely for use and for operation on the Internet and the Owner's Intranet. This functionality for operational access shall extend down to the field panel and field point level.
4. The primary controls systems nodes (NSC) shall be fully IT compatible nodes operating over the industry standard IT infrastructure provided for the project. The Controls Contractor shall coordinate with the IT infrastructure support staff or trade contractors to ensure compatibility and performance of the operation of the controls systems over the LAN/WAN made available for its shared use.
5. The controls systems Tier 1 network shall be configured on IT industry standard off-the-shelf technologies compatible with other building systems and project network arrangements.
6. The primary NSC shall manage and direct all information traffic on the Tier 1 network, between the Tier 1 and Tier 2 networks and to the server(s). The NSC shall monitor the network of application specific, configurable and programmable field level controllers. Provide global strategy and direction and communicate on a peer-to-peer basis with the other NSCs on the Tier 1 network.

7. All NSC on the Tier 1 network shall be equipped with all software and functionality necessary to operate the complete user interface, including graphics, via a browser connected to the node on the network or directly via a local port on the NSC.
8. A failure at a primary NSC shall not cause failures or non-normal operation at any other system NSC other than the possible loss of active real-time information from the failed NSC.
9. Tier 1 primary NSC shall maintain all programming in non-volatile or battery backed memory and shall automatically resume normal monitoring and control following the restoration of stable electrical power after a power outage. ECC to supply uninterruptible power supplies (UPS) on all NSC where noted. UPS to allow a minimum of 12 minutes of full operation before the emergency power is in full operation. Software shall allow an orderly shutdown to save all data in the event power is not restored before the battery is fully discharged.
10. All communication between controls application nodes shall be digital.
11. All controls systems application facilities and features shall be accessible via Intranet and Internet browser with user ID or password access control for user access.
12. The primary NSC shall be capable of direct connection to multiple field busses using different protocols simultaneously as indicated below. Should the NSC not support multiple field busses then install multiple NSC in parallel to achieve this functionality.

    a) BACnet Standard MS/TP Protocol ASHRAE SSPC-135.
    b) A LON field bus for supervision and control of LON based controllers that conform to the LonTalk standard.
13. Manufacturer's legacy proprietary field bus if adding to existing legacy network [**Johnson Controls N2.**][**Siemens P1.**]

14. The NSC shall integrate data from all field busses into a common and conformal object structure. Data from all field busses shall appear in common displays throughout the Operator Interface in the same format. Conformal formatting shall be provided for each type of data not dependent on the type of field bus from which the data originated.
15. The controls systems application shall support auto-dial/auto-answer communications to allow controls systems nodes to communicate with other remote controls systems nodes via standard telephone lines.
16. Downloading and Uploading:

    a) Provide the capability to generate and modify the controls systems application software-based sequences, database elements, associated operational definition information and user-required revisions to same at any designated workstation together with the means to download same to the associated NSC.
    b) The controls systems application software tool provided for the generation of custom and database definitions shall be resident in both the NSC and controls systems application server(s).
    c) Provide the capability to upload controls systems application operating software information, database items, sequences, and alarms to designated server(s).
    d) The functions of this Part shall be governed by the codes, approvals, and regulations applying to this controls systems application as provided.

17. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
18. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.

B. Tier 2 – HVAC System Specific Application Node (AN):

1. Tier 2 HVAC system AN shall provide both standalone and networked direct digital control of mechanical and electrical building systems as required by the system design.
2. A dedicated HVAC system AN shall be configured and provided for each primary HVAC system (air handler, chiller, boiler, etc.). At the ECC's option, the AN for primary HVAC system(s) may reside on the Tier 1 network, however, it is the ECC's responsibility to coordinate the additional network "drops" and associated IP addressing with the Owner's IT Department. The ECC will also be responsible for any costs necessary to compensate the Owner, or Subcontractor hired by the Owner to provide and install the additional network connections not shown on construction documents.

a) The system AN shall have a built-in panel interface that allows the user to monitor status as well as adjust setpoints locally, in addition to the ability to temporarily override input and output points for troubleshooting and maintenance.
b) The system AN shall have expandable point capacity with multiple configurations allowing for 25% future analog and binary input/output points. Additional points shall be eligible for use in any control strategy that resides in the AN.
c) Local Display on all Primary AHU systems plus primary hot water and chilled water systems:

(1) The display shall allow the user to view and change set points, modes of operation and parameters of all binary and analog points associated with respective AN.
(2) A local display terminal that allows for multiple lines of text and graphical representation of the equipment being controlled by the AN including actual data from all points residing on the system controller.
(3) The display terminal shall have the ability to view an alarm summary for current alarms as well as alarm history.

3. A dedicated HVAC system AN shall be configured and provided for each terminal HVAC system (unit heater, fan coil unit, cabinet heater, heat pump, chilled beam, etc.).

a) The terminal AN shall have a library of control strategies capable of performing sequences specified.
b) The terminal AN shall support a connection directly at the node or its associated temperature sensor for a portable user interface.

4. A dedicated HVAC system AN shall be configured and provided for each terminal box (VAV, CAV, F/P, and AFCV) application.

a) The terminal box AN shall include an integral pressure transducer and damper actuator and the entire assembly shall be mounted or removed as one piece.
b) The damper actuator shall be capable of stroking 90 degrees in 30 seconds.
c) The terminal box AN shall have the auto zero ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature and humidity effects.

5. Each HVAC system AN shall retain program, control algorithms, and setpoint information for at least 72 hours in the event of a power failure and shall return to normal operation upon stable restoration of normal line power.
6. Each HVAC system AN (AHU, hot water, chilled water, terminal box, etc.) shall monitor and report its communication status to the controls system application. The controls systems shall provide a system advisory upon communication failure and restoration.
7. Provide a means to prevent unauthorized personnel from accessing setpoint adjustments and equipment control definitions at the HVAC system AN.
8. The HVAC system AN shall perform the functional monitoring of all controls application variables, both from real hardware points, software variables, and controller parameters such as setpoints.
9. A failure at an HVAC AN shall not cause failures or non-normal operation at any other system AN other than the possible loss of active real-time information from the failed AN.
10. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
11. LonWorks Compliance: Communicate using EIA/CEA 709.1 datalink/physical layer protocol using LonTalk protocol.
12. Enclosure: Dustproof rated for operation at 32 to 120 deg F.

C. Servers:

1. As required for the functional operation of the control systems, the Controls Contractor shall provide all necessary digital processor programmable server(s). These server(s) shall be utilized for controls systems application configuration, for archiving, reporting, and trending of data, for operator transaction archiving and reporting, for network information management, for alarm annunciation, for operator interface tasks, for controls application management and the like. These server(s) shall utilize IT industry standard data base platforms such as Microsoft SQL server and Microsoft data engine (MSDE) or approved equal.
2. Provide controls systems application server(s) to archive historical data including trends, alarm, and event histories and transaction logs.
3. Equip these server(s) with the same software tool set that is located in the primary controls systems application nodes for system configuration and custom logic definition.
4. Equip these server(s) with the same software tool set that is located in the primary application nodes for color graphic configuration.
5. Access to all information on the control systems server(s) shall be through the same operator interface functionality used to access individual nodes. When logged onto a server, the Operator will be able to also interact with any of the primary nodes on the controls systems application.

6. Server disc shall have capacity to store all programmed trends, alarm history, user graphics, etc., for a minimum of 18 months minimum. The server shall allow a hard copy printout of all alarms as they occur.

D. Time Clock: Solid-state, programmable time control with 8 separate programs each with up to 100 on-off operations; 1-second resolution; lithium battery backup; keyboard interface and manual override; individual on-off-auto switches for each program; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; system fault alarm; and communications package allowing networking of time controls and programming from PC.

E. Operator Interface:

1. The Operator Interface provided shall include the functionality to selectively combine data and information from any system element or component in the controls systems application on a single browser window display panel at the operator's option. This shall include both current information and historical data stored on the server(s).
2. All aspects of the controls systems operator interface shall be provided to operate through an IT industry standard web browsers such as Internet Explorer or Chrome or approved equivalent.
3. The web browser based operator interface provided shall incorporate complete tool sets, operational information displays, multi-window displays, and other interactive aids to assist interpretation and ease of use. Simple HTML based web page displays are not acceptable; all values must be dynamic such that they are constantly changing.
4. The web browser based operator interface provided shall not require the procurement or licensing of any special or proprietary software from the Controls Contractor or its suppliers for the controls systems OWS.
5. The controls systems application OWS shall operate on Microsoft Windows 2000/XP or other approved platform.
6. Each controls systems application fixed and portable OWS shall be on-line configurable for specific functionalities and associated groups of system points and elements.
7. The controls systems application portable OWS shall operate identically and have equal functionality to the fixed OWS. All Operator access into the controls systems from portable OWS shall be the same browser format and functionality as provided for the fixed OWS.
8. File and system management display (navigation trees):

    a) The operator interface shall include the ability to display system names in a hierarchal (navigation tree) format that allows logical grouping of systems and point names. This hierarchal organization shall represent the logical system network layout.
    b) Provide the capability to display multiple navigation trees that aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the controls systems networks.
    c) Provide the capability for the Operator to add custom trees. The Operator shall be able to define any logical grouping of systems or points and arrange them on the tree in any selected order. Provide the capability to nest groups within other groups. Provide at minimum for 5 levels of nesting.
    d) The navigation trees shall be "dockable" to other displays in the operator interface including graphic displays. The tees shall

appear as part of the display and may be individually detached and minimized to the Windows task bar or closed. Provide for a single keystroke to reattach the navigation tree to a primary display.

9. Divisible display windows:

a) Provide for the operator to divide the display area within a single browser window into multiple display panels. The content of each display panel can be any of the standard summaries and graphics provided in the controls systems application.
b) Provide each display panel with minimize, maximize, and close icons.

10. Alarms:

a) Alarms shall be routed directly from primary controls systems application nodes to OWS and server(s). Provide for specific alarms from specific points to be routed to selectable OWS and server(s). The alarm management portion of the controls systems software shall, at minimum, provide the following functions:

(1) Log date and time of alarm occurrence.
(2) Generate a "Pop-Up" window on the browser display panel, with audible alarm, informing the operator that an alarm has been received.
(3) Allow an operator, with the appropriate password, to acknowledge, temporarily silence or cancel an alarm.
(4) Provide an audit trail on hard drive for alarms by recording user acknowledgement, deletion, or canceling of an alarm. The audit trail shall include the ID of the user, the alarm, the action taken on the alarm and a time/date stamp.
(5) Provide the ability to direct alarms to an e-mail address or alpha-numeric pager. This must be provided in addition to the pop-up window described herein. Controls systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.
(6) Provide for any attribute of any object in the controls systems to be designated to report as an alarm.

b) The controls systems application shall annunciate systems diagnostic alarms indicating system failures and non-normal operating conditions.
c) The controls systems application shall annunciate controls alarms at minimum as required by Part 3.
d) Provide the on-line means to display alarms within the browser windows by date/time of occurrence, priority class, point designation, value, or other defined text keywords.

11. Operator transaction archiving:

a) Provide the means to automatically archive all operator activities on the controls systems application and for the recall of same for reporting.
b) Provide the means to sort and report archived activities by operator, date/time, activity type and system area.

c) Provide access protection to preclude the unauthorized removal or tampering with archived records.
d) Provide management support facilities for the deletion and reinitializing of archived record logs under master password control or equal means.

12. Reports:

a) Reports shall be generated and directed to one or more of the following: User interface displays, printers archived at the Owner's defined option. As a minimum, the controls systems application shall provide the following reports:

(1) All points in the controls systems application.
(2) All points in a specific controls systems AN.
(3) All points in a user-defined group of points.
(4) All points currently in alarm.
(5) All points locked out.
(6) All controls systems application schedules.
(7) All user defined and adjustable variables, schedules, interlocks, diagnostics, systems status reports, and the like.

b) Provide all applicable original manufacturer's standard reports for the controls systems.
c) Provide any custom report as specified.

13. Dynamic Color Graphics:

a) Provide for any number of real-time color graphic displays shall be able to be generated and displayed in the controls systems application limited only by memory data storage capacity.
b) Graphics shall be based on Scalar Vector Graphics (SVG) technology.
c) Values of real-time attributes displayed on the graphics shall be dynamic and updated on the displays.
d) The graphic displays shall be able to display and provide animation based on real-time data that is acquired, derived, or entered into the operating controls systems.
e) Provide for the Owner to be able to change values (setpoints) and states in system controlled equipment directly from the graphic display.
f) Provide a graphic editing tool that allows for the creation and editing of graphic files. It shall be possible to edit the graphics directly while they are on line, or at an off line location for later downloading to the AN.
g) Provide a complete user expandable symbol library containing all of the basic symbols used to represent components of a typical system. Implementing these symbols in a graphic shall involve dragging and dropping them from the library to the graphic.
h) ECC Project Manager and/or programmer/technician shall meet with the Owner’s Maintenance and Facility Staff prior to graphic development. Graphics shall not be installed on BAS system until the Owner’s Staff has reviewed, commented and approved graphic appearances, layouts, etc. including floor plan graphics.

14. Schedules:

a) Provide multiple schedule input forms for automatic time-of-day scheduling and override scheduling of operations. At a minimum, the following spreadsheet types shall be accommodated:

(1) Weekly schedules.
(2) Temporary override schedules.
(3) Special "Only Active If Today Is A Holiday" schedules.
(4) Monthly schedules.

b) Schedules shall be provided for each group, system, and sub-system in the controls systems application. It shall be possible to include all of any commandable points residing within the controls systems in any custom schedule. Each point shall have a unique schedule of operation relative to the system use schedule, allowing for sequential starting and control of equipment within the system. Scheduling and rescheduling of points shall be accomplished easily via the system schedule spreadsheets.
c) Multiple monthly calendars for a 12-month period shall be provided that allow for simplified scheduling of holidays and special days in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the weekly schedules.

15. Historical trending and data collection:

a) Trend and store point history data for all actual and virtual (software) points and values as required by the Owner.
b) The trend data shall be stored in a manner that allows custom queries and reports using industry-standard software tools.
c) At a minimum, provide the capability to perform statistical functions on the historical database:

(1) Average.
(2) Arithmetic mean.
(3) Maximum/minimum values.
(4) Range – difference between minimum and maximum values.
(5) Standard deviation.
(6) Sum of all values.
(7) Variance.

16. Operator access security (combined password and user ID):

a) Provide for Operator access into the controls systems via the use of on-line Owner defined software password and user identification (ID) pairs, unique for each operator and unique throughout the controls systems application, to supplement standard password access control.
b) Stored password/user ID definitions shall be stored in encrypted formats whether at the controls server or at the AN.
c) Password logins shall not be echoed on any screen or printer except during master password definition processes. An operator defining a password shall be required to re-enter to confirm authenticity.

d) Operator access privileges shall be definable in terms of functions and project areas.
e) As part of the access privileges definition for each user the Owner shall be able to define at minimum the following:

(1) Access times by day.
(2) Permanent or temporary, with expire date, password.
(3) Number of incorrect access attempts allowed before the password is disabled.
(4) Whether or not the operator is able to redefine their own password.
(5) A field for the operator's e-mail address.
(6) A field for the operator's contact phone number.
(7) Definition of the operator's access privilege functionalities including viewing only, fully control, selected functions, etc.

17. Primary DDC Issues:

a) All analog and binary signaling to be wired and piped to DDC panels as detailed on plans. Bidder to verify total of points scheduled. Global communication trunk LAN to allow sharing of data between individual panels.
b) DDC controllers to have points as scheduled on plans as a minimum. ECC to note that additional analog and binary points may be required to achieve the operating sequence of operation or as dictated by standards and codes.
c) A separate application node controller shall be required for each individual air-handling unit unless detailed to the contrary.
d) Miscellaneous requirements:

(1) All analog points to have applicable high and low alarm points programmed to identify operation out of acceptable ranges.
(2) Status of all motors to be programmed to consider programmed off cycle as non-alarm. Normal status of all motors to be shown.
(3) Flow sensing for BTU calculations to be performed with turbine meters or magnetic inductive transmitter as detailed.
(4) All safety thermostats and pressure switches to have manual reset requiring manual rest on restart.
(5) Each DDC controller of each type shall be equipped with an integral "ON-OFF" switch that disconnects it from the primary electrical service.

e) The entire DDC system shall employ capability for compatibility to BAC net technology.
f) Where specifically called for and where detailed in the unit specification, this Contractor to furnish gateways that allow for the integration of data into the BAS system.
g) Furnish to Owner at project completion a CD incorporating the entire software system.
h) The operating system requires that the operator shall have access to all analog and binary data points through the global LAN. This shall include all points contained in all application node controllers,

and such other points as are integral in auxiliary mechanical and electrical components. Access to be accomplished through integral network terminals or separate laptop computers. The resulting communication network shall allow the ability to read and adjust all binary and analog points throughout the entire network through any interface. Refer to architecture detailed on HPE drawings.

EXECUTION

VI. INSTALLATION

A. Instrumentation Mounting:

1. All sensing capillaries on coils shall be rigidly supported as directed by the Architect/Engineer to prevent capillary vibration and to accurately sense coil temperature.
2. All sensors except where installed in finished areas shall have bakelite plates identifying their function keyed to control schematics.
3. All sensors where duct or unit housing 30" or more in width or height shall utilize flexible averaging bulb elements installed to sense average temperature. Element to cover entire coil surface with multiple passes to insure accurate average. Multiple sensors to be utilized as required. Elements to be mounted on field fabricated frame or cable support with nylon tie wraps.
4. Room thermostats, humidistats, and other space sensors shall be installed where shown on the Drawings. These components shall not be installed between a light switch and doorway when they are co-located on the Drawings. These components shall be installed at a height of 46" above finished floor to the center of the component, unless indicated otherwise.
5. Sensors located in fire-resistance rated walls shall be installed within steel electrical boxes. Boxes shall be protected with listed firestop putty pads if located less than 24” from other electrical boxes on the opposite side of the wall. Install putty pads on all boxes (existing or by other trades) within 24” of the box with the sensor.
6. This Contractor shall be responsible for exact field location of all airflow measuring stations, water flow turbine meters, vortex shedding sensors, pitot tubes, airflow sensors, thermal sensors, humidity sensors, pressure sensors, and any other variables required as a part of the environmental control system. This Contractor shall coordinate the sensors with devices furnished and installed under other sections of the project. Any conflicts to be brought to Architect/Engineer prior to installation.
7. All controllers, alarms, and sensors, except in finished areas, shall carry plastic laminate identifying tags describing their function and keyed to automation diagrams.
8. Vortex shedding sensors to be field installed by ECC.
9. All controllers and control panels shall utilize mounting support that insures no vibration from the structure or mechanical equipment. Back boxes or backing panels are required as appropriate. Where walls are plaster or drywall, channels shall be utilized screwed to studs with laminated panel facing to support instruments or control panels; all such assemblies to be crafted to present easy access to controls. Proper engraved identification nameplates are required.
10. ECC is responsible to coordinate with Mechanical, Sheet Metal, and Electrical Contractors the proper location of all air, water, and steam

measurements and control components to insure that sizing and locations meet all manufacturer's standards for maximum accuracy of sensing and control. Instances where piping or duct sizing and location need be modified from what is shown on drawings to achieve required accuracy shall be brought to designer's attention prior to bidding; failure to so notify designer requires ECC to accommodate required field modifications.

11. Instrument operating assemblies located within finished spaces intended to be accessed by personnel shall be installed at a height of 46" above finished floor to the center of the assembly. This applies for all controllers, readout components, pressure monitors, and safety devices.

12. Within mechanical rooms, all instrument operating assemblies for all controllers, readout components, and safety devices shall be installed in locations that are easily accessible to maintenance and operating personnel. Locations such as those on remote sides of air handling units or other mechanical systems are not acceptable.

B. Electrical Wiring:

1. Under this division, furnish and install interlock, LAN, sensor, and actuator wiring. Connect controls in accordance with approved wiring diagrams. Install wiring inside panels to terminal strips.

2. Configure LAN as either a bus, star, or combination of the two. Use twisted pair, coax, or fiberoptic cable to meet noise immunity and/or distance requirements. Design system for data transfer rate of no less than 1 megabaud. LAN wiring requires shielded cable or shall be cable certified for LON or BAC net. All LAN wiring must meet supplier's standards of operation and quality.

a) Use Belden No. 22 gage or larger Beldfoil or equal for runs up to 250 feet.

b) Use Belden No. 18 gage or larger Beldfoil or equal for runs 250 feet to 500 feet.

c) All input/output wiring shall have sufficient strength to meet all operational requirements.

3. Sensor wiring over 50 feet, where run in a common conduit or near inductive loads, shall be shielded cable.

a) Use Belden No. 24 gage or larger Beldfoil or equal for runs up to 100 feet.

b) Use Belden No. 18 gage or larger Beldfoil or equal for runs up to 500 feet.

c) All input/output wiring shall have sufficient strength to meet all operational requirements.

4. Power Wiring for 24volt power trunk shall be minimum two conductor No. 14 gage plenum rated wiring.

5. Install all control and interlock wiring in addition to low voltage sensor and LAN wiring in accordance with local requirements, the National Electrical Code and Division 26 of project specifications.

6. Installation minimum requirements:

a) Mechanical and service areas plus any areas without finished ceilings: All wiring including cables in EMT.

b) Space sensors and alarms: All wiring and cables in EMT within wall construction.
c) Ceiling returns (accessible or drop ceilings - ducted returns): Approved non-plenum cable.
d) Ceilings (open returns): Approved plenum-rated cable.
e) Ceiling returns (non-accessible): EMT or code compliant equal solid conduit.
f) Inside air handling units: All wiring including cables in EMT or code compliant equal solid conduit.
g) Note that the use of cable is limited to low voltage service less than 24 volt only.
h) In no case shall cables be allowed to lay on ceiling grid.
i) Note that all conduit junctions and terminations shall utilize compression fittings.
j) Installation of all cabling in ceilings and walls shall be run in a professional workmanlike fashion acceptable to Architect/Engineer. Cables to be supported with tie wraps such that droop and sag is within acceptable degrees and shall be securely fastened to fixed members of the building structure at sufficient points to avoid excessive freedom of movement.

7. Grounding:

a) Provide suitable grounding for all digital equipment.
b) Install a separate ground to earth using existing water piping or a copper rod driven into the ground as indicated by the equipment manufacturer. In no situation may the ground be connected to the building neutral conductors, either at the breaker or at the main feeder entrance to the building (no exceptions).

8. Transient protection:

a) All electronic equipment including processors, relays, monitoring devices, temperature sensors, and other non-computerized solid state equipment will be adequately protected against power line transients or RFI interference. All components to meet IEEE/ANSI standards.
b) Equipment that fails to operate properly due to transient or other electrical interference, in the opinion of the Engineer, will be required to be retrofitted with the appropriate protection device(s).
c) Provide an isolation transformer as a separate component, on the 110 VAC power supply to the digital controllers to protect all controllers to manufacturer's requirements.

d) All control wiring that must be routed in EMT shall be separate from any power feed wiring.
e) The sizing type and provision of cable, conduit, cable trays, and trunking shall be the design responsibility of the ECC. If complications arise, however, due to the incorrect selection of cable, cable trays, trunking, and/or conduit by the ECC, the Contractor shall be responsible for all costs incurred in replacing the selected components.
f) Note that any disconnect switches between variable frequency drives and operating motors shall be interlocked such that drive inverter returns to zero position when motor is disconnected. Interlock wiring

between disconnect and VFD by EC. Refer to VFD Specifications Section.

9. General:

a) Any penetration of an air handling unit enclosure for passage of tubing, conduit, or sensing elements shall be sealed with an appropriate grommet and caulked.
b) Contractor to insure that all instruments requiring reset or field adjustment are mounted with the operating heads located on the exterior of air handling units in positions of ready access. In instances of rooftop assemblies, all such devices to be inside unit enclosures with access via manufacturer's access panels.

C. DEMOLITION

1. Existing controls systems to be demolished shall be physically removed complete by the ECC. Reuse of existing conduits and raceways is permitted, if they do not interfere with the work of other trades.

2. The ECC shall install temporary measures as required for phasing and temporary operating conditions. The ECC shall examine the complete document set and verify phasing with other subcontractors prior to submitting a bid. These measures may include temporary wiring to maintain floor level networks.

a) Any pneumatic lines cut during demolition must be checked and refed as required to keep the existing equipment in operation.
b) Any pneumatic lines removed must be plugged and capped immediately to avoid excessive compressor run time.

D. FIELD QUALITY CONTROL

1. 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.

2. Perform the following field tests and inspections and prepare test reports:

a) Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
b) Test and adjust controls and safeties.
c) Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
e) Pressure test high-pressure control air piping at 150 psig and low-pressure control air piping at 30 psig for 2 hours, with maximum 1-psig loss.
f) Test calibration of pneumatic and electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.

g) Test each point through its full operating range to verify that safety and operating control set points are as required.
h) Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
i) Test each system for compliance with sequence of operation.
j) Test software and hardware interlocks.

3. DDC Verification:

a) Verify that instruments are installed before calibration, testing, and loop or leak checks.
b) Check instruments for proper location and accessibility.
c) Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
d) Check instrument tubing for proper fittings, slope, material, and support.
e) Check installation of air supply for each instrument.
f) Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
g) Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
h) Check temperature instruments and material and length of sensing elements.
i) Check control valves. Verify that they are in correct direction.
j) Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
k) Check DDC system as follows:

l) Verify that DDC controller power supply is from emergency power supply, if applicable.
m) Verify that wires at control panels are tagged with their service designation and approved tagging system.
n) Verify that spare I/O capacity has been provided.
o) Verify that DDC controllers are protected from power supply surges.
p) Verify all supervisory and application controllers are operating on the latest version of software/firmware. If newer versions of software and/or firmware are released during the project's duration, the ECC shall upgrade/update those controllers to the newer version at no additional cost to the Owner. The ECC shall submit a spreadsheet as part of the project closeout documents listing the software version of each controller.

4. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

E. ADJUSTING

1. Calibrating and Adjusting:

2. Calibrate instruments.

3. Make three-point calibration test for both linearity and accuracy for each analog instrument.
4. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
5. Control System Inputs and Outputs:

    a) Check analog inputs at 0, 50, and 100 percent of span.
    b) Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
    c) Check digital inputs using jumper wire.
    d) Check digital outputs using ohmmeter to test for contact making or breaking.
    e) Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

6. Flow:

    a) Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
    b) Manually operate flow switches to verify that they make or break contact.

7. Pressure:

    a) Calibrate pressure transmitters at 0, 50, and 100 percent of span.
    b) Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

8. Temperature:

    a) Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
    b) Calibrate temperature switches to make or break contacts.

9. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
10. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
11. Provide diagnostic and test instruments for calibration and adjustment of system.
12. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

13. Adjust initial temperature and humidity set points.

14. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

F. DEMONSTRATION

1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Section 017900 "Demonstration and Training."

2. When the project encompasses a formal commissioning process, this Environmental Control Contractor shall furnish, as a requirement of the contract, the services of an approved Engineer/Technician who will demonstrate the complete operation of the Environmental Control Installation including all hardware and software in the presence of the Commissioning Agent.

a) The services of a qualified representative of the Control Contractor shall be provided to demonstrate the installation, startup of system and instruct the Owner's maintenance personnel in the care and proper operation of the system. This shall require the Contractor to demonstrate the installed accuracy of all controlled variables as herein detailed, i.e.,

b) All temperature, pressure, humidity and flow sensors, controllers, alarms, relays, and safety devices.
c) All actuators functioning with control loops. All actuators to be demonstrated for complete travel from full open to full closure; all actuators to have 200% power for intended functionality.
d) All hardware and software of all DDC controllers and BAS control loops.
e) Current sensors to be field calibrated to insure alarm status on loss of electrical power or loss of drive sheaves or belts.
f) Other control features installed as part of the contract and as requested by Design Engineer.
g) Provide an override report indicating that all controls are fully automatic.
h) The installation and Service Contractor shall provide the Owner with 40 hours of instruction and training. This shall be done as follows:

(1) Job completion – 24 hours.
(2) 30 days later – 4 hours.
(3) 3 months later – 4 hours.
(4) The remaining 8 hours as requested by Owner.

H. WARRANTY

1. At completion of final test of installation and acceptance by Owner, provide any service incidental to proper performance for a period of 24 months beginning with the project's last, final Certificate of Substantial Completion which has been signed by the Owner. This final Certificate of Substantial Completion utilized for the start of the warranty period shall not contain an attached list of punch list items which includes any items for the Environmental Control System.
2. Warrant equipment for 24 months for defects in workmanship and material under normal use and service. During warranty period, replace or repair, free of charge, equipment proven to be defective in workmanship or material.

3. Certain electronic devices not manufactured by the Environmental Control Supplier, such as computers, printers, and CRTs display, shall carry the same warranty as above. Pass any registration and warranty documents and warranty rights to the Owner.
4. All valve and damper actuators to carry a warranty of 60 months after project acceptance. Warranty to cover both labor and material without exception.
5. Control Supplier/Engineering Contractor to provide written documentation of availability of repair parts for all material installed under this contract for a period of 60 months after project acceptance. In the event a component is obsolete, it shall be replaced with the new generation at no cost to the Owner.

## I. SERVICE CONTRACT

1. In addition to the contractually required Quality Checks, Adjustments and Demonstrations and Warranty, this Contractor shall include a full service maintenance contract for a period of 18 months from the Date of Substantial Completion.

2. This Contract shall include, but not be limited to:
   a) Monthly tests of entire Environmental Control System with reprogramming of DDC controllers as required to achieve maximum efficiency and comfort
   c) All safety thermostats, switches, and devices to be exercised on a monthly basis.

3. At the conclusion of this 18-month service contract, the Owner shall be given a proposal to continue the service on an annual basis. Contractor to spend no less than 8 hours on the job site for each monthly system test.
4. A written report shall be submitted to the Architect/Engineer Project Engineer detailing condition and operation of Environmental Control System after each service visit.

**END OF SECTION**

**SECTION 232213**
**STEAM AND CONDENSATE PIPING**

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 steam and condensate piping and specialties for systems up to 100 psig (688 kPa), inside the building.

1.3 DEFINITIONS

A. MP Systems: Medium pressure systems operating at 16 psig up to 100 psig.

B. LP Systems: Low-pressure systems operating at or less than 15 psig.

1.4 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures:

1. MP Steam Piping: 150 psig (365 deg F saturated steam).
2. LP Steam Piping: 125 psig (353 deg F saturated steam).
3. Condensate Piping: 125 psig at 250 deg F.
4. Steam Vent Piping: 125 psig at 250 deg. F.
5. Makeup Water Piping: 125 psig at 225 deg F.
6. Blowdown Drain Piping: Equal to pressure of the piping system to which it is attached.
7. Air Vent and Vacuum Breaker Piping: Equal to pressure of the piping system to which it is attached.
8. Safety Valve Inlet and Outlet Piping: Equal to pressure of the piping system to which it is attached.

1.5 SUBMITTALS

A. Product Data:

1. For each type of pressure reducing valve, safety relief valve and other special-duty valve and steam trap indicated, including rated capacities and accessories. Identify safety relief valves which are “UV” labeled and utilized on hydronic components.

2. For each type of piping system including pipe type, grade and schedule, fitting types, flexible connectors, gaskets, nuts and bolts.

3. Strainers, flash tanks, air vents, and vacuum breakers for steam coils and heat exchangers.
4. Identify MPR drip leg traps. Identify LPR drip leg traps.

B. Shop Drawings: Detail flash tank assemblies and fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, and expansion joints and loops and their attachment to the building structure. Include dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

C. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

D. Maintenance Data: For pressure reducing valves, safety valve, other special duty valves, steam traps, vacuum breakers, and meters to include in maintenance manuals specified in Division 1.

## 1.6 QUALITY ASSURANCE

A. Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 unless denoted to be non-stamped.

## 1.7 COORDINATION

A. Coordinate layout and installation of steam and condensate piping and suspension system components with other construction, including light fixtures, hydronic piping, fire-suppression-system components, and partition assemblies.

B. Coordinate closely all gravity condensate lines that cannot lift condensate (due to control valve modulation) such that these pipes are installed in the ceiling space prior to all other piping, ductwork, conduit, ceilings, or other components.

C. Coordinate pipe sleeve installation for foundation wall penetrations.

D. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations.

E. Coordinate pipe fitting pressure classes with products specified in related Sections.

F. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

G. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 7 Section "Firestopping" for fire and smoke wall and floor assemblies.

## 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. Supply one end of main steam trap assembly with shutoff valves, strainer, piping and pipe fittings and insulation required to install steam trap assembly.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

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

1. Safety Valves:

a. Armstrong International, Inc.
b. Kunkle Valve; a Tyco International Co.
c. Spirax Sarco, Inc.
d. Watts Industries, Inc.; Watts Regulators.

2. Pressure-Reducing Valves:

a. Armstrong International, Inc.
b. Fisher.
c. ITT Hoffman; ITT Fluid Technology Corp.
d. Leslie Controls, Inc.
e. Spence Engineering Company, Inc.
f. Spirax Sarco, Inc.
g. Watson McDaniel.

3. Steam Traps:

a. Armstrong International, Inc.
b. Best-O-Bell.
c. Fisher.
d. ITT Hoffman; ITT Fluid Technology Corp.
e. MEPCO.
f. Mueller.
g. Spirax Sarco, Inc.
h. Sterling, Inc.
i. Watson McDaniel.

4. Air Vents and Vacuum Breakers:

a. Armstrong International, Inc.
b. ITT Hoffman; ITT Fluid Technology Corp.

c. Johnson Corp. (The).
d. Spirax Sarco, Inc.
e. Watson McDaniel.

## 2.2 PIPING MATERIALS

A. General: Refer to Part 3 piping application articles for applications of pipe and fitting materials.

## 2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe, NPS 2 (DN 50) and Smaller: ASTM A 53/A 53M or ASTM A106, Type S (seamless) Grade B, Schedules 40 and 80, black steel, plain ends.

B. Steel Pipe, NPS 2-1/2 through NPS 10 (DN 65 through DN 250): ASTM A 53/A 53M or ASTM A106, Type E (electric-resistance welded), Grade B, Schedules 40 and 80, black steel, plain ends.

C. Steel Pipe, NPS 12 through NPS 20 (DN 300 through DN 500): ASTM A 53 or ASTM A106, Type E (electric-resistance welded), Grade B, standard weight, black steel, plain ends.

1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53, Schedules 40 and 80, black steel; seamless for NPS 2 (DN 50) and smaller and electric-resistance welded for NPS 2-1/2 (DN 65) and larger.

D. Cast Iron Threaded Fittings: ASME B16.4; Classes 125 and 300.

E. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300; female pattern; ground joint brass-to-iron seat.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding. Weld neck flanges.
3. Facings: Raised face.
4. Bolt holes: Spot faced.
5. Wall thickness: Same as pipe in which installed.

H. Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig (1035-kPa) minimum working pressure and 250 deg F (121 deg C) maximum operating temperature. Connectors shall have flanged or threaded-end connections to match equipment connected and shall be capable of 3/4-inch (20-mm) misalignment.

I. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

J. Gasket Material:

1. ASME B16.20, spiral wound gasket with stainless steel metal winding strip flat, asbestos-free graphite filler, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated. Suitable for pressure class of service and a minimum operating temperature of 400 deg. F. Similar to Flexitallic Style CG.
2. Do not apply compounds, adhesives, or anti-stick lubricants to gaskets surface.

K. Flange Bolts and Nuts:

1. ASME B18.2.1, carbon steel, unless otherwise indicated.
2. Medium pressure steam systems shall utilize the following at all locations where the operating pressure is greater than 30 psig:

   a. Use alloy steel heavy hex bolts per ASTM A193, Grade B7 with alloy steel heavy hex nuts per ASTM A194, Grade 4 or 7.
   b. Bolts shall be marked B7.

## 2.4 VALVES

A. Gate, globe, and check valves are specified in Division 23 Section "General Duty Valves for HVAC Piping."

## 2.5 SAFETY VALVES

A. Size and Capacity: As required for equipment according to the ASME Boiler and Pressure Vessel Code.

B. Cast-Iron Safety Valves (1-1/2" NPT inlet and larger): Class 250; forged copper-alloy disc with bronze nozzle; fully enclosed, cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed; raised-face flanged inlet and threaded outlet connections; factory set and sealed.

C. Bronze Safety Valves (1-1/4" NPT inlet and smaller): Class 250, bronze trim and nozzle, fully enclosed, stainless steel spring with adjustable pressure range and positive shutoff, factory set and sealed, open lever assembly, threaded inlet and outlet connections.

D. Drip Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.

E. Stop-Check Valves: Class 250, malleable-iron body and bonnet, cylindrical disc, removable liner and machined seat, brass-alloy stem, outside screw and yoke, polytetrafluoroethylene-impregnated packing with 2-piece packing gland assembly, flanged end connections, and cast-iron handwheel.

## 2.6 PRESSURE-REDUCING VALVES

A. Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated.

B. Valve Characteristics: Pilot-actuated, diaphragm type, with adjustable pressure range and positive shutoff. Valves shall have cast-iron body with threaded connections for valves NPS 1-1/2 and smaller and flanged connections for valves

NPS 2 and larger; and hardened stainless-steel trim, replaceable head and seat, main head stem guide fitted with flushing and pressure-arresting device, cover over pilot diaphragm, and non-asbestos gaskets, 125 psig minimum working steam pressure, regulation accuracy from required capacity down to 5% of rated maximum capacity. Provide minimum scheduled valve body sizes with reduced ports as required.

C. Delivery Pressure Control Accuracy: Delivery pressures greater than 30 psig = ±1 psig. Delivery pressures less than or equal to 30 psig = ±0. 5 psig.

D. Acoustic Mufflers and Orifice Plates: Manufacturer's standard construction to meet specified acoustic performance.

E. Insulating Blanket:

1. Custom fit thermal/acoustic insulating jacket by PRV manufacturer or secondary supplier such as Insultech (Shannon Enterprises)
2. Inner and outer PTFE impregnated fiberglass cloth jackets over needled fiberglass mat.
3. 2" thick insulation.
4. Sewn seams with velcro fasteners.
5. Blankets shall be removable, reusable, and rated to 450°F.

## 2.7 STEAM TRAPS

A. Float and Thermostatic Traps: ASTM A 126, Class 30 cast-iron body and bolted cap; renewable, replaceable, stainless-steel float mechanism with renewable, hardened stainless-steel head and seat; maximum operating pressure of 125 psig (860 kPa); balanced-pressure, stainless-steel or monel thermostatic bellow element.

1. Thermostatic air vent capable of withstanding 45 deg F (25 deg C) of superheat and resisting water hammer without sustaining damage.

B. Inverted Bucket Traps: ASTM A-278 Class 30 cast-iron body and cap, pressure rated for 250 psig (1725 kPa); stainless-steel head and seat; stainless-steel valve retainer, lever, and guide pin assembly; and brass or stainless-steel bucket.

1. Air Vent: Stainless-steel thermostatic vent.

## 2.8 VACUUM BREAKERS

A. Vacuum Breakers: 150-psig (1035-kPa) steam working pressure, 365 deg F (185 deg C) maximum operating temperature, brass or stainless-steel body, and stainless-steel retainer, spring, and ball; with plain or threaded outlet.

## 2.9 THERMOSTATIC AIR VENTS

A. Thermostatic Air Vents: 125 psig steam working pressure, stainless steel body, threaded ends, stainless steel float, valve, and seat.

## 2.10 STRAINERS

A. Y-Pattern Strainers:

1. Threaded Connections: 250-psig (1725-kPa) working steam pressure; ASTM A 126, Class B cast-iron body; stainless-steel screen, No. 30 mesh (1/50" openings) for NPS 2 (DN 50) and smaller; tapped blowoff plug. Threaded connections for strainers NPS 2 (DN 50) and smaller.
2. Flanged Connections: 125-psig (860-kPa) working steam pressure; ASTM A126, Class B cast iron body, stainless steel screen, 3/64" perforations, tapped blowoff plug, bolted cover flange with tapered seats.
3. Utilize stainless steel strainer body construction where noted on drawings.

B. Basket Strainers: 250-psig (1725-kPa) working steam pressure; ASTM A 126, Class B cast-iron body; stainless-steel screen bolted cover; threaded connections for strainers NPS 2 (DN 50) and smaller and flanged connections for strainers NPS 2-1/2 (DN 65) and larger.

## 2.11 FLASH TANKS

A. Shop or factory fabricated of welded steel according to the ASME Boiler and Pressure Vessel Code, for 150-psig (1035-kPa) rating. Fabricate with tappings for vents, low-pressure steam and condensate outlets, high-pressure condensate inlet, air vent, safety valve, and legs. Flash tanks vented to atmosphere shall not bear the ASME "UV" label. Flash tanks not vented to atmosphere without any intervening valves shall bear the ASME "UV" label.

# PART 3 - EXECUTION

## 3.1 LP STEAM PIPING APPLICATIONS

A. Steam Piping and Steam Vent Piping, NPS 2 (DN 50) and Smaller: Schedule 40 steel pipe, with threaded joints using Class 125 cast iron fittings.

B. Steam Piping and Steam Vent Piping, NPS 2-1/2 through NPS 10 (DN 65 through DN 250): Schedule 40 steel pipe, with welded joints using Schedule 40 wrought-steel welding fittings and Class 150 wrought-steel flanges.

C. Steam piping for atmospheric steam between the humidifier evaporator and the humidifier dispersion grid shall be Schedule 10 stainless steel or brazed copper as noted on the Drawings.

D. Steam Piping, NPS 12 through NPS 20 (DN 300 through DN 500): Standard weight steel pipe, with welded joints using standard weight wrought-steel welding fittings and Class 150 wrought-steel flanges.

E. Condensate Piping, NPS 2 (DN 50) and Smaller: Schedule 80 type S (seamless) steel pipe, with threaded joints using Class 125 cast iron fittings.

F. Condensate Piping, NPS 2-1/2 through NPS 12 (DN 65 through DN 300): Schedule 80 steel pipe, with welded joints using Schedule 80 wrought-steel welding fittings and Class 150 wrought-steel flanges.

G. Boiler Blowdown, Chemical Feed, Steam System Sampling Piping, and Boiler Feedwater Piping: Schedule 80 steel pipe.

H. Air Vent Piping:

1. Inlet: Same as service where installed.
2. Outlet: Type K (A) annealed-temper copper tubing with brazed joints.

I. Vacuum Breaker Piping: Inlet and outlet, same as service where installed.

J. Safety Valve Inlet and Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

## 3.2 MP STEAM PIPING APPLICATIONS

A. Steam Piping and Steam Vent Piping, NPS 2 (DN 50) and Smaller: Schedule 40 steel pipe, with threaded joints using Class 300 malleable-iron fittings.

B. Steam Piping and Steam Vent Piping, NPS 2-1/2 through NPS 10 (DN 65 through DN 250): Schedule 40 steel pipe, with welded joints using Schedule 40 wrought-steel welding fittings and Class 150 wrought-steel flanges.

C. Steam Piping, NPS 12 through NPS 20 (DN 300 through DN 500): Standard weight steel pipe, with welded joints using standard weight wrought-steel welding fittings and Class 150 wrought-steel flanges.

D. Condensate Piping, NPS 2 (DN 50) and Smaller: Schedule 80 Type S (seamless) steel pipe, with threaded joints using Class 150 malleable-iron fittings.

E. Condensate Piping, NPS 2-1/2 through NPS 12 (DN 65 through DN 300): Schedule 80 steel pipe, with welded joints using Schedule 80 wrought-steel welding fittings and Class 150 wrought-steel flanges.

F. Safety Valve Inlet and Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

## 3.3 VALVE APPLICATIONS

A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:

1. Shutoff Duty: Gate valves.
2. Throttling Duty: Globe valves.

B. Install shutoff-duty valves at each branch connection to supply and return mains, at inlet connection to each steam trap, and elsewhere as indicated.

C. Valves shall be installed with the valve stem at or above the center of the pipe. All valves shall be installed to be easily accessible.

D. Provide chain wheel operators on all valves in Equipment Rooms over 4” size which are installed at a height of 84” or higher above finished floor.

## 3.4 LP STEAM-TRAP APPLICATIONS

A. Float and Thermostatic Traps: Steam main and riser drip legs, laundry equipment, kitchen equipment, heat exchangers, and heating coils. Size for a minimum three times the load at one psig pressure differential.

## 3.5 MP STEAM-TRAP APPLICATIONS

A. Inverted Bucket Traps: Steam main drip legs, end of main drip legs, riser drip legs, and laundry equipment. Size for a minimum four times the load at 5 psig pressure differential.

B. Float and Thermostatic Traps: Kitchen equipment, heat exchangers, heat tracer lines, and heating coils. Size for minimum three times the load at one psig pressure differential.

## 3.6 PIPING INSTALLATIONS

A. Refer to Division 23 Section "Common Work Results for HVAC" for basic piping installation requirements.

B. Drawing plans, schematics and diagrams indicate general location and arrangement of piping systems. Use indicated piping locations and arrangements if such were used to size pipe and calculated friction loss, expansion and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

D. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) ball valve, and short NPS 3/4 (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

E. Install steam supply piping at a uniform grade of 1” in 40’-0” downward in direction of steam flow.

F. Install condensate return piping at a uniform grade of 2” in 40’-0” downward in direction of condensate flow.

G. Reduce pipe sizes using eccentric reducer fitting installed with level side down.

H. Unless otherwise indicated, install branch connections to steam mains using 45-degree fittings in main pipe, with the takeoff coming out the top of the main pipe. Use of 90-degree tee fittings is permissible if 45-degree fittings are impractical. If length of branch takeoff is less than 10 feet (3 m), pitch branch line down toward mains at a 0.4 percent grade.

I. Install unions in piping NPS 2 (DN 50) and smaller adjacent to each valve, at final connections of each piece of equipment, and elsewhere as indicated.

J. Install flanges in piping NPS 2-1/2 (DN 65) and larger at final connections of each piece of equipment and elsewhere as indicated.

K. Install strainers on supply side of each control valve, pressure-reducing valve, solenoid valve, traps, and elsewhere as indicated. Install NPS 3/4 (DN 20) nipple and gate valve in blowdown connection of strainers NPS 2 (DN 50) and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2 (DN 50). Extend valve blow-off to nearest equipment drain. Lay strainers upstream of control valves and pressure reducing valves on their side to minimize accumulation of condensate.

L. Install unions adjacent to each threaded valve, at the final threaded connection to each piece of equipment, in equipment connections as required to perform major maintenance or removal and where shown on the Drawings. Insulating (dielectric) fittings shall be used wherever two dissimilar metals are joined.

M. Anchor piping for proper direction of expansion and contraction. Provide expansion loops as shown on the Drawings.

N. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, control valves, isolation valves, pipe bends, and expansion joints.

1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 300 feet (90 m) where pipe is pitched down in direction of steam flow and a maximum of 150 feet (45 m) where pipe is pitched up in direction of steam flow.
2. Size drip legs at vertical risers same size as pipe and extend beyond rise. Size drip legs at other locations same diameter as main. In steam mains NPS 6 (DN 150) and larger, dirt leg size can be reduced, but to no less than NPS 4 (DN 100).
3. Install gate valve at drip legs, dirt pockets, and strainer blowdowns to allow removal of dirt and scale.
4. Install steam traps close to drip legs.

O. Install flexible connectors for inlet and discharge connections to pumps and other vibration producing equipment.

P. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

Q. Install piping to permit valve servicing.

R. Install piping free of sags and bends.

S. Install fittings for changes in direction and branch connections.

T. Install piping to allow application of insulation.

U. Install expansion loops, expansion joints, anchors, and pipe alignment guides.

V. Identify piping as specified in Division 23 “Identification for HVAC Piping and Equipment.”

## 3.7 STEAM-TRAP INSTALLATION

A. Install steam traps in accessible locations as close as possible to connected equipment, but not more than 48 inches (1200 mm) from connected equipment.

1. Unless otherwise indicated, install gate valve, strainer, and union upstream from trap; install union, check valve, and gate valve downstream from trap.

B. Install trap assemblies in all piping runs as required to eliminate build-up of condensate.

C. Install extra steam trap assembly at low point of steam piping as required to remove condensate from low points of piping. Provide extra steam trap assemblies at all low points created by the installing contractor's piping arrangement.

## 3.8 PRESSURE-REDUCING VALVE INSTALLATION

A. Install pressure-reducing valves in readily accessible location for maintenance and inspection.

B. Install bypass piping around each pressure-reducing valve, with globe valve equal in size to area of largest pressure-reducing valve seat ring, unless otherwise indicated.

C. Install gate valves on the inlet and outlet of each pressure-reducing valve.

D. Install unions on the inlet and outlet of each pressure-reducing valve having threaded-end connections.

E. Install pressure gages on low-pressure side of each pressure-reducing valve and ahead of shutoff valve. Install pressure gages downstream from globe valve on pressure-reducing valve bypass.

1. On two-stage pressure-reducing stations, install drip trap and pressure gage upstream from second stage pressure-reducing valve.

F. Install strainers upstream for each pressure-reducing valve.

G. Install safety valves downstream from each pressure-reducing valve station.

H. Set-up for Multiple Parallel PRVs:

1. Obtain manufacturer's written recommendations for setpoints on PRVs such that the smaller sized PRV controls low flows.
2. Submit manufacturer's setpoint recommendation and setup procedure to Architect/Engineer.

I. Install safety valves on pressure reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

J. Install insulating blanket after all adjustments are complete.

## 3.9 STEAM METER INSTALLATION

A. Install lengths of straight pipe upstream and downstream from meters according to steam meter manufacturer's instructions. Confirm requirements with manufacturer's written installation instructions prior to installing any steam piping.

## 3.10 SAFETY VALVE INSTALLATIONS

A. Install safety valves according to ASME B31.1. Pipe safety valve discharge without any intervening valves to atmosphere outside building. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.

## 3.11 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for all sizes of individual horizontal branch piping less than 20 feet (6 m) long.
2. Adjustable steel clevis hangers for condensate piping up to 3” NPS for individual horizontal branch piping less than 60 feet long.
3. Adjustable roller hangers for individual horizontal piping 20 feet (6 m) or longer.
4. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, regardless of size, supported on a trapeze.
5. Spring hangers to support vertical runs.

D. Install hangers with the following maximum spacing and minimum rod sizes:

1. NPS 3/4 (DN 20) – NPS 1 (DN 25): Maximum span, 9 feet (2.7 m); minimum rod size, 1/4 inch (6.4 mm).
2. NPS 1-1/2 – NPS 3 (DN 80) (DN 40): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (10 mm).
3. NPS 4 (DN 100) NPS 6 (DN 150): Maximum span, 10 feet (3 m); minimum rod size, 1/2 inch (13 mm).
4. NPS 8 (DN 200): Maximum span, 10 feet (3 m); minimum rod size, 5/8 inch (16 mm).
5. NPS 10 (DN 250): Maximum span, 10 feet (3 m); minimum rod size, 3/4 inch (19 mm).
6. NPS 12 (DN 300): Maximum span, 10 feet (3 m); minimum rod size, 7/8 inch (22 mm).
7. NPS 14 (DN 350) NPS 16 (DN 400): Maximum span, 10 feet (3 m); minimum rod size, 1 inch (25 mm)
8. NPS 18 (DN 450) NPS 20 (DN 500): Maximum span, 10 feet (3 m); minimum rod size, 1-1/4 inches (32 mm).

E. Support vertical runs at roof and at each floor and at 10 foot intervals between floors.

## 3.12 PIPE JOINT CONSTRUCTION

A. Refer to Division 23 Section "Common Work Results for HVAC" for joint construction requirements for threaded, welded, and flanged joints.

## 3.13 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be same as for equipment connections.

B. Install traps and control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If multiple, parallel control valves are installed, only one bypass is required.

D. Install vacuum breaker downstream from control valve and bypass and close to coil inlet connection. Install thermostatic air vent adjacent to vacuum breaker to let the air back out.

E. Install ports for pressure and temperature gages at coil inlet connections.

F. Install a drip leg at coil outlet.

G. Install shutoff gate valve at each piping connection to the equipment.

## 3.14 FIELD QUALITY CONTROL

A. Prepare steam and condensate piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Flush system with clean water. Clean strainers.
3. 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.
4. 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 steam and condensate piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release trapped air. Use drip legs installed at low points for complete draining of liquid.
3. Flush steam and condensate piping with clean water. Remove and clean or replace strainer screens.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure. Design pressure shall be 100 psig for LP systems and 125 psig for MP systems. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

## 3.15 ADJUSTING AND CHECKOUT

A. Mark calibrated nameplates of condensate pump discharge valves after steam and condensate system balancing has been completed, to permanently indicate final balanced position.

B. Perform these tests and adjustments before operating the system in an unsupervised mode:

1. Open valves to fully open position. Close coil bypass valves.
2. Set temperature controls so all coils are calling for full flow.
3. Check operation of automatic bypass valves.
4. Verify pressure settings of pressure reducing stations during operation.
5. Verify safety relief valve discharge and reseating.
6. Confirm vacuum breakers and thermostatic air vents are operational.
7. Operate the system for a minimum of four hours with maximum flow rates, then shutdown and remove and clean and replace all strainers.
8. Confirm that all ASME data sheets are provided to the Owner's Maintenance Staff.

## 3.16 CLEANING

A. Flush steam and condensate piping with clean water. Remove and clean or replace strainer screens.

**END OF SECTION**

**SECTION 232923**
**VARIABLE FREQUENCY CONTROLLERS**

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 solid-state, PWM, VFC's for speed control of three-phase, squirrel-cage induction motors.

B. Related Sections include the following:

1. Division 26 Section "Transient Voltage Suppression" for low-voltage power, control, and communication surge suppressors.

1.3 DEFINITIONS

A. BMS: Building management system.

B. IGBT: Integrated gate bipolar transistor.

C. LAN: Local area network.

D. PID: Control action, proportional plus integral plus derivative.

E. PWM: Pulse-width modulated.

F. VFC: Variable frequency controller.

1.4 SUBMITTALS

A. Product Data: For each type of VFC. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.

B. Shop Drawings: For each VFC.

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. Fully rated, short-circuit current rating of integrated unit.

2. Wiring Diagrams: Power, signal, and control wiring for VFC's. Provide schematic wiring diagram for each type of VFC.
3. Manufacturer's complete parameter list including default settings on the VFC.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFC's where pipe and ducts are prohibited. Show VFC 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. Field quality-control test reports.

E. Operation and Maintenance Data: For VFC's, all installed devices, 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 VFC's and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

F. Load-Current and List of Settings of Adjustable Overload Relays: Solid state, adjustable, Class 20, compile after motors have been installed and arrange to demonstrate that settings for motor running overload protection suit actual motor to be protected.

G. Compliance to IEEE 519 – Harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).

1. The VFC manufacturer shall provide calculations, specific to this installation, showing total harmonic voltage distortion is less than 5% at the point of common coupling. Input line filters shall be sized and provided as required by the VFC manufacturer to ensure compliance with IEEE Standard 519.

## 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, startup, all warranty work, and emergency maintenance and repairs. Emergency maintenance and repair shall be available from this service center such that a service technician will be on the project site within 24 hours after the service center has been contacted.

B. Source Limitations: Obtain VFC's of a single type 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.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Store VFC's indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFC's from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover VFC's to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

## 1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:

1. Ambient Temperature: 0 to 40 deg C.
2. Humidity: Less than 90 percent (non-condensing).
3. Altitude: Not exceeding 3300 feet (1005 m).

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFC's, including clearances between VFC's, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

## 1.8 COORDINATION

A. Coordinate layout and installation of VFC's with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate features of VFC's, installed units, and accessory devices with pilot devices and control circuits to which they connect.

C. Coordinate features, accessories, and functions of each VFC and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

## 1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of variable frequency controllers and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty period: 36 months from the date of certified start-up.
2. The warranty shall include all parts, labor, travel time, and expenses, including readjustments and startup necessary for acceptable controls system functionality.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

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

1. ABB Power Distribution (Design reference: Model ACH550 with E-Clipse bypass, circuit breaker disconnect, and VFD service switch.).
2. Eaton (Design reference: HVX 9000 Series with input line fuses, manual HOA bypass controller, dynamic braking).
3. Toshiba (Design reference: Q9 series).

### 2.2 VARIABLE FREQUENCY CONTROLLERS

A. Description: NEMA ICS 2, IGBT, PWM, VFC; UL listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.

B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

C. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

D. Unit Operating Requirements:

1. Input ac voltage tolerance of plus or minus 10 percent.
2. Input frequency tolerance of 50/60 Hz, plus or minus 5 percent.
3. Minimum Efficiency: 96 percent at 60 Hz, full load.
4. Minimum Displacement Primary-Side Power Factor: 96 percent.
5. Overload Capability: 1.1 times the base load current for 60 seconds; 1.3 times the base load current for 3 seconds.
6. Starting Torque: 100 percent of rated torque or as indicated.
7. Speed Regulation: Plus or minus 1 percent.
8. Power loss ride through of 2 seconds.
9. The drive shall include password protection against parameter changes.
10. The minimum full load current rating shall meet or exceed the value in the N.E.C. Table 430-150 for 4-pole motors.

E. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.

1. Electrical Signal: 4 to 20 mA at 24 V.

F. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to a minimum of 999 seconds.
4. Deceleration: 0.1 to a minimum of 999 seconds.
5. Current Limit: 50 to a minimum of 110 percent of maximum rating.

G. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors. Surge suppression shall consist of 4-120 Joule rated MOV (phase to phase and phase to ground) and capacitor clamping. Include snubber network to protect against malfunction.
2. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
3. Motor Overload Relay: Solid state, adjustable and capable of NEMA ICS 2, Class 20 performance.
4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination. Include minimum of three (3) settings.
5. Instantaneous line-to-line and line-to-ground overcurrent trips.
6. Loss-of-phase protection.
7. Reverse-phase protection.
8. Short-circuit protection.
9. Motor overtemperature fault.
10. Drive overtemperature/overload.
11. Ground fault.
12. CPU error.

H. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

I. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

J. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

K. Input Line Conditioning: 5% input line reactor to reduce the total harmonic distortion to the power line voltage and to add protection from AC line transient per IEEE 519.

L. Output Line Conditioning: Provide output line filter for all installations where the cable length distance between the VFC and the motor exceeds 75 feet.

M. LCD display with key pad (HMI): Back lit LCD display; time clock with battery backup, selector switch, mounted flush in controller door and connected to indicate and control of the following controller parameters:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (VDC).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

11. Power on, operating condition.
12. Automatic/manual selection.
13. Run or operating hours.
14. Control location (local/remote/hand/auto).
15. Manual speed control in local mode.
16. Running log of total power versus time.
17. Total run time.
18. Fault log, maintaining last four faults with time and date stamp for each.

N. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following input signals from the BMS or other control systems:

    a. Speed signal: 0 to 10-V dc.
    b. Remote start.
    c. Digital programmable input – minimum of 6.
    d. Fixed frequencies using digital inputs.
    e. RS485.
    f. Keypad display for local hand operation.
    g. Analog programmable input – minimum of 2.
3. Run permissive circuit to accept a system ready signal to ensure VFC does not start until auxiliary equipment is in the proper state.
4. Run permissive output signal suitable for use as a start command to auxiliary equipment where the auxiliary equipment must be started prior to allowing the VFC to start.
5. Output Signal Interface:

    a. A minimum of 1 analog output signal (4-20 mA), which can be programmed to any of the following:

        1) Output frequency (Hz).
        2) Output current (load).
        3) DC-link voltage (VDC).
        4) Motor torque (percent).
        5) Motor speed (rpm).
        6) Set-point frequency (Hz).

6. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

    a. Motor running.
    b. Power on.
    c. Fault and warning indication (overtemperature or overcurrent).
    d. Terminate each dry contact at a terminal strip for use by Building Controls.

O. Communications:

1. Communication capabilities shall include, but not be limited to, run-stop control, and speed set adjustment.

P. EMI/RFI Filters:

1. All VFC's shall include EMI/RFI filters. The onboard filters shall allow the VFC assembly to be CE marked and the VFC shall meet product standard EN 61800-3 for the First Environment restricted level.

Q. Manual Bypass: Arrange magnetic contactor to safely transfer motor between controller output and bypass controller circuit when motor is at zero speed. Unit shall be capable of stable operation (starting, stopping, and running), with motor completely disconnected from controller, and allowing the controller to be completely disconnected from the power. Three-contactor bypass scheme or two contactor with fast acting fuse bypass scheme.

1. The drive/bypass shall include the following:

   a. On/off switch.
   b. Local/Automatic switch. Hand (local) operation speed control may be manually varied from manual speed control.
   c. Drive mode/bypass mode selector switches (Inverter/Bypass), and bypass fault reset.
   d. Test mode on/off selector switch.
   e. Indicator (LED) for power-on, bypass mode selector, bypass fault, safety open and automatic transfer to bypass.
   f. Form C relay output(s) for system started, system running bypass, override enabled, bypass fault.
   g. Bypass Controller: Full-voltage, non-reversing controller with across-the-line starting capability in manual-bypass mode. Solid state, Class 20 selectable motor overload protection with phase loss/phase reversal under both modes of operation with control logic that allows common start-stop capability in either mode.
   h. Door interlocked main fused disconnect padlockable in the OFF position.
   i. In Test position the motor is operated at full speed from the AC line power while power is applied to the input of the VFC. This allows the VFC to be given an operational test while continuing to run the motor at full speed in bypass.
   j. Provide for a normally closed dry contact to be able to stop the motor whether in drive mode or bypass mode.
   k. Bypass shall allow user to operate motor with failed electronic control.

R. Integral Disconnecting Means: NEMA KS 1, heavy-duty fusible switch. Service personnel shall be able to defeat the main power disconnect and open the bypass enclosure without disconnecting power while still meeting all local and national code requirements for safety. Safety/services switch shall be provided integral with each VFC.

S. The VFC shall include the following:

1. A "run permissive circuit" that will provide a fail open contact for use by the Building Automation System. Whenever a run command is provided (local or remote start command in VFC or bypass mode) the run permissive circuit is closed. When the VFC system safety interlock (fire detector, freezestat, high static pressure switch, etc.) opens, the motor shall coast to a stop and the run permissive contact shall open, thereby closing the damper or valve.
2. Internal switch to select manual or automatic bypass. Set switch to manual.
3. An adjustable current sensing circuit for the bypass to provide loss of load indication (broken belt) when in the bypass mode.

T. VFC short circuit withstand rating shall be minimum of 65 KAIC.

2.3 ENCLOSURES

A. NEMA 1 or 12, UL listed.

B. Provide an air cooling fan with filter.

2.4 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, LED Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

2.5 FACTORY FINISHES

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFC's for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Select features of each VFC to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

A. Install VFC with tops at uniform height and with disconnect operating handles not higher than 72 inches above finished floor, unless otherwise indicated.

B. Install wall-mounted VFC by bolting units to lightweight structural-steel channels which are bolted to the structural wall of the building.

C. Install VFC not located on walls with floor-mounted freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems." Do not attach channels to air handling unit panels, casings, or any other HVAC component. Do not utilize channels attached to HVAC plenum wall panels. Utilize freestanding floor-mounted racks when VFC are located adjacent to HVAC air handling units and plenum wall panels.

D. Anchor each VFC channel support assembly to floor-mounted or wall-mounted steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with floor-mounting surface.

E. Comply with mounting and anchoring requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems".

## 3.4 IDENTIFICATION

A. Identification is provided by Division 23. Utilize Division 26 Section "Electrical Identification of Electrical System for detailed requirements. Identify VFC's, components, and control wiring.

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFC with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

## 3.5 CONTROL WIRING INSTALLATION

A. Install control wiring between VFC's and remote devices according to Division 26 Section "Low Voltage Electrical Power Conductors and Cables."

B. Install control wiring within EMT.

C. Connect hand-off-automatic switch and other 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 control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.
3. Provide control wiring between VFC and remote safety switch (disconnect).

## 3.6 CONNECTIONS

A. Power conduit installation requirements are specified and provided in Division 26 Sections. Drawings indicate general arrangement of VFC, fittings, and specialties. Line wiring and load wiring shall reside within separate conduits. Verify location and routing of conduit with installing Tradesmen.

B. Grounding of equipment is furnished and provided according to Division 26 "Grounding and Bonding."

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.

## 3.7 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.
3. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Electrical Engineer of Record before starting the motor(s).
4. Test each motor for proper phase rotation.
5. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
6. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

B. Manufacturer's Startup Service: Startup personnel shall not be employees of the installing contractor nor tradesmen temporarily employed by the installing contractor. Startup personnel shall have completed the most current factory training and certifications for the specific model of the VFC being installed. Startup service shall be included in the Project by the VFC manufacturer via the VFC manufacturer's authorized representative. 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. Perform the following field tests, inspections, demonstrations and training, and prepare test reports:

    a. Perform each electrical test and visual and mechanical inspection, as follows. Certify compliance with test parameters.
        1) Compare equipment nameplate data with drawings and specifications.
        2) Inspect physical and mechanical condition.
        3) Inspect anchorage, alignment, and grounding.
        4) Verify the unit is clean.
        5) Ensure vent path openings are free from debris and that heat transfer surfaces are clean.
        6) Verify correct connections of circuit boards, wiring, disconnects and ribbon cables.
        7) Motor running protection:
            a) Verify drive overcurrent setpoints are correct for their application.
            b) If drive is used to operate multiple motors, verify individual overload element ratings are correct for their application.

c) Apply minimum and maximum speed setpoints. Verify setpoints are within limitations of the load coupled to the motor

8) Inspect bolted electrical connections for high resistance using calibrated torque wrench method.

9) Test for the following parameters as recommended by the manufacturer:
   a) Input phase loss protection.
   b) Input overvoltage protection.
   c) Output phase rotation.
   d) Overtemperature protection.
   e) DC overvoltage protection.
   f) Overfrequency protection.
   g) Drive overload protection.
   h) Fault alarm outputs.

10) Perform startup of drive in accordance with manufacturer's published data. Calibrate drive to the system's minimum and maximum speed control signals.

11) Perform operational tests by initiating control devices:
   a) Slowly vary drive speed between minimum and maximum. Observe motor and load for unusual noise or vibration.
   b) Verify operation of drive from remote start/stop and speed control signals.

b. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

4. 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.
5. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
6. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes. Where these maximum settings do not allow starting of a motor, notify Electrical Engineer of Record before increasing settings.
7. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Overcurrent Protective Device Coordination Study."
8. Identify in writing every single input setting that is adjustable (controller settings and physical settings such as knobs and dipswitches). Differentiate settings available by level of controller access.
9. Report all results in writing directly to the Mechanical Engineer of Record within 12 hours of the each measurement being taken. Telephone and fax the written results directly to the Mechanical Engineer of Record.
10. The startup technician shall directly telephone the Mechanical Engineer of Record while on the Project Site to verbally report on any issues.
11. Prepare formal written startup report for submission to Owner during Training.
12. Failure to contact the Engineer of Record as required shall negate any startup work performed. Repeat of negated work shall be included at no additional cost nor schedule delay.
13. Said startup service shall not be less than 4 hours total time on job site for each VFC installed and shall continue until such time as the Engineer of Record determines that the equipment operation and startup is satisfactory.

14. Coordinate startup service closely with the Controls Installation Contractor, Electrical Contractor, Owner's Energy Management personnel, and the responsible coordinating Mechanical Contractor.
15. Test Reports: Prepare a written report to record the following:

    a. Test procedures used.
    b. Test results that comply with requirements.
    c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
    d. Final operational parameter list of all VFD settings.

## 3.8 CLEANING

A. Clean VFC's internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

## 3.9 DEMONSTRATION AND TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

1. Adjust, operate, and maintain variable frequency controllers. Operate driven equipment, including accessories and controls, to demonstrate compliance with requirements.
2. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
3. Review data in the maintenance manuals.
4. Demonstrate to the Owner's maintenance personnel the procedures and settings required to start, stop, troubleshoot, service and maintain the VFC. Review data in maintenance manual. Allow for a six hour training session on-site for all the VFC associated with this project. Specifically review a pump VFC, a fan VFC and each VFC which differ from the typical pump and fan.
5. Provide a written summary programming and settings to the Owner as required for the proper operation of the specific mechanical equipment.
6. Schedule training with Owner with at least 4 days' advance notice. Provide written startup report to Owner with at least 4 day's advance notice.
7. Said demonstration service shall not be less than 4 hours total time on job site and shall continue until such time as the Owner determines that the equipment operation and training is satisfactory.

## 3.10 OCCUPANCY ADJUSTMENTS

A. When requested by the Owner or the Engineer of Record, within 18 months of Substantial Completion, provide on-site assistance adjusting the system to suit actual occupied conditions. Provide up to three visits to the project site for this purpose. Project site visits for occupancy adjustment shall commence within 72 hours of when requested and shall be staffed appropriately such that they are fully completed within 24 hours of arrival on the Project site.

B. The above on-site occupancy adjustment assistance shall be performed by direct factory employees of the VFC manufacturer unless otherwise requested in writing by

the Engineer of Record. The VFC shall be “restarted up” at the end of each of the visits with all new complete written documentation of setpoints and operability provided prior to the technician leaving the project site.

C. The factory technician shall directly telephone the Engineer of Record 24 hours prior to arrival at the Project Site and once every day while on the Project Site to verbally report on the status and issues. Failure to contact the Engineer of Record as required shall negate any startup work performed. Repeat of negated work shall be included at no additional cost nor schedule delay.

**END OF SECTION**

**SECTION 233113**
**METAL DUCTS**

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 metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2- to plus 10-inch wg. Metal ducts include the following:

1. Rectangular ducts and fittings.
2. Single-wall, round and flat-oval spiral-seam ducts and formed fittings.
3. Double-wall, round and flat-oval spiral-seam ducts and formed fittings.
4. Sheet metal materials.
5. Sealants and gaskets.
6. Hangers and supports.
7. Seismic restraint devices.
8. Duct liner.

B. Related Sections include the following:

1. Division 23 Section "Nonmetal Ducts" for fibrous-glass ducts, thermoset FRP ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
2. Division 23 Section "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
3. Division 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
4. Division 23 Section “Testing, Adjusting and Balancing for HVAC” for testing, adjusting and balancing requirements for metal ducts.
5. Division 23 Section “Vibration and Seismic Controls for HVAC Piping and Equipment” for seismic hazard levels.

1.3 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.

B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under

conditions described in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" and SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

1.4 SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic restraint devices.

B. LEED Submittals:

1. Product Data for Prerequisite EQ 1: Documentation indicating that duct systems comply with ASHRAE 62.1-2004, Section 5 – "Systems and Equipment."
2. Product Data for Prerequisite EA 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1-2004, Section 6.4.4 – "HVAC System Construction and Insulation."
3. Leakage Test Report for Prerequisite EA 2: Documentation of work performed for compliance with ASHRAE/IESNA 90.1-2004, Section 6.4.4.2.2 – "Duct Leakage Tests."
4. Duct Cleaning Test Report for Prerequisite EQ 1: Documentation of work performed for compliance with ASHRAE 62.1-2004, Section 7.2.4 – "Ventilation System Startup."

C. Shop Drawings: CAD-generated and drawn at minimum 1/4" = 1'-0" scale. Shop drawings shall include the following:

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 all duct and terminal units along with applicable elevations of structural elements.
4. Dimensions of main duct runs from building grid lines.
5. Fittings, including details of construction and turning vanes.
6. Reinforcement and spacing.
7. Duct gauge thickness by pressure class.
8. Seam and joint construction.
9. Duct material type and coatings.
10. Penetrations through fire-rated barriers and partitions and smoke barriers.
11. Equipment installation based on equipment being utilized on this Project.
12. Duct accessories, including access doors and panels, volume dampers, fire dampers, smoke dampers and flexible connectors.
13. Length of application of acoustic duct liner where it will be applied.
14. Hangers and supports, including methods for duct and building attachment, vibration isolation, and seismic restraints.
15. Ceiling suspension assembly members.
16. Other systems installed in the same space as ducts where order of installation effects access.

17. Ceiling and wall-mounting access doors and panels required to provide access to dampers and other operating devices.
18. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, smoke detectors, sprinklers, access panels, and special moldings.
19. On each drawing, include a tabular listing of each fan system's ductwork represented on that drawing and the total square foot surface area of each fan's duct system illustrated on that drawing.
20. Duct riser elevations/sections which detail duct passing through structure, shaft construction and shaft bottom construction. Illustrate fire damper high hats, duct takeoff, boot taps and other pertinent features.
21. Shop drawings shall be submitted prior to the fabrication or installation of the ductwork and serve as the foundation for coordination between the various trades to maintain required ceiling heights.

D. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

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

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout. Include plumbing, piping, electrical, and other building systems components including, but not limited to, roof drain piping, sanitary piping, plumbing piping, fire protection piping, heating and cooling water piping, condensate drains, steam and condensate return piping, conduit cable tray, electrical pull boxes, etc.
2. Suspended ceiling components (projectors, booms, partitions, etc).
3. Structural members size (depth) and location to which duct will be attached.
4. Size and location of access through acoustical ceiling tile. Denote which tiles are reserved for access to HVAC components above ceiling.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinkler heads.
    e. Access panels/access doors.
    f. Perimeter moldings and bulkheads.
    g. Occupancy/vacancy sensors.
    h. Smoke detectors.
    i. Strobe lights.
    j. Exit signage.
    k. Security cameras.
    l. Wireless access nodes.
    m. Projectors.
    n. Projector screens.
    o. Safety showers.
    p. Casework which penetrates the ceiling.

7. Coordination drawing final submission and sheet metal shop drawing final submission shall occur simultaneously.

F. Leak Testing Documentation: Contractor shall submit a written report to the authorities having jurisdiction which documents that 100% of the ducts designed at static pressures in excess of 3” wg. has been leak tested and that the air leakage class is less than 6.0 (see Energy Code). Provide duplicate submittal to the Owner and the Engineer.

G. Grease duct light test documentation.

H. Mockups: Of architecturally exposed ductwork installations including duct, hangers, connectors and sealant.

## 1.5 QUALITY ASSURANCE

A. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations," Ch. 3, "Duct System," for range hood ducts, unless otherwise indicated.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports, AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports, AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

D. 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.

E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

F. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Store all ductwork and associated ductwork components to prevent damage and to prevent entrance of dirt, debris, and moisture.

B. Support all ductwork and associated ductwork components to prevent sagging or bending.

C. Provide temporary storage, delivery and handling in accordance with the SMACNA Duct Cleanliness Standard level specified herein.

## PART 2 - PRODUCTS

### 2.1 SINGLE WALL RECTANGULAR DUCTS AND FITTINGS

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. Minimum sheet metal gage shall be 24.
4. Utilize radius elbows with centerline radius equal to 1.5 times the width unless specifically shown otherwise on the drawings.
5. Square throat elbows where specifically shown on the drawings shall include turning vanes for all applications (supply, return, exhaust, relief, outdoor air, etc.) except grease hood duct.
6. Utilize SMACNA Figure 4-6, 45 degree entry branch connections with a minimum “L” dimension of six inches or one quarter of “W” whichever is greater.

B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement, or roll formed flange connection system TDC or TDF according to “SMACNA HVAC Duct Construction Standards – Metal and Flexible” maximum 24” long duct section whenever any side exceeds 96 inches.

1. Manufacturers:

   a. Ductmate Industries, Inc.
   b. Nexus Inc.
   c. Ward Industries, Inc.

C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.

1. Manufacturers:

   a. Ductmate Industries, Inc.
   b. Lockformer.

2. Duct Size: Maximum 30 inches wide and up to 2-inch wg pressure class.
3. Longitudinal Seams: Pittsburgh lock sealed with non-curing polymer sealant.

D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of non-braced panel area unless ducts are lined. Cross break or cross bead all pressure class duct even where SMACNA Figure 2-9 says you do not need to.

## 2.2 SINGLE WALL, ROUND AND FLAT-OVAL, SPIRAL-SEAM DUCTS AND FORMED FITTINGS

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, Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC DUCT Construction Standards – Metal and Flexible."

1. Minimum sheet metal gage shall be 24.
2. Mechanically fasten ducts by means of at least three sheet metal screws spaced in approximately uniform intervals along the circumference of the ducts.

C. Flat-Oval, Spiral Lock-Seam Ducts: Fabricate supply ducts according to SMACNA's "HVAC Duct Construction Standards—Metal and Flexible." Fabricate ducts larger than 72 inches in diameter with butt-welded longitudinal seams.

1. Manufacturers:

a. Eastern Sheet Metal.
b. Foremost.
c. JTD Spiral.
d. LaPine.
e. Lindab, Inc.
f. McGill Airflow LLC.
g. SEMCO Incorporated.

D. Duct Joints:

1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling at least two gages heavier than duct wall, 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 which compresses the gasket between the internal flanges.
3. Ducts larger than 72 inches in diameter: Companion angle flanged joints per SMACNA "HVAC Duct Construction Standards—Metal and Flexible," Figure 3-1. Refer to manual for proper sizing and construction details.
4. Round ducts (Optional): Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.

a. Manufacturers:

1) Ductmate Industries, Inc.
2) Lindab Inc.

5. Flat-Oval Ducts: Prefabricated connection system consisting of two flanges and one synthetic rubber gasket.

a. Manufacturers:

1) Ductmate Industries, Inc.
2) Lindab, Inc.
3) McGill Airflow LLC

4) SEMCO.

E. Conical Tees, 90-Degree Tees, 45-Degree Laterals, Bellmouths and 45-Degree Entry Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards—Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.

F. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

G. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Centerline 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 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.

3. Flat-Oval Mitered Elbows: Welded construction with same metal thickness as longitudinal-seam flat-oval duct.
4. 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.
5. 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.
6. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 40, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
7. Round Elbows Larger than 14 Inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.
8. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick with 2-piece welded construction.
9. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.
10. Flat-Oval Elbow Metal Thickness: Same as longitudinal-seam flat-oval duct specified above.
11. Pleated Elbows for Sizes through 14 Inches in Diameter and Pressures through 10-Inch wg: 0.022 inch.

H. PVC-Coated Elbows and Fittings: Fabricate elbows and fittings as follows:

1. Round Elbows 4 to 8 Inches in Diameter: Two piece, die stamped, with longitudinal seams spot welded, bonded, and painted with PVC aerosol spray.

2. Round Elbows 9 to 26 Inches in Diameter: Standing-seam construction.
3. Round Elbows 28 to 60 Inches in Diameter: Standard gored construction, riveted and bonded.
4. Other Fittings: Riveted and bonded joints.
5. Couplings: Slip-joint construction with a minimum 2-inch insertion length.

## 2.3 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

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

1. McGill AirFlow LLC.
2. Sheet Metal Connectors, Inc.

B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Traverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

G. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

H. Interstitial Insulation: Fibrous-glass liner complying with ASTM C1071, NFPA 90A, and with NAIMA AH124, "Fibrous Glass Duct Liner Standard." Cover insulation with polyester film complying with UL 181, Class 1.

## 2.4 DOUBLE-WALL DUCT, ROUND AND FLAT-OVAL SPIRAL SEAM DUCTS AND FORMED FITTINGS

A. Manufacturers:

1. Eastern Sheet Metal.

2. Foremost.
3. Lindab Inc.
4. McGill AirFlow LLC.
5. SEMCO Incorporated.

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. Provide spiral lock seam (without standing ribs). 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**][**2-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. Minimum installed R value of [**3.5**][**6.0**][**8.0**] mean temperature.
    b. Minimum 1.0 lb/cubic feet nominal density.

3. Solid Inner Ducts: Use the following minimum 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.
5. Maintain concentricity of inner duct to outer shell by mechanical means. Prevent dislocation of insulation by mechanical means.
6. Connections: use connections suitable for architecturally exposed ductwork systems. Do not provide raised flanges (e.g. AccuFlange, Econoflange) which extend from the outer surface of the duct more than 1”. Spiralmate closure pieces shall be located on top of the duct and in a non-visible location.

C. Fittings: Fabricate double-wall (insulated) fittings with an outer shell and an inner duct.

1. Solid inner ducts: Use the following minimum sheet metal thicknesses:

    a. Ducts 3 to 34 inches in diameter: 0.028 inches.
    b. Ducts 35 to 58 inches in diameter: 0.034 inches.
    c. Ducts 60 to 88 Inches in Diameter: 0.040 inch.

2. Solid outer shells: Use the following minimum sheet metal thicknesses:

    a. Ducts 3 to 34 inches in diameter: 0.028 inches.
    b. Ducts 35 to 58 inches in diameter: 0.034 inches.
    c. Ducts 60 to 88 inches in diameter: 0.040 inches.

3. Perforated inner ducts: Fabricate with 0.028-inch thick sheet metal having 3/32-inch-diameter perforations, with overall open area of 23 percent.
4. Construction: Provide solid welded fittings, fabricated without fasteners or sealant. Insulation type and thickness shall match adjoining ductwork. Inner duct liners shall be solid.

D. Materials:

1. Provide paintable galvanized steel outer duct suitable for Direct to Metal paint products. Remove all surface contaminants and protective oils from the manufacturing process and dirt due to installation prior to applying paint. Comply with direct to metal paint manufacturer's written requirements.
2. All ductwork, fittings and hangers shall be fabricated and installed suitable for visibility by the public and shall be considered "architecturally exposed".
3. Provide [**G90 galvanized**][**stainless steel**] outer liner for exterior mounted duct.

E. Mockup: Provide a mockup of the duct hanger, duct connector and duct sealant prior to fabricating any ductwork. Make all revisions requested by the Owner and the Architect based upon mockup review. Implement the mockup (with revisions) for the actual installation.

## 2.5 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 G60 coating designation (G90, if exterior duct); 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 G90 coating designation. Factory-applied PVC coatings shall be 4 mils thick on sheet metal surfaces of ducts and fittings exposed to corrosive conditions and 1 mil thick on opposite surfaces.

D. Polyamide Epoxy 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 G90 coating designation. Shop applied and cured coating prior to delivery to job site. Two coats of Tnemec Series 66 high build epoxoline polyamide. The epoxy shall be approximately 4 mils per layer. Aggregate dry film thickness total of both layers shall be 6-8 mils. All surface prep, primers, etc. shall be in accordance with coating manufacturer's written instructions. Solvent clean ductwork prior to coating per SSPC-SPI procedure.

E. Carbon-Steel Sheets: ASTM A 1008/A, 1008/M; commercial quality; with oiled, matte finish for exposed ducts.

F. Stainless Steel: ASTM A 480/A 480M, Type 304 or 304L and having a No. 2D finish for concealed ducts and No. 3 finish for exposed ducts.

G. Aluminum Sheets: ASTM B 209 (ASTM 209M), alloy 3003, temper H14; with mill finish for concealed ducts and standard, one side bright finish for duct surfaces exposed to view.

H. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts. Aluminum reinforcement where installed on aluminum ducts.

I. 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. Aluminum material for aluminum ducts.

## 2.6 SEALANT AND GASKETS

A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.

B. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

C. Solvent-Based Joint and Seam Sealant: One-part, non-sag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75 percent solids.

D. For indoor applications, use sealant that has a VOC content of 75 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Exterior duct sealants shall be marketed specifically as forming a positive air and watertight seal, bonding well to the metal, remaining flexible with metal movement, having a service temperature range of -30 deg F to 175 deg F, be ultraviolet ray and ozone resistant.

F. Flanged Joint Sealant: Single component, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, use O.

G. Flange Gaskets: Butyl rubber, neoprene or EPDM polymer with polyisobutylene plasticizer.

H. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa) and shall be rated for 10-inch wg (2500-Pa) 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.
4. Provide additional sealant applied to the entire exterior of the circumferential joint for ductwork of 2” wg pressure class or greater.
5. Install screw attachments, 12” on center at gasketed joints.

## 2.7 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Do not use powder-actuated concrete fasteners.

B. Hanger Rods for Non-Corrosive Environments: Cadmium plated steel rods and nuts.

C. Hanger Rods for Corrosive Environments: Electro-galvanized, all thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

D. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Table 4-1 (Table 4-1M), "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

E. Steel Cables for Galvanized Steel Ducts: Galvanized steel complying with ASTM A 603.

F. Steel Cables For Stainless Steel Ducts: Stainless steel complying with ASTM A 492.

G. Steel Cable End Connections: Cadmium plated steel assemblies with brackets, swivel, and bolts designed for duct hanger services with an automatic locking and clamping device.

H. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

I. 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 or galvanized steel coated with zinc chromate.
4. Strut type trapeze supports shall be minimum 14 gauge.

J. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

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

   a. CertainTeed Corporation; Insulation Group.
   b. Johns Manville.
   c. Knauf Insulation.
   d. Owens Corning.

2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Solvent or Water Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C916.

a. For indoor application, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

4. Liner must have a noise reduction coefficient of at least 0.65.
5. Polyester liner must be able to withstand a constant internal temperature up to 150 deg. F and contain zero VOCs per ASTM D5116. Comply with ASTM E84, ASTM C518, ASTM G-21, NFPA 90A and 90B and UL 181.
6. Polyester duct liner must be pinned and attached using a non-flammable low VOC water based adhesive. Provide edge coating and metal nosing on all edges perpendicular to the airstream direction.

K. Flexible Elastomeric Duct Liner: Preformed, cellular, closed cell, sheet materials complying with ASTM C534, Type II, Grade 1 and with NFPA 90A or NFPA 90B.

1. Manufacturers: Subject to compliance with requirements, provide products by one fo the following:

a. Aeroflex USA, Inc.
b. Armacell LLC.
c. Rubatex International, LLC.

2. Surface burning characteristics: Maximum flame spread index of 25 and maximum smoke developed index of 50 when tested according to UL 723; certified by an NRTL.
3. Liner adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
4. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
5. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers".

L. Insulation Pins and Washers:

1. Cupped-Head, Capacitor Discharge Weld Pins: Copper or zinc coated steel pin, fully annealed for capacitor discharge welding, 0.135 inch (3.5-mm) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch (0.41-mm) thick aluminum with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

M. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of the duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps and coat joints with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and it to ensure butted-edge overlapping.

5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.
7. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or “Z” profiles or are internally formed from duct wall. Fabricate edge facings at the following locations:

    a. Fan discharge and fan inlets.
    b. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm (12.7 m/s) or where indicated.

8. Terminate inner ducts with build-outs attached to fire damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated build-outs (metal hat sections) or other build-out means are optional; when used, secure build-outs to duct walls with bolts, screws, rivets or welds.

## PART 3 - EXECUTION

### 3.1 DUCT APPLICATIONS

A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:

1. Supply Ducts (before Air Terminal Units): 4-inch wg.
2. Supply Ducts (after Air Terminal Units): 1-inch wg.
3. Supply Ducts (in Mechanical Equipment Rooms and inside shafts): 6-inch wg.
4. Return and Outside Air Ducts (in Mechanical Equipment Rooms and inside shafts) (Negative Pressure): 4-inch wg.
5. Return Ducts (above ceiling): 2-inch wg.
6. General Exhaust Ducts (Negative Pressure): 2-inch wg.
7. Laboratory and Pharmacy Exhaust Ducts (Negative Pressure): 6-inch wg.
8. Relief Ducts (Positive Pressure): 4-inch wg.
9. Isolation Room Exhaust Ducts (Negative Pressure): 6-inch wg.

B. All ducts shall be galvanized steel except as follows:

1. Grease Exhaust Ducts

    a. Type 1 (Grease) Field fabricated or manufactured ductwork
    b. Concealed: Carbon-steel sheet, 16 gage.
    c. Exposed: Type 304, stainless steel with finish to match kitchen equipment and range hood.
    d. Continuous liquid-tight welds on external duct surface.
    e. Access doors shall be grease-tight, hinged and self-closing. Gasket shall be suitable for 1,500 deg F.

2. Dishwasher Hood Exhaust Ducts:

a. Type II (Dishwasher), stainless steel with finish to match kitchen equipment and range hood. Weld all seams and joints.

3. Corrosion-Resistant (Fume-Handling) Ducts [**for the entire EF-X system**]: [**Type 316 stainless steel sheet with No. 3 finish.**][**PVC coated galvanized steel with thicker coating on duct interior.**][**Polyamide epoxy coated galvanized steel.**]
4. Fully welded stainless steel ducts as noted on plans.

a. Type 304, weld all seams and joints.
b. Utilize wet air exhaust ductwork system requirements.

5. MRI Exam Rooms: All aluminum construction, duct, hangers, fasteners, etc.

6. Exhaust air ducts: **[Fibrous glass], [Elastomeric]**, Type I, 2 inches thick. Liner only included to the extent specifically noted on the plans and details and herein. Clarify as required during bidding.
7. Return air ducts: FSK lined polyester, Type I, 2 inches thick. Liner only included to the extent specifically noted on the plans and details and herein. Clarify with the Engineer as required during bidding.

8. Exposed supply air, relief air, exhaust air and outdoor air ductwork in occupied areas and as noted on the drawings shall be double wall with paintable surfaces. Duct size indicated on drawings shall be the inner duct size.

## 3.2 WET AIR EXHAUST DUCTWORK SYSTEM

A. Duct material shall be constructed of no lighter than 18 gage, 304 stainless steel. Construction shall be -6” wg minimum.

B. All seams and joints shall be continuously welded externally with 304L welding rod and ground smooth. Spiral pipe is not acceptable. Butt weld all connections.

C. Where ducts are not self-draining back to the equipment, provide low point drain pocket with polypropylene drain pipe to sanitary sewer. Drain pocket is not to accumulate more than one gallon. Provide access doors or panels for duct cleaning inside of horizontal duct at drain pockets at 20 foot intervals and at each change of direction.

D. Volume dampers frames, damper blades, and shafts shall be 304 stainless steel. Dampers shall be mounted inside with horizontal penetrating shaft.

E. Hang ductwork so as to not penetrate the duct with any screws. Utilize trapeze on rectangular. Utilize straps which hug the circumference on round duct.

F. Ductwork, which is exposed to an occupied space, shall be polished to a uniform satin (#3) finish.

## 3.3 STAINLESS STEEL CANOPY HOODS

A. Type 302 or Type 304 stainless steel shall be used for all hood components including exposed trim and connection flanges.

B. Exposed surfaces inside the hood and on the exterior of the hood exposed below the ceiling shall be polished to a uniform satin (#3) finish. If original finish is disturbed, polish to match original finish.

C. Hem all edges. Include drip lip turned up.

D. Exposed external corners shall be tightly welded, ground smooth and polished.

E. Minimum 18 gage construction, thicker as required for adequate stiffness.

F. One piece construction with all seams and corners welded.

G. Support separately from structure and kick brace so no sway.

H. Thoroughly clean all surfaces prior to above ceiling inspection.

## 3.4 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. Cable hangers may only be used on low pressure (2" wg construction and lower) round spiral ductwork which is not insulated and has a diameter of 10" or less. Utilize the double lock method such that the lower loop is cinched tight to the ductwork and the cable is vertical. Utilize manufacturer's top attachment device.

E. Install fabricated fittings for changes in directions, size, and shape and for connections.

F. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at maximum intervals of 12 inches, with a minimum of 3 screws in each round metallic duct coupling.

G. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

I. Install ducts with a minimum clearance of 2 inches, plus allowance for insulation thickness, to all components.

J. Install ductwork takeoffs at smoke dampers such that there is a minimum of 24" between the damper and the start of the first takeoff.

K. Low pressure ductwork shall extend a minimum of 9 inches beyond last diffuser takeoff.

L. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

M. Do not penetrate ducts with conduit or piping. Provide SMACNA Figure E obstruction fitting where structural members are shown penetrating ductwork.

N. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, smoke partition rated walls and similar finished work allowing for proper maintenance and installation.

O. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

P. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures. Do not route duct over motor control centers or panelboard.

Q. 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.

R. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 7 Section "Firestopping."

S. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by applicable building codes. Refer to SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

T. Protect duct interiors from the elements and foreign materials until the building envelope is fully enclosed and all dust producing activities are complete. Follow SMACNA's "Duct Cleanliness for New Construction," [**intermediate**] level for [**all AHU systems**].

## 3.5 CLOTHES DRYER EXHAUST DUCTS, SPECIAL INSTALLATION REQUIREMENTS

A. Ducts shall not be connected or installed with sheet metal screws or other fasteners that will obstruct the exhaust flow.

B. Male ends of ducts at overlapped duct joints shall extend in the direction of airflow.

C. Clothes dryer transition ducts used to connect the appliance to the exhaust duct system shall be limited to single lengths not-to-exceed 8 feet in length and shall be listed and labeled for the application.

D. Each vertical riser shall be provided with a cleanout or other means for cleaning the interior of the duct.

E. Install permanent labels in an observable location on all clothes dryer exhaust duct indicating the developed length of the exhaust duct system. The developed length shall include 2.5 feet for each 45 degree elbow and 5 feet for each 90 degree elbow unless indicated otherwise.

## 3.6 TYPE I GREASE HOOD EXHAUST DUCTS, SPECIAL INSTALLATION REQUIREMENTS

A. Install ducts to allow for thermal expansion through 2000 deg. F temperature range.

B. Install ducts without dips or traps that may collect residues unless traps have continuous or automatic residue removal.

C. Install access openings at each change in direction and at intervals defined by NFPA 96 maximum 20 foot intervals; locate on sides of duct a minimum of 1-1/2 inches from bottom; and fit with grease-tight covers of same material as duct.

D. Do not penetrate fire-rated assemblies except as permitted by applicable building codes.

E. Perform light test of entire ductwork run and submit results.

F. Install an access door at every change in direction.

G. Install an access door every twelve feet.

H. Install an access door at each floor.

I. Mount access doors at a minimum of 2” from bottom of duct.

J. Fasteners for access doors shall not penetrate ductwork.

K. Label each access door with signage reading: “Access Panel Do Not Obstruct.”

L. Slope ductwork ¼” per foot back to the grease hood. Do not create any low spots in ductwork.

M. Provide 6” minimum to 12” maximum clearance from rated shaft walls.

N. Provide at least 18” clearance to combustible materials and at least 3” clearance to limited combustible materials.

O. Support duct such that hangers and attachments can support weight of duct plus 800 pounds at any point.

P. Provide ductwork inspection by a certified company acceptable to the authority having jurisdiction.

Q. Coordinate with all trades such that a minimum of 4” clearance is provided between ductwork and limited combustible materials such as gypboard, fiberglass insulation, etc.

## 3.7 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. Rotate spiral seams to align with the seams of adjoining duct section or adjoining fittings prior to joining sections together.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

F. For painted architecturally exposed ductwork, clean the outer duct prior to installation to remove oils. Clean the outer duct after installation to remove construction dirt just prior to painting.

## 3.8 SEAM AND JOINT SEALING

A. Seal duct seams and joints of all ductwork according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" to meet seal Class A requirements. Supply ducts after terminal units shall be sealed to meet seal Class B requirements.

B. Seal ducts before external insulation is applied.

C. Do not utilize pressure sensitive tapes to externally seal ductwork.

D. Seal round duct couplers continuously around both ends of the coupler prior to assembling and then again after fastening.

## 3.9 EXTERIOR STACK GUYING AND BRACING MATERIALS INSTALLATION

A. Cable: Four stainless stranded wires of the following thickness:

1. Minimize size: 1/4 inch (6 mm) in diameter.
2. For ID sizes 4 to 15 inches (100 to 381 mm): 5/16 inch (8 mm).
3. For ID sizes 18 to 24 inches (457 to 610 mm): 3/8 inch (9.5 mm).
4. For ID sizes 27 to 30 inches (685 to 762 mm): 7/16 inch (11 mm).
5. For ID sizes 33 to 36 inches (838 to 915 mm): 1/2 inch (13 mm).
6. For ID sizes 39 to 48 inches (990 to 1220 mm): 9/16 inch (14.3 mm).
7. For ID sizes 51 to 60 inches (1295 to 1524 mm): 5/8 inch (16 mm).

B. Cable Encasement: 2” diameter, white Schedule 40 PVC pipe (ASTM D1784) and white Schedule 40 fittings (ASTM D2466, Type 1, Grade 1). Pipe and fittings shall be painted white with a water based latex paint suitable for exterior use. Provide Guy wire cable encasement on only the portion of the guy wire cables which are less than 7’-0” above the finished roof surface. Portions of the guy wires above 7’-0” shall not be encased.

C. Install stack on exhaust fan discharge as required. Provide stacks constructed of stainless materials unless noted otherwise. Utilize stainless fasteners.

D. Erect stacks plumb to finished tolerance of no more than 1 inch out of plumb from top to bottom. Install guy wires and cable encasement.

## 3.10 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. Utilize trapeze hangers for all ductwork greater than 48” in width.

D. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

E. Install concrete inserts before placing concrete.

F. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

G. Install flexible duct hanger at least once per segment such that each flexible duct is supported a minimum of three times, counting the two end connections. Support at intervals no greater than 5 feet. Maximum permissible sag is 0.5 inch per foot of spacing between supports. A connection to another duct or to equipment at each end is considered a support point. Flexible duct hangers shall be at least 1.0” wide.

## 3.11 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Seismic restraints are specified in Division 23 Section “Vibration and Seismic Controls for HVAC Piping and Equipment.”

B. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems." Requirements of the Seismic Restraint Manual may require closer spacing than the maximums described here.

1. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
2. Brace a change of direction longer than 12 feet (3.7 m).

C. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

D. Install cables so they do not bend across edges of adjacent equipment or building structure.

E. Install cable restraints on ducts that are suspended with vibration isolators.

F. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.

G. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

H. Drilling for and Setting Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

## 3.12 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 9 painting Sections.

B. Paint exteriors of architecturally exposed metal ducts. Paint materials and application requirements are specified in Division 09.

## 3.13 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.

## 3.14 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:

1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give two days' advance notice for testing to the Owner’s maintenance staff, the commissioning agent (if applicable) and the Owner’s project management staff. [**All tests shall be witnessed by personnel other than the Contractor.**]
3. All supply ductwork from fan or AHU outlet to the inlet of every terminal unit or reheat coil shall be tested. The terminal unit and all ductwork downstream of the terminal unit shall not be tested. All return and exhaust ductwork shall be

tested from the fan to the end of the branch to every grille. Do not test flexible ductwork.

4. Maximum Allowable Leakage:

    a. In accordance with the following total leakage quantity limitations, provide a leakage per square foot of ductwork for each fan or AHU to meet the following requirements:

        1) Allowable Leakage, Supply Duct: 1.0 percent of total scheduled supply fan design airflow.
        2) Allowable Leakage, Return, Outside Air and Relief Air Duct: 5.0 percent of total scheduled applicable fan design airflow.
        3) Allowable Leakage, General Exhaust Duct: 5.0 percent of total scheduled general exhaust fan design airflow.
        4) Allowable Leakage, Laboratory Exhaust Duct: 2.0 percent of total lab exhaust scheduled fan design airflow. Do not include redundant fan airflow capacity in system total.
        5) Allowable Leakage, Welded Duct: No measureable leakage.
        6) Contractor shall identify fan or AHU total scheduled fan airflow, surface area of ductwork to be tested, total duct surface area of the fan or AHU system and location of ductwork prior to testing. All testing shall be witnessed, documented, and submitted by persons other than the Sheet Metal Contractor. Document individual test sections, test pressure, orifice size, pressure drop across orifice, surface area of ductwork to be tested, and measured leakage for each section tested. Summarize total leakage by fan or AHU system.
        7) Submit handwritten field test reports within two business days of the individual test date. Do not proceed with insulating ductwork until the test report demonstrating acceptable leakage has been submitted and processed by the Architect. Include a running total leakage summary on each individual test submission that includes total system surface area, total system leakage allowed, individual test surface area and individual test measured results.
        8) Concurrent with the leakage pressurization test, perform an acoustic pressure cycling test. Pressurize the ductwork in the direction of normal operation (supply positive pressure, return/exhaust negative pressure) to a pressure 0.5” less than the design static pressure class duct construction. Remove the pressure and identify areas with duct flexure noise. Reapply the pressure and identify areas with duct flexure noise. Externally reinforce the ductwork such that flexure noise is removed. Repeat pressure testing and add reinforcement until noise is removed and is acceptable to these witnessing the test.

B. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner and/or the Engineer, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

    a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

C. Duct system will be considered defective if it does not pass leakage and cleanliness tests and inspections.

D. Prepare test and inspection reports.

## 3.15 CLEANING EXISTING SYSTEMS

A. Use service openings, as required, for physical and mechanical entry and for inspection.

1. Use existing service openings where possible.
2. Create other openings to comply with duct standards.
3. Disconnect flexible ducts as needed for cleaning and inspection.
4. Reseal rigid fiberglass duct systems according to NAIMA recommended practices.
5. Remove and reinstall ceiling sections to gain access during the cleaning process.

B. Mark position of dampers and air-directional mechanical devices before cleaning, and restore to their marked position on completion.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron size (or larger) particles.
2. When venting vacuuming system to the outside, use filtration to contain debris removed from HVAC system and locate exhaust down wind and away from air intakes and other points of entry into building.

D. Clean the following metal duct systems by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.

3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean all duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace all duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide operative drainage system for washdown procedures.
7. Biocidal Agents and Coatings: Apply biocidal agents if fungus is present. Apply biocidal agents according to manufacturer's written instructions after removal of surface deposits and debris.

F. Cleanliness Verification:

1. Verify cleanliness after mechanical cleaning and before application of treatment, including biocidal agents and protective coatings.
2. Visually inspect metal ducts for contaminants.
3. Where contaminants are discovered, re-clean and reinspect ducts.

G. Gravimetric Analysis: At discretion and expense of Owner, sections of metal duct system, chosen randomly by Owner and/or the Engineer, may be tested for cleanliness according to NADCA vacuum test gravimetric analysis.

1. If analysis determines that levels of debris are equal to or lower than suitable levels, system shall have passed cleanliness verification.
2. If analysis determines that levels of debris exceed suitable levels, system cleanliness verification will have failed and metal duct system shall be re-cleaned and re-verified.

H. Verification of Coil Cleaning: Cleaning must restore coil pressure drop to within 10 percent of pressure drop measured when coil was first installed. If original pressure drop is not known, coil will be considered clean only if it is free of foreign matter and chemical residue, based on thorough visual inspection.

**END OF SECTION**

**SECTION 233300**
**AIR DUCT ACCESSORIES**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Backdraft dampers.
2. Pressure relief doors.
3. Manual volume dampers.
4. Fire dampers.
5. Ceiling dampers.
6. Smoke dampers.
7. Combination fire and smoke dampers.
8. Duct silencers.
9. Turning vanes.
10. Duct access panel assemblies.
11. Flexible connectors.
12. Flexible ducts.
13. Duct accessory hardware.

B. Related Sections:

1. Division 23 Section "HVAC Gravity Ventilators" for roof-mounted ventilator caps.

2. Division 23 Environmental Control System
3. Division 28 Section "Fire Detection and Alarm" for duct-mounted fire and smoke detectors.

### 1.3 SUBMITTALS

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

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
2. For fire dampers, smoke dampers and fire/smoke dampers, provide pressure drop at 1000 fpm, 1500 fpm and at 2000 fpm.
3. For flexible air ducts, indicate R value.

B. LEED Submittal:

1. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1-2004, Section 5 - "Systems and Equipment."

C. 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: For power, signal, and control wiring.

2. Detailed fire damper, smoke damper, combination fire and smoke damper installation requirements which incorporate manufacturer's and UL listing requirements for opening size, stud construction, opening framing and other required construction features. Provide detailed drawings for the penetrations of all floor assemblies.

D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

E. Source quality-control reports.

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

G. Acceptance Test Reports: Perform and submit NFPA 90A acceptance test reports for each fire damper and fire/smoke damper. Acceptance test demonstrating removal and reinstallation of fusible links shall be completed after all above ceiling installations are complete to confirm acceptable access. Submit acceptance test report prior to occupancy of the building.

## 1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with AMCA 500-D testing for damper rating.

C. Perform NFPA 90A acceptance tests and document results. Replace fusible links at the completion of acceptance tests.

1.5 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 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: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90 (Z275).
2. Exposed-Surface Finish: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and No. 3 finish for exposed ducts.

D. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: Comply with ASTM B 221 (ASTM B 221M), Alloy 6063, Temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.2 BACKDRAFT DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.
2. American Warming and Ventilating; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Greenheck Fan Corporation.
5. Nailor Industries Inc.
6. NCA Manufacturing, Inc.
7. Pottorff; a division of PCI Industries, Inc.
8. Ruskin Company.
9. SEMCO Incorporated.

10. Vent Products Company, Inc.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2500 fpm.

D. Maximum System Pressure: Matching ductwork design pressure.

E. Frame: 0.063-inch- (1.6-mm-) thick extruded aluminum, with welded corners and mounting flange.

F. Blades: Multiple single-piece blades, maximum 6-inch (150-mm) width, 0.025-inch- (0.6-mm-) thick, roll-formed aluminum with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Extruded vinyl, mechanically locked.

I. Blade Axles:

1. Material: Non-ferrous metal.
2. Diameter: 0.20 inch (5 mm).

J. Tie Bars and Brackets: Aluminum.

K. Return Spring: Adjustable tension.

L. Bearings: Steel ball or synthetic pivot bushings.

M. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Chain pulls.
4. Screen Mounting: Front mounted in sleeve.

a. Sleeve Thickness: 20-gage (1.0-mm) minimum.
b. Sleeve Length: 6 inches (152 mm) minimum.

5. Screen Material: Aluminum.
6. Screen Type: Insect.
7. 90-degree stops.

## 2.3 PRESSURE RELIEF DOORS

A. Manufacturers:

1. A.J. Manufacturing.
2. American Warming and Ventilating; a Division of Mestek.
3. Greenheck.
4. Pottorff.

5. Ruskin.
6. United Enertech.

B. Frame: 0.063 inch thick aluminum extrusion.

C. Door: Minimum 24 gage solid double wall door galvanized steel with 1" thick insulation. Fully hinged.

D. Trim Flange: Minimum 1" width.

E. Seal: Polyurethane, PVC or neoprene gasket. Gasket shall cover the entire perimeter of the flange.

F. Mechanism:

1. Cable assembly: Cable limits door opening past 90 degrees. Components located outside of airstream.
2. Outward opening door in positive pressure ductwork. Inward opening door in negative pressure ductwork.

G. Latch: Adjustable magnet assembly, factory set at desired relief pressure. Field adjustable relief pressure settings.

H. Leakage: Not-to-exceed 0.6 cfm/ft.$^2$ at 12 inches w.g.

## 2.4 MANUAL VOLUME DAMPERS

A. Small, Low Pressure, Steel, Manual Volume Dampers:

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

a. Air Balance Inc.; a division of Mestek, Inc.
b. American Warming and Ventilating; a division of Mestek, Inc.
c. Cesco.
d. Greenheck.
e. Lindab.
f. Metalaire, Inc.
g. Nailor Industries Inc.
h. Pottorff; a division of PCI Industries, Inc.
i. Ruskin Company.
j. Vent Products Company, Inc.

2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:

a. Hat-shaped, galvanized-steel channels, 0.052-inch minimum thickness.
b. Mitered and welded corners.
c. Flanges for attaching to walls and flangeless frames for installing in ducts.
d. Maximum size 12" X 12".

e. Suitable for 2 inch w.g. pressure class construction.

5. Blades:

   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized-steel, 0.040-inch thick.
   e. Locking hand quadrant and 2” standoff mounting bracket for all insulated ductwork applications.

6. Blade Axles: Galvanized steel.
7. Bearings:

   a. Molded synthetic.
   b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel.
9. Provide stainless and aluminum dampers to match ductwork construction where dampers are shown in stainless or aluminum ductwork.

B. Larger Size or Higher Pressure, Steel, Manual Volume Dampers:

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

   a. Air Balance, Inc., a division of Mestek, Inc.
   b. American Warming and Ventilating; a division of Mestek, Inc.
   c. Cesco.
   d. Greenheck.
   e. Lindab.
   f. Metalaire, Inc.
   g. Nailor Industries, Inc.
   h. Pottorff; a division of PCI Industries, Inc.
   i. Ruskin Company.
   j. Vent Products Company, Inc.

2. Pressure classes of 3-inch w.g. or higher or 14” X 14” and larger duct size:

   a. Multiple opposed blade design.
   b. End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.
   c. Suitable for 2000 fpm velocity at the width and height required.
   d. Jackshaft to operate multi-section dampers from one side.
   e. Locking hand quadrant and 2” stand-off mounting bracket.
   f. Minimum 16 gauge frame thickness.
   g. Linkage out of the airstream.
   h. Flanged frame on both entering and leaving faces.

3. Provide stainless and aluminum dampers to match ductwork construction where dampers are shown in stainless or aluminum ductwork.

C. Standard, Aluminum, Manual Volume Dampers:

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

    a. Air Balance Inc.; a division of Mestek, Inc.
    b. American Warming and Ventilating; a division of Mestek, Inc.
    c. Greenheck.
    d. Metalaire, Inc.
    e. Nailor Industries Inc.
    f. Pottorff; a division of PCI Industries, Inc.
    g. Ruskin Company.
    h. Vent Products Company, Inc.

2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames: Hat-shaped, 0.10-inch- (2.5-mm-) 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. Parallel- or opposed-blade design.
    c. Stiffen damper blades for stability.
    d. Roll-Formed Aluminum Blades: 0.10-inch- (2.5-mm-) thick aluminum sheet.

6. Blade Axles: Nonferrous metal.
7. Bearings:

    a. Molded synthetic.
    b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or greater shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Aluminum.

D. Jackshaft:

1. Size: 1-inch (25-mm) 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.

E. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- (2.4-mm-) thick zinc-plated steel, and a 3/4-inch (19-mm) hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting for all pressure class dampers (including low pressure run-outs to diffusers. No bent handles).

## 2.5 FIRE DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Greenheck Fan Corporation.
4. Nailor Industries Inc.
5. NCA Manufacturing, Inc.
6. Pottorff; a division of PCI Industries, Inc.
7. Prefco; Perfect Air Control, Inc.
8. Ruskin Company.
9. United Enertech.
10. Vent Products Company, Inc.
11. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class and minimum 2000 fpm velocity.

D. Fire Rating: 1-1/2 and 3 hours as required.

E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.052 or 0.138 inch (1.3 or 3.5 mm) thick, as indicated, and of length to suit application.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
3. Provide non-breakaway style, seal welded sleeve where the ductwork system is welded.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.

1. Provide double wall airfoil blades for multiple segment dampers.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165F or 212F rated, fusible links.

K. Provide 304 stainless steel frame, blades, bearings, jamb seals, axle and linkage for dampers installed within stainless steel duct systems.

## 2.6 CEILING DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Greenheck.
4. Nailor Industries Inc.
5. Prefco; Perfect Air Control, Inc.
6. Ruskin Company.
7. United Enertech.
8. Vent Products Company, Inc.
9. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. General Requirements:

1. Labeled according to UL 555C by an NRTL.
2. Comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."

C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.

D. Blades: Galvanized sheet steel with refractory insulation.

E. Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) or 212 deg F (100 deg C) rated, fusible links as required.

F. Fire Rating: 2 or 3 hours as required.

2.7 SMOKE DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Greenheck Fan Corporation.
4. Nailor Industries Inc.
5. Pottorff.
6. Ruskin Company.
7. United Enertech.

B. General Requirements: Label according to UL 555S by an NRTL.

C. Smoke Detector: By fire alarm provider, duct mounted.

D. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.

E. Blades: Interlocking, minimum 0.034-inch- (0.85-mm-) thick, galvanized sheet steel.

1. Provide double wall airfoil shaped blades for dampers.
2. Blade edge seals.

F. Leakage: Class I, bi-directional.

G. Rated pressure and velocity to exceed design airflow conditions, minimum 2000 fpm and 4-inch water gauge at 250 degrees F.

H. Mounting Sleeve: Factory-installed, 0.052-inch- (1.3-mm-) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished UL listed silicone caulking.

I. Damper Motors: Two-position action.

J. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

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. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC" and Division 26 Sections.
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism to close upon loss of power unless noted otherwise (e.g. for elevator shaft venting). Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).
5. 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 (minus 40 deg C).
6. Electrical Connection: 115 V, single phase, 60 Hz.

K. Pneumatic Actuator:

1. Large enough to properly operate at a differential pressure equal to the ductwork construction in inches.
2. Utilize 20 psig control air.

L. Accessories:

1. Auxiliary switches for position indication with connections for the building automation system.
2. Momentary test switch, damper or remote mounted.

2.8 COMBINATION FIRE AND SMOKE DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.

2. Cesco Products; a division of Mestek, Inc.
3. Greenheck Fan Corporation.
4. Nailor Industries Inc.
5. Pottorff.
6. Ruskin Company.
7. United Enertech.

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: 1-1/2 and 3 hours as required.

E. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.

F. Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) or 212 deg F (100 deg C) rated, fusible links as required.

G. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.

H. Smoke Detector: By fire alarm provider, duct mounted.

I. Blades: Interlocking, minimum 0.034-inch- (0.85-mm-) thick, galvanized sheet steel.

1. Provide double wall airfoil shaped blades.
2. Blade edge seals.

J. Leakage: Class I, bi-directional.

K. Rated pressure and velocity to exceed design airflow conditions, minimum 2000 fpm and 4-inch water gauge at 250 degrees F.

L. Mounting Sleeve: Factory-installed, 0.052-inch- (1.3-mm-) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished UL listed silicone caulking.

M. Damper Motors: Two-position action.

N. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

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. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC" and Division 26 Sections.

3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism to close upon loss of power. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).
5. 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 (minus 40 deg C).
6. Electrical Connection: 115 V, single phase, 60 Hz.

O. Accessories:

1. Auxiliary switches for position indication
   a. Connection to the building smoke management system
   b. Connection to the building automation system.
2. Momentary test switch, damper or remote mounted.

## 2.9 DUCT SILENCERS

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

1. Aerosonics.
2. Commercial Acoustics.
3. Industrial Noise Control, Inc.
4. Price Industries.
5. Ruskin Company.
6. SEMCO.
7. VAW Systems.
8. Vibro-Acoustics.

B. General Requirements:

1. Factory fabricated.
2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

C. Shape:

1. Rectangular straight with splitters or baffles.
2. Other shapes as scheduled and shown on the drawings.

D. Rectangular Silencer Outer Casing: ASTM A 653/A 653M, G90 (Z275), galvanized sheet steel, 0.034 inch (0.85 mm) thick.

E. Round Silencer Outer Casing: ASTM A 653/A 653M, G90 (Z275), galvanized sheet steel.

1. Sheet Metal Thickness for Units up to 24 Inches (600 mm) in Diameter: 0.034 inch (0.85 mm) thick.
2. Sheet Metal Thickness for Units 26 through 40 Inches (660 through 1000 mm) in Diameter: 0.040 inch (1.02 mm) thick.
3. Sheet Metal Thickness for Units 42 through 52 Inches (1060 through 1300 mm) in Diameter: 0.052 inch (1.3 mm) thick.
4. Sheet Metal Thickness for Units 54 through 60 Inches (1370 through 1500 mm) in Diameter: 0.064 inch (1.62 mm) thick.

F. Inner Casing and Baffles: ASTM A 653/A 653M, G90 (Z275) galvanized sheet metal, 0.034 inch (0.85 mm) thick, and with 1/8-inch- (3-mm-) diameter perforations.

G. Special Construction:

1. Suitable for outdoor use where located outdoors.

H. Connection Sizes: Match connecting ductwork unless otherwise indicated.

I. Principal Sound-Absorbing Mechanism:

1. No-media type: Controlled impedance membranes and broadly tuned resonators without absorptive media.
2. Film lined type:

   a. Fill material: Inert, moisture-proof fibrous material.
   b. Erosion Barrier: Polymer film bag enclosing fill, and heat sealed before assembly.
   c. Lining: Polymer.

J. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.

1. Lock form and seal or continuously weld joints.
2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
3. Reinforcement: Cross or trapeze angles for rigid suspension.

K. Accessories:

1. Factory-installed end caps to prevent contamination during shipping.

L. Source Quality Control: Test according to ASTM E 477, latest revision.

1. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000-fpm (10-m/s) face velocity.
2. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg (1500-Pa) static pressure, whichever is greater.

## 2.10 TURNING VANES

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

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. METALAIRE, Inc.
4. SEMCO Incorporated.
5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."

D. Vane Construction: Double wall.

## 2.11 DUCT-MOUNTED ACCESS DOORS

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

1. Air Balance.
2. American Warming and Ventilating; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Ductmate Industries, Inc.
5. Flexmaster U.S.A., Inc.
6. Greenheck Fan Corporation.
7. Kees.
8. Nailor Industries Inc.
9. Pottorff; a division of PCI Industries, Inc.
10. Ruskin.
11. Ventfabrics, Inc.
12. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."

1. Door:

a. Double wall, rectangular.
b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Hinges and Latches: Piano hinge and cam latches with safety chain.
d. Fabricate doors airtight and suitable for duct pressure class.
e. Access doors for ductwork pressure class 3-inch or greater shall include a 1” frame flange for duct mounting (access doors for ductwork pressure class 2-inch and less may be bent over tabs and foam gasketing).
f. [**Vision panel.**]

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

    a. Access Doors Less Than 12 Inches (300 mm) Square: One hinge and two sash locks.
    b. Access Doors up to 18 Inches (460 mm) Square: Two hinges and two sash locks.
    c. Access Doors up to 24 by 48 Inches (600 by 1200 mm): Three hinges and two compression latches.
    d. Access Doors Larger Than 24 by 48 Inches (600 by 1200 mm): Four hinges and two compression latches with outside and inside handles.

## 2.12 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 (1.3-mm) carbon or 0.0428-inch (1.1-mm) stainless steel.

D. Fasteners: Stainless 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 (1093 deg C).

F. Minimum Pressure Rating: 10-inch wg (2500 Pa), positive or negative.

## 2.13 FLEXIBLE CONNECTORS

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

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Ventfabrics, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches (89 mm) wide attached to 2 strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber (Hypalon) resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd. (810 g/sq. m).
2. Tensile Strength: 530 lbf/inch (93 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C).

G. High-Corrosive-Environment (Grease Duct) System, Flexible Connectors: Glass fabric with chemical-resistant coating.

1. Minimum Weight: 14 oz./sq. yd. (474 g/sq. m).
2. Tensile Strength: 450 lbf/inch (79 N/mm) in the warp and 340 lbf/inch (60 N/mm) in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).

H. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. 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.
2. Outdoor 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 rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch (6-mm) movement at start and stop.

## 2.14 FLEXIBLE DUCTS

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

1. Flexmaster U.S.A., Inc.
2. McGill AirFlow LLC.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Low Pressure Insulated, Flexible Duct: UL 181, Class 1, 2-ply polymer film supported by helically wound, spring galvanized steel wire; fibrous-glass insulation; black polyethylene fire retardant vapor-barrier film.

1. Pressure Rating and Operating Pressure: 4-inch wg positive and 0.5-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 175 deg F.
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1, minimum R-6.

C. High Pressure Insulated, Flexible Duct: UL 181, Class 1, 2-ply polymer film supported by helically wound, spring galvanized steel wire; fibrous glass insulation, black polyethylene fire retardant vapor barrier film.

1. Pressure Rating: 10-inch wg positive and 2-inch wg negative.
2. Operating Pressure: 6-inch wg positive pressure and 2-inch wg negative minimum all duct sizes.
3. Maximum Air Velocity: 4000 fpm.
4. Temperature Range: Minus 20 to plus 175 deg. F.
5. Insulation R-Value: Comply with ASHRAE/IESNA 90.1, minimum R-6.

D. Flexible Duct Connectors:

1. Clamps: Nylon strap in sizes 3 through 18 inches (75 through 460 mm), to suit duct size.

## 2.15 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install [**backdraft**] [**control**] dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
   1. Install steel volume dampers in steel ducts.

   2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers according to UL listing written installation instructions. Install manufacturer's UL listed optional sealant around the full perimeter of the angle on both sides of the wall. Install duct sealant for the full perimeter of the breakaway connections in accordance with the manufacturer's written UL listing installation instructions. It is the contractors responsibility to coordinate the penetration of any rated assembly. The contractor shall provide additional detail to floor penetrations and provide the required space between systems in accordance with the manufacturer recommendations.

H. Connect ducts to duct silencers rigidly.

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 and downstream from duct filters.
   3. At outdoor-air intakes and mixed-air plenums.
   4. At drain pans and seals.
   5. Downstream from control dampers, backdraft dampers, and equipment.
   6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links or to clean duct detectors.
   7. Control devices requiring inspection, specifically humidity sensors, airflow sensors and pressure sensors.
   8. Elsewhere as indicated. Note that not all access doors required may be indicated on the drawings. Provide in bid to provide and install access doors as specified in addition to those shown on the drawings.

J. Install access doors with swing against duct static pressure.

K. Install external angle duct reinforcement across the long side of the duct at each access door which is greater than 14" in dimension.

L. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

M. Install flexible connectors to connect ducts to equipment supported by vibration isolators.

N. For fans developing static pressures of 5-inch wg (1250 Pa) and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

O. Connect terminal units to supply ducts directly or with maximum 12-inch (300-mm) lengths of flexible duct. Do not use flexible ducts to change directions.

P. Connect light troffer boots with maximum 60-inch (1500-mm) lengths of flexible duct clamped or strapped in place.

Q. Connect diffusers to ducts with maximum 96-inch lengths of flexible duct clamped or strapped in place unless indicated length differs on drawings.

R. Connect flexible ducts to metal ducts with draw bands.

S. Install flexible duct hangers at least once per segment such that each flexible duct is supported a minimum of three times, counting the two end connections. Support at internals no greater than 5 feet and as required such that flexible duct does not contact the ceiling, ceiling hangers, lighting, lighting hangers or piping. Maximum permissible sag is 0.5 inch per foot of spacing between supports. A connection to another duct or to equipment at each end is considered a support point. Flexible duct hangers shall be at least 1.0” in width where they contact the flexible duct.

T. Install duct test holes where required for testing and balancing purposes.

U. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch (6-mm) movement during start and stop of fans.

V. Utilize high pressure flexible duct on the inlet of supply terminal units where the use of flexible duct is indicated on the drawings. Utilize high pressure flexible duct on the discharge side of exhaust valves where the use of flexible duct is indicated on the drawings.

## 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.
6. Adjust pressure relief doors for relief setting.

B. NFPA 90A Acceptance Testing:

1. Perform NFPA 90A acceptance testing for each fire damper and each fire/smoke damper.
2. Acceptance test demonstrating removal and reinstallation of fusible links shall be completed only after all above ceiling installations are complete to confirm acceptable access. Under no circumstances shall the test demonstrations be undertaken greater than two weeks prior to Substantial Completion award is finalized.
3. Test report contents; for each damper list:

    a. Damper size.
    b. Room number the damper was accessed from.

c. Access means (duct access door or exposed face).
d. Results of link removal and reinstallation.
e. Name of the person testing the damper.
f. Date test was completed.
g. The Substantial Completion Date for the area in which the particular damper is located.
h. Yes check box that the test date is no greater than two weeks prior to the Substantial Completion date.

4. Relocate the work of any trade which does not provide for required maintenance access to fusible links. See Division 23 Section “Common Work Results for HVAC” coordination requirements.
5. Submit acceptance test report results prior to occupancy of the building.

**END OF SECTION**

**SECTION 233416**
**CENTRIFUGAL HVAC FANS**

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. Centrifugal fans.
2. Mixed flow in-line fans.

1.3 PERFORMANCE REQUIREMENTS

A. 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.
6. Dimensional details of motor and fan arrangement on inertia bases which illustrates overall size of inertia base and the relative arrangement of the fan and motor on the inertia base.

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.

C. Operation and Maintenance Data: For centrifugal fans to include in emergency, 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 a testing agency 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.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA 1.

## 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.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

## 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. Final fan belts: Two (2) sets for each belt driven fan. Field installed and sized by the Testing, Adjusting and Balancing contractor the size as required to deliver the necessary airflow through the system account for all system losses.
2. Final fan sheave: One (1) set for each belt driven fan. Field installed and sized by the Testing, Adjusting and Balancing Contractor. Sized as required to deliver the necessary airflow through the system accounting for all system losses.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

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

2. Greenheck Fan Corporation.
3. Loren Cook Company.
4. New York Blower.
5. Twin City Fan Company.

## 2.2 CENTRIFUGAL FANS

A. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.

B. 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.

C. 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; cast-iron or cast-steel hub welded to backplate and fastened to shaft with set screws.

D. Backward Inclined Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades[ **welded to flange and backplate; cast-iron or cast-steel hub welded to backplate**] and fastened to shaft with set screws.

E. Mixed Flow Wheels: Mixed flow wheels shall be constructed with a wheel cone, spherical back plate and single thickness cambered blades.

F. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.

1. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

G. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.

1. Ball-Bearing Rating Life: ABMA 9, Ll0 at 200,000 hours.

H. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: 1.5.
2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.

3. Motor Pulleys: Adjustable pitch for use with other than 3600 rpm motors through 5 hp; fixed pitch for use with larger motors. Fixed pitch for all 3600 rpm motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
4. Belts: Oil resistant, non-sparking, and non-static; matched sets for multiple belt drives.
5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements. Fabricated from diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
6. Motor Mount: Adjustable for belt tensioning.

I. Accessories:

1. Access Door: [**Bolted**] [**Quick-opening, latch-type**] [**raised for insulated fans**] gasketed door allowing access to fan scroll, of same material as housing.
2. Scroll Drain Connection: NPS 1 (DN 25) steel pipe coupling welded to low point of fan scroll, with plug.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Discharge Dampers: Assembly with [**parallel**] [**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 ]** [**weight mechanism**] of same material as housing.
5. Inlet Screens: Grid screen of same material as housing.
6. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
7. Spark-Resistant Construction: AMCA 99, Class [**A**][**B**][**C**].
8. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
9. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
10. Shaft Guard: Enameled steel sheet with ventilation slots, bolted to housing.
11. Plenum fan protective cage guarding fully enclosing four sides of the fan assembly discharge.
12. Special Coating: Coat all airstream surfaces with special coating.

J. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

## 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, "Laboratory Methods of Testing Fans for Rating."

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install centrifugal fans level and plumb.

B. Support unit as scheduled on the drawings and as specified in Division 23 Section “Mechanical Vibration and Seismic Controls”.

C. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Install units with clearances for service and maintenance.

E. Label fans according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

### 3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."

B. Install ducts adjacent to fans to allow service and maintenance.

C. Install line-sized piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### 3.3 FIELD QUALITY CONTROL

A. 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 HVAC" for testing, adjusting, and balancing procedures.
10. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

## 3.4 DEMONSTRATION

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

**END OF SECTION**

**SECTION 233423**
**HVAC POWER VENTILATORS**

## 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. Utility set fans.
2. Centrifugal roof ventilators.
3. In-line centrifugal fans
4. Propeller fans
5. Ceiling Exhaust Fan

### 1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on 700 feet above sea level.

B. 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.
6. Roof curbs.
7. Fan speed controllers.

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. Seismic Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

D. 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.

E. Coordination Drawings: Reflected ceiling plans 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. Roof framing and support members relative to duct penetrations.
   2. Ceiling suspension assembly members.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For power ventilators to include in emergency, 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 a testing agency 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.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to 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.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

## 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. Final Fan Belts: Two sets for each belt-driven fan. Field installed and sized by the Testing, Adjusting and Balancing Contractor. Sized as required to deliver the necessary airflow through the system accounting for all system losses.
2. Final Fan Sheave: One set for each belt-driven fan. Field installed and sized by the Testing, Adjusting and Balancing Contractor. Sized as required to deliver the necessary airflow through the system accounting for all system losses.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck.
2. Loren Cook Company.
3. JencoFan; Div. of Breidert Air Products.
4. Penn Barry.
5. Twin City Fan and Blower.

B. Parking Garage Propeller Fan Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck

C. Residential Style Ceiling Fan Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Delta Breeze

## 2.2 UTILITY SET FANS

A. Description: [**Direct**] [**Belt**]-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.

B. Housing: Fabricated of galvanized steel with side sheets fastened with a deep lock seam or welded to scroll sheets.

1. Housing Discharge Arrangement: Adjustable to eight standard positions.

C. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.

1. Blade Materials: [**Steel**] [**Aluminum**].
2. Blade Type: [**Backward inclined**] [**Forward curved**] [**Airfoil**].

D. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub. Stainless steel where scheduled.

E. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9, $L_{10}$ of 200,000 hours.

F. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: 1.5.
2. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
3. Belts: Oil resistant, non-sparking, and non-static; matched sets for multiple belt drives.
4. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

G. Accessories: Refer to Fan Schedule on drawings for individual fan requirements.

## 2.3 CENTRIFUGAL ROOF VENTILATORS

A. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Housing: Removable, spun-aluminum, dome top and outlet baffle square, one-piece, aluminum base with venturi inlet cone.

1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub. Stainless steel where scheduled.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust airstream.

E. Accessories: Refer to Fan Schedule on drawings for individual fan requirements.

F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Overall Height: Minimum 16 inches.
2. Pitch Mounting: Manufacture curb for roof slope.
3. Metal Liner: Galvanized steel.

## 2.4 IN-LINE CENTRIFUGAL FANS

A. Description: In-line, [**direct**] [**belt**]-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.

B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

C. Direct-Driven Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing[**; with wheel, inlet cone, and motor on swing-out service door**].

D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

F. Accessories: Refer to Fan Schedule on drawings for individual fan requirements.

## 2.5 PROPELLER FANS

A. Description: Direct- or belt-driven propeller fans consisting of fan blades, hub, housing, orifice ring, motor, drive assembly, and accessories.

B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.

C. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.

D. Fan Wheel: Replaceable, cast-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

E. Belt-Driven Drive Assembly: Resiliently mounted to housing, statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: 1.4.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

    a. Ball-Bearing Rating Life: ABMA 9, $L_{10}$ of 100,000 hours.

4. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
6. Belts: Oil resistant, non-sparking, and non-static; matched sets for multiple belt drives.
7. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

F. Accessories: Refer to Fan Schedule on drawings for individual fan requirements.

1. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
2. Wall housing, wall housing guard (OSHA approved).
3. Damper, damper actuator (factory wired) and end switch with damper guard.

2.6 CEILING EXHAUST FAN

1. Description: Ceiling Mounted Energy Star Qualified exhaust fan. Manufactured in an ISO 9001 Certified Factory. Fan shall have a low sound level (less than 1 Sone)
2. Motor: Brushless DC motor with integral disconnect
3. Options
   a. Ceiling Radiation Damper
   b. Integral LED light with frosted lens.
   c. Integral motion detector
4. Refer to schedule or drawings for capacity.

2.7 MOTORS

A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

B. Roof Ventilator Direct Drive Fans with Single Phase Motors: Furnish electronically commutated (EC) motor to convert AC power to DC power. Furnish a speed controller matched to the motor which allows for at least a 50% speed reduction adjustment via a manual potentiometer. Provide all transformers and wiring factory mounted for a completely functional unit.

C. Fan Motor Wiring:

1. Each fan shall be wired separately to a non-fused disconnect mounted with thermal overload protection on the exterior of the fan section per NEC requirements.
2. Provide conduit sized for motor conductors routed from the fan motor to the disconnect. Provide power wiring inside the conduit.
3. For fans indicated to be driven by variable frequency controllers (VFC), the disconnect shall incorporate a remote contact connection for the interlock of the variable frequency controller.
4. Penetrations of junction boxes and disconnects shall be sealed watertight inside (around the wires) and outside of the conduit.

2.8 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, "Laboratory Methods of Testing Fans for Rating."

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Support units as scheduled on the drawings and as specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

C. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.

E. Install units with clearances for service and maintenance.

F. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

### 3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### 3.3 FIELD QUALITY CONTROL

A. 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. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

## 3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

**END OF SECTION**

**SECTION 233713**
**DIFFUSERS, REGISTERS AND GRILLES**

## GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section includes ceiling and wall mounted diffusers, registers and grilles.

B. Related Sections:

1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

### 1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheets: Indicate materials of construction, finish, and mounting details; performance data including horizontal throw and vertical drop, total pressure and static-pressure drop, and noise ratings. Include all assumptions utilized for noise ratings. Indicate thermal insulation and acoustic insulation provided with materials information. Indicate mounting type.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
3. Color chips: Where custom colors are required.
4. Techzone compatibility statement: Where Armstrong TechZone ceiling system compatibility is required.

### 1.4 EXTRA MATERIALS

A. Furnish extra materials that match product installed.

1. Air baffles: Furnish quantity equal to 5 percent of the diffusers installed or a minimum of five.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Manufacturers:

1. Diffuser Registers and Grilles
   a. Donco.
   b. Metalaire; as manufactured by Metal Industries, Inc.
   c. Nailor Industries Inc.
   d. Price Industries.
   e. Titus
2. Laminar Flow Diffusers
   a. Price
   b. Titus
   c. Nailor
   d. AAF Flanders

B. See drawing schedules, plans and details for required materials, finishes, style, sizes, pattern, performance and accessories.

1. Internal insulation of slot diffuser plenums is not allowed. All slot diffuser plenums shall be externally insulated.

C. Laminar Flow Diffusers
1. Aluminum or Stainless steel construction with continuously welded joints.
2. Dual chamber construction to provide unidirectional, non-aspirating airflow and consistent face velocity. Exterior shall be insulated with ½ inch foil backed insulation.
3. Face operable damper and safety cables.
4. Filter units shall have static pressure port and be factory tested for leaks.
5. Mounting frame to match the ceiling condition identified on the architectural plans.

### 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."

## 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.

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 practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Engineer for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, fire dampers, terminal units, control valves and other above ceiling components.

D. Do not modify slot diffuser plenums nor penetrate slot diffuser plenums for piping, conduit, cable tray or other interferences.

E. Do not install diffuser neck mounted dampers, except where specifically scheduled as noted as such. Clarify the installation of all neck mounted dampers directly with the Engineer prior to furnishing the submittal.

F. Support all slot diffusers and laminar flow diffusers independently of the ceiling. Support all other diffusers, registers and grilles which weigh more than five pounds independently of the ceiling. Support all components independently of the ceiling if so required by Division 09 ceiling specifications and CISCA recommendations.

## 3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

B. Install air baffles in diffusers identified as being drafty. Confirm individual diffusers to be corrected with the space occupants and coordinate the installation of air baffles with the occupant's schedule. Confirm acceptability of draft reduction forty-eight (48) hours after air baffle installation with the space occupants and report results in writing.

**END OF SECTION**

# SECTION 235523
# LOW INTENSITY GAS FIRED RADIANT HEATERS

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes low-intensity, gas-fired, forced-draft radiant heaters.

1.3 GENERAL

1. Condensing System: Design gas-fired radiant systems to operate such that water vapor present in products of combustion will be condensed, and this heat of condensation will be extracted by the system and will be added to the heated space.

2. Vacuum Vented: To preclude the possibility of combustion gases escaping into the building, the entire system must be under a negative pressure at all times and vented to the outside atmosphere.

1.4 CODES AND STANDARDS

1. American National Standard / CSA Standard Gas-Fired Low Intensity Infrared Heaters:

a. Construct and certify gas-fired infrared heaters in accordance with latest edition ANSI Z83.20 / CSA 2.34 "Gas-Fired Low-Intensity Infrared Heaters" including all current supplements.

2. Installation Compliance: United States: Refer to National Fuel Gas Code NFPA 54/ANSI Z223.1 - latest revision.

3. CSA Compliance: Provide CSA Seal affixed to each burner name plate and provide CSA Certification of heater design as vented or unvented infrared heater for indoor installation.

4. National Standard Gas Piping Compliance: Install and connect gas piping to gas fired infrared heaters in accordance with United States: Refer to National Fuel Gas Code NFPA 54/ANSI Z223.1 - latest revision.

5. National Electrical Code Compliance: Install and connect electrical wiring to gas fired infrared heaters in accordance with: 1.) United States: Refer to National Electrical Code®, NFPA 70 - latest revision. Wiring must conform to the most current National Electrical Code®, local ordinances and any special diagrams furnished.

6. Venting: Venting shall be installed in accordance with the requirements within the manufacture installation operation and service manual and in compliance with United States: Refer to National Fuel Gas Code NFPA 54/ANSI Z223.1 – latest revision.

7. Compressed and Liquefied Natural Gas Installation: Installation must comply with Code for Motor Fuel Dispensing Facilities and Repair Garages NFPA 30A – latest revision. Heaters are certified by CSA to meet maximum tube temperature of 750℉ (399℃) in accordance with NFPA 30A (2012 edition) section 7.6.6.

6. National Performance Rating for Gas Fired Infrared Heaters Standard: Radiant output of gas fired infrared

heaters shall be rated in accordance with AHRI Standard 1330. Refer to Performance Rating for Radiant Output of Gas Fired Infrared Heaters Standard CAN/ANSI/AHRI 1330-2015.

1.5 ACTION SUBMITTALS

1 Product Data: For each type of product.

Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

2 Shop Drawings:

1 Signed, sealed, and prepared by or under the supervision of a qualified professional engineer.
2 Include plans, elevations, sections, and mounting details.
3 Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4 Detail fabrication and assembly of high-intensity, gas-fired, radiant heaters, as well as procedures and diagrams.
5 Include diagrams for power, wiring.

1.6 INFORMATIONAL SUBMITTALS

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

1 Structural members to which equipment will be attached.
2 Gas piping to heater installations
3 Thermostats and wiring to heaters.
4 Heater locations and clearance requirements.
5 Other suspended ceiling components including the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Sprinklers.

2 Field quality-control reports.

3 Sample Warranty: For manufacturer's special warranties.

1.7 CLOSEOUT SUBMITTALS

1 Operation and Maintenance Data: For gas-fired, radiant heaters to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Igniter: One hot-surface burner igniter(s) for each style of high-intensity, gas-fired, radiant heater furnished.

1.9 WARRANTY

Manufacturer to provide written warranty agreeing to replace/repair, within warranty period, components of gas fired infrared systems furnished by manufacturer, which are defective in either material or workmanship, provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty periods as follows:

1. Three (3) year warranty on the burner system from the date of final acceptance of the infrared heaters.
2. Five (5) year warranty from the date of final acceptance of cast iron combustion chambers.
3. Three (3) year warranty from date of final acceptance of all other components including electrical.

1.10 QUALITY ASSURANCE

A. Manufacturer's Qualifications

1. Firms regularly engaged in manufacture of gas fired infrared systems with characteristics, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than 15 years.

B. Alternate Manufacturers

1. Other low intensity infrared heaters of equal or greater thermal efficiency and with the same or lower burner firing rate capacity and with the infrared distribution pattern shown on drawing while CSA certified to be in compliance with NFPA 30A 7.6.6 (2012 edition) may be acceptable provided they meet the intent of these specifications and prior approval in writing is obtained from the engineer. If such systems are approved, the contractor assumes responsibility for the design, performance and expense of same. The redesigned system, gas piping, and electric wiring shall be done by a registered mechanical engineer. Shop drawings of the entire new system shall be provided by this contractor. The contractor should state the amount to be credited to the owner due to this substitution.

2. Where approved substitutes are used, the contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work as necessitated by other trades as a result of the substitutions.

3. The engineer reserves the right to require the contractor to remove and replace any material or equipment which does not meet specifications or does not have any prior approval as a substitute item. Work shall be completed without cost or inconvenience to the owner.

**PART 2 - PRODUCTS**

2.1 Manufacturers

A. Roberts-Gordon.

B. Dayton

C. Modine

D. Space-ray

E. Approved equal.

2.2 PERFORMANCE REQUIREMENTS

A. CSA certified, with CSA Seal and certification number clearly visible on units indicating compliance with ANSI Z83.20/CSA 2.34.

B. UL listed and labeled, with UL label clearly visible on units indicating compliance with ANSI Z83.20/CSA 2.34.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 Burner Box

A. Natural Gas burner assemblies consisting of heavy-duty cast-iron burner heads. Pre-wired gas controls with direct spark ignition module and combustion air filters. Provide minimum number of burners shown on plans to insure proper radiant heat distribution. Burners shall be designed for firing in tandem without adverse effects from combustion gases from upstream burners. Burners shall be CSA certified to be in compliance NFPA 30A (2012 edition) section 7.6.6.

B. Design firing rate of burners shall be as stated on drawings. Provide manufacturer recommended clearance to combustible surfaces as measured from the tube surface.

C. Premix Gas and Air: Provide burners to totally pre-mix air and gas required for combustion.

D. Constant Air/Gas Ratio: Provide burners designed to maintain constant proportion of fuel gas to filtered combustion air. Introduce both fuel gas and air at atmospheric pressure, and establish flow of both by means

of negative pressure on the downstream side of the flow metering orifices. If combustion air flow is impeded, gas flow rate will decrease in constant proportion to maintain proper gas/air mixture for complete combustion.

2.4 Burner Controls

A. Factory Wired: All burners shall be factory wired for 115 VAC with transformer for 24 VAC DSI operation and supplied with a grounded 24-30 inch (61–76 cm) three wire pigtail located at rear of burner

B. Fail-Safe Controls: To assure a high degree of fail-safe operation, the design shall preclude main flow of gas if any or all of the following abnormal conditions occur:

1. Power fails (Gas valves in burners close in safe position).

2. Main Valve fails in open position

3. Vacuum pump motor fails (Vacuum proving switch cuts power to burners).

B. Ignition Controls: All gas vacuum-firing burner units shall be equipped with a Direct Spark Ignition Module (DSI). The DSI module shall have a 15-second flame safety time per ignition trial before lockout occurs. In addition, the DSI module shall be capable of a minimum of 3 trials for ignition to provide maximum reliability.

2.5 Vacuum Pump (1/3 HP):

A. Outdoor Venting: The system shall vent all products of combustion outdoors by means of the vacuum pump.

B. Motor: Vacuum pump shall be equipped with a 1/3 horsepower, 60 hertz, 120/230 volts AC, 3450 RPM, single phase motor. This motor shall have thermal overload protection, high temperature sealed ball bearings, and shall be constructed in accordance with electric motor industry standards.

C. Housing: The scroll of this pump shall 12-gauge stamped steel construction. The impeller wheel shall be pressure cast 319-alloy aluminum with a minimum metal thickness of approximately 3/32 inch (.24 cm).

D. Pressure Switch: As an additional safety measure, there will be a low voltage (24 VAC) interlock circuit from the pressure switch (located at the inlet to the vacuum pump) to the controller to prove pump operation.

E. High Temperature Acoustical Isolation: The vacuum pump shall be acoustically isolated from the system with a flexible connector with a constant service temperature rating of 350ºF (177ºC) minimum. The connection between the 4” (10 cm) pump inlet and tailpipe is made with acoustic boot and clamps provided. The discharge connection is made with an acoustic boot and

schedule 40 steel pipe or 4 inch (10 cm) ABS schedule 5 pipe and fittings. The motor in the vacuum pump shall be secured with rubber mounts for acoustical isolation.

F. Rotation: Vacuum pump motor requires a grounded circuit 120/230 volts AC, single phase, 60 hertz for a maximum of 4.8/2.4 full load. This motor must have the same rotation to match the direction of the arrow on the fan scroll. If the motor is not rotating in this direction, it must be reversed by interchanging the black and red line leads as shown on the motor nameplate.

2.6 Provide high radiant reflective aluminum reflectors installed over all heat exchangers. Provide reflector joint pieces over heat exchanger fittings such as elbows so reflector covers heat exchanger continuously. In order to maximize radiant output and reduce convective heat losses, reflectors are to extend below the bottom of the heat exchanger tube.

A. Cover Elbow Fittings: Provide reflector joint pieces over heat exchanger elbows so reflector covers heat exchanger continuously.

B. End Cap Fittings: All reflectors at end of the heat exchanger pipe and any elbows joints shall have end caps to prevent convective heat from escaping.

C. Side Reflectors: System to have perimeter side extension reflector in certain areas of layout as shown on plan where specified. Side reflectors permanently attach to side of top reflector and are secured to the pipe by three side reflector supports and two "Z" clips for each 8’ (2.44 m) section of side reflector. To prevent convection losses, tilting of reflectors will not be acceptable.

D. Over Entire pipe Network: Standard reflectors shall be installed on all radiant pipe and tail pipe as indicated on system layout furnished.

2.7 Outside Air

A. Provide fresh outside air to supply each burner and end vent for the support of combustion air as called for on plans. Fresh outside air supply must be installed in accordance with the requirements within the installation operation and service manual.

1. Outside Air Blower: Blower shall be 167 watt, 60 hertz, 120 volts AC, 3000 RPM, single phase motor. Provides system with pressured outside air supply to each burner and end vent for the support of combustion air as called for on plans.

2. Fresh Air Filter Box: System shall be equipped with fresh air filter box providing pre-filtered outside air through 1” thick E-Z Kleen® aluminum mesh filters, or equivalent. Filter box to be constructed of 22-gauage galvanized steel with 8” (20 cm) inlet and outlet as per the manufacture of the infrared system specifications. The fresh air filter box must be installed

in accordance with the requirements within the installation operation and service manual.

2.8 Controls

A. Thermostats: Provide where indicated, low voltage type connected to infrared heater. Mount thermostat as noted on the drawing. All thermostats shall be numbered instead of marked in degrees.

2.9 Infrared Piping – Radiant Piping - Heat Exchanger

A. Radiant Tube: Shall be new schedule 40 ASTM A53 (Latest edition) grade B ERW black steel pipe TNC 4” (10 cm), both ends threaded to 4” (10 cm) NPT conforming to ANSI/ASME B1.20.1 (Latest edition).

B. Tail Pipe Tube: Shall be new schedule 40 ASTM A53 (Latest edition) grade B ERW black steel pipe TNC 4” (10 cm), both ends threaded to 4” (10 cm) NPT conforming to ANSI/ASME B1.20.1 (Latest edition).

C. Radiant Tube Fittings: Shall be 150 lb. malleable black iron 4” (10 cm), both ends threaded to 4” (10 cm) NPT conforming to ANSI/ASME B1.20.1 (Latest edition).

D. Tail Pipe Tube Fittings: Shall be 150 lb. malleable black iron 4” (10 cm), both ends threaded to 4” (10 cm) NPT conforming to ANSI/ASME B1.20.1 (Latest edition). For tubes as described in the installation, operation and service manual.

E. Hanging Materials: All system’s tube must be supported in accordance with best building practices, local codes, seismic requirements, and applicable standards and as shown on plans. Pipe shall pitch down at least ½” in 20’ (1.27 cm in 6.1 m) on radiant lines and 1” in 20’ (1.27 cm in 6.1 m) on tailpipe lines toward the vacuum pump.

F. End Vent Assembly: Each open end combustion chamber shall have an approved end vent with fresh air connected for the support of combustion air and the reflector shall terminate with an end cap, and be installed according to manufacturer’s installation operation and service manual and as shown on plans.

G. Condensate Piping: Above Ground: copper tubing type M hard drawn. Fittings: ANSI/ASME 816.23 cast brass or ANSI/AMSE 816.29, wrought copper. Joints ANSI/ASTM B32, solder, grade 95TA.

H. Condensate Neutralization Tube: Provide and install condensate neutralization tube as per the manufacture instructions in the installation operation and service manual.

**PART 3 EXECUTION**

3.1 EXAMINATION

A. Examine structures, substrates, areas and conditions, with Installer present, for compliance with requirements for installation tolerances, required clearances, and other conditions affecting performance of the Work.

B. Examine roughing-in for fuel-gas piping to verify actual locations of piping connections before equipment installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Equipment Installation: Install gas-fired, radiant heaters and associated gas features and systems according to NFPA 54.

B. Suspended Units: Suspend from substrate using chain hanger kits and building attachments.

1. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

C. Maintain manufacturers' recommended clearances for combustibles.

3.3 CONNECTIONS

A. Gas Piping: Comply with Section 231123 "Facility Natural-Gas Piping." Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.

B. Gas Connections: Connect gas piping to radiant heaters according to NFPA 54.

C. Where installing piping adjacent to gas-fired, radiant heaters, allow space for service and maintenance.

D. Vent Connections: Comply with Section 233113 "Metal Ducts".

E. Electrical Connections: Comply with applicable requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Install electrical devices furnished with heaters but not specified to be factory mounted.

3.4 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 tests and inspections with the assistance of a factory-authorized service representative:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Verify bearing lubrication.
3. Verify proper motor rotation.
4. Test Reports: Prepare a written report to record the following:

A. Test procedures used.
B. Test results that comply with requirements.
C. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

C. Gas-fired, radiant heaters will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial-temperature set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

3.6 TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain gas-fired, radiant heaters.

**END OF SECTION**

**SECTION 237433**
**DEDICATED OUTDOOR AIR UNITS**

# 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 packaged dedicated outdoor air handling units with refrigerant compressors, air-cooled condensers, natural gas heat, electric heat, energy recovery devices and required controls and safeties to provide a complete operational system.

B. Related Sections include the following:
1. Division 23 Section "HVAC Instrumentation and Control for HVAC" for control devices not packaged with units.

## 1.3 SUBMITTALS

A. Product Data: Include rated capacities, required maintenance clearances, ducted sound power ratings, furnished specialties, and accessories for each type of product indicated.

B. Shop Drawings:

1. Dimensions, weights, method of field assembly, location, and size of field connections.
2. Diagram power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For self-contained air-conditioners to include in emergency, operation, and maintenance manuals.

F. Warranty: Special warranty specified in this Section.

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

1. Structural members to which RTU's will be attached.
2. Roof openings.
3. Roof curbs and flashing.
4. Pipe penetrations.
5. Conduit penetrations.

1.4 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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2007

D. ARI Certification:

1. Cooling capacity shall be rated in accordance with ARI Standards.
2. Ducted sound power ratings shall be in accordance with ARI Standards.

1.5 COORDINATION

A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."

1.6 WARRANTY

A. General Warranty: Special warranty 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. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of self-contained air-conditioners that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

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. Filters: One set of filters for each unit.
2. Final fan belts: Two (2) sets for each belt driven fan. Field installed and sized by the Testing, Adjusting, and Balancing Contractor. Sized as required to deliver the necessary airflow through the system accounting for all system losses.
3. Final fan sheave: One (1) set for each belt driven fan. Field installed and sized by the Testing, Adjusting, and Balancing Contractor. Sized as required to deliver the necessary airflow through the system accounting for all system losses.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

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

a. Carrier Air Conditioning; Div. of Carrier Corporation.
b. Daikin International.
c. Trane Co. (The); North American Commercial Group.
d. JCI York
e. AAON

### 2.2 GENERAL DESCRIPTION

A. Description: Self-contained, factory-assembled, packaged rooftop dedicated outside air unit consisting of cabinet, compressor, evaporator fan, evaporator coil, air filters, energy recovery device and unit controls; and fully charged with refrigerant and oil.

B. Disconnect Switch: Factory mounted inside control panel.

### 2.3 CABINET

A. Frame and Panels: Structural-steel frame with double wall galvanized-steel panels with baked- enamel finish in color selected by Architect, and with access doors or panels. Exterior and interior panels shall be constructed of G90 Galvanized steel Provide pitched roof panels and lifting lugs. Cabinet leakage shall not exceed 1% following AHRI Standard 340/360. Exterior paint shall be capable of withstanding at least 2500 hours when tested in accordance with ASTM B 117-95.

B. Insulation: Minimum 2-inch thick to provide a R value of 13 for the assembly. Insulate coils sections. Provide solid metal liner on all surfaces exposed to the airstream.

C. Drain Pan: Stainless steel, complying with ASHRAE 62.1-2010.

D. Isolation: Spring isolators for mounting under base of unit, with minimum static deflection of 1 inch (25 mm).

E. Discharge Plenum: Cabinet extension with directional louvers.

F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2010.

## 2.4 FANS

A. Material: Galvanized steel.

B. Configuration: Double-width, double-inlet, backward curved centrifugal fan; statically and dynamically balanced.

C. Drive: Direct, with fan and motor resiliently mounted.

D. Fan Sheaves: Cast-iron or steel sheaves, dynamically balanced, bored to fit shafts and keyed.

E. Motor Sheave: Variable and adjustable pitch selected so required rpm are obtained when set at mid-position.

F. Rating: As recommended by the manufacturer or a minimum of one and one-half times nameplate rating of motor.

G. Bearings: Grease lubricated with grease lines extended to exterior of unit.

H. Variable Air Volume: Variable-frequency motor controller.

I. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

J. Motors: Open-drip-proof type.

1. Special Motor Features: Premium efficiency, as defined in Division 23 Section "Common Motor Requirements for HVAC Equipment."

K. Isolation: Mount fan and motor on common subbase and mount assembly on spring isolators with minimum static deflection of 1 inch (25 mm).

## 2.5 COMPRESSOR

A. Description: Hermetically sealed, 3600 rpm maximum, and resiliently mounted with positive lubrication and internal motor protection.

B. Compressor Type: Scroll. Internal overcurrent, overtemperature and pressure relief.

## 2.6 EVAPORATOR COIL

A. Direct-Expansion Coil: Seamless copper tubes expanded into aluminum fins.

B. Refrigerant Circuits: A separate circuit for each compressor, with externally equalized thermal- expansion valve with adjustable superheat, filter-dryer, sight glass, high-pressure relief valve, and charging valves. Coils shall be interfaced such that refrigerant circuit covers the entire coil face which has the total scheduled airflow of the unit/coil bank. All the air passes over an active circuit at all times.

INTEGRAL AIR-COOLED CONDENSER

C. Description: Factory assembled and tested; consisting of condenser coil, fans and motors, and cabinet.

1. Condenser Coil: Aluminum-fin copper tube with integral sub-cooler; leak tested to 425 psig (2930 kPa).
2. Condenser Fan: Direct-drive propeller type with permanently lubricated motor with built- in thermal-overload protection.
3. Low Ambient Control: Cycles fans to permit operation down to 0 deg F (minus 18 deg C).

## 2.7 REFRIGERATION SYSTEM

A. Description: Factory assembled and tested, and charged with CFC-free refrigerant; consisting of piping and accessories connecting scroll compressor, evaporator coil, and condenser coil, and including the following:

1. Four-way reversing valve and suction-line accumulator.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant dryer, replaceable core.
4. High-pressure switch.
5. Low-pressure switch.
6. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
7. Low ambient switch.
8. Brass service valves installed in discharge and liquid lines.

B. Provide separate refrigerant circuits for each compressor. Provide a minimum of two refrigerant circuits.

C. Refrigerant: R-32 or R-454B.

D. Provide hot gas bypass on one refrigerant circuit. Factory installed and wire all components.

## 2.8 HEATING COIL

A. Hot Gas Refrigeration reheat coil shall be provided to maintain system leaving air temperature.

## 2.9 HEAT EXCHANGER

A. Stainless steel heat exchanger and drain pan construction for natural gas fired burners with 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 interlocked with gas valve.
5. Flame rollout switch.
6. Fully modulating gas valve with turn down ratio of at least 4:1.
7. Electric space heater for gas burner compartment.

B. High Turndown Modulating Natural Gas Furnace shall be equipped with modulating gas valves, adjustable speed combustion blowers, stainless steel tubular heat exchangers, and electronic controller. Combustion blowers and gas valves shall be capable of modulation. Electronic controller includes a factory wired, field installed supply air temperature sensor. Sensor shall be field installed in the supply air ductwork. Supply air temperature setpoint shall be adjustable on the electronic controller within the controls compartment. Gas heater shall be capable of capacity turndown ratio as shown on the unit rating sheet. Heat trace shall be included on the condensate drain

## 2.10 AIR FILTERS

A. Extended-Surface, Disposable Panel Filters: 12-inch thick, dry, filters with fibrous media material formed into deep-V-shaped pleats and held by self-supporting wire grid holding frames, with nonflammable cardboard media and media-grid frame.

1. Efficiency: ASHRAE 52.2 MERV rating of 7 or higher.

B. Air-Pressure Switch: Indicates dirty filters.

## 2.11 ENERGY RECOVERY

A. Unit shall contain a factory mounted and tested energy recovery wheel. The energy recovery wheel shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seals and bearings. Frame shall slide out for service and removal from the cabinet.

B. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belt.

C. The energy recovery cassette shall be an Underwriters Laboratories Recognized Component for electrical and fire safety. The wheel drive motor shall be an Underwriters Laboratory Recognized Component and shall be mounted in the cassette frame and supplied with a service connector or junction box. Thermal performance shall be certified

by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment. Cassettes shall be listed in the AHRI Certified Products.

D. Unit shall include 2-inch-thick, pleated panel outside air and exhaust air filters with an ASHRAE MERV rating of 8, upstream of the wheels.

E. Hinged service access doors shall allow access to the wheel.

F. Polymer Energy Recovery Wheels

1. Shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without

   the use of tools to facilitate maintenance and cleaning. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.

2. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belts of stretch urethane shall be provided for wheel rim drive.
3. Polymer Energy recovery wheel cassette shall carry a 5-year non-prorated warranty, from the date of original equipment shipment from the factory. The first 12 months from the date of equipment startup, or 18 months from the date of original equipment shipment from the factory, whichever is less, shall be covered under the standard AAON limited parts warranty. The remaining period of the warranty shall be covered by Airxchange. The 5- year warranty applies to all parts and components of the cassette, with the exception of the motor, which shall carry an 18-month warranty. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided the Airxchange written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts. Refer to the Airxchange Energy Recovery Cassette Limited Warranty Certificate.
4. Total energy recovery wheels shall be coated with silica gel desiccant permanently bonded by a process without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.

## 2.12 CONTROLS

A. Control Package: Factory wired, including contactor, high- and low-pressure cutouts, internal- winding thermostat for compressor, control-circuit transformer, and non-cycling reset relay.

B. Time-Delay Relay: Five-minute delay to prevent compressor cycling for five minutes after a shutdown.

C. Adjustable Thermostat: Unit mounted to control the following:

1. Supply fan.
2. Compressor.
3. Condenser.
4. Hot-water coil valve.
5. Electric heater.

D. System Selector Switch: Off-heat-auto-cool.

E. Low ambient control down to 0 deg F for units without airside economizers.

F. Microprocessor Control Panel: Controls unit functions, including refrigeration and safety controls and the following:

1. Supply fan.
2. Supply-fan motor speed. Constant volume
3. Compressors.
4. Air-cooled condenser.
5. Panel-mounted control switch to operate unit in remote or local control mode, or to stop or reset.
6. Panel-mounted indication and adjustable control of the following:

    a. Operating status.
    b. System diagnostics and safety alarms.
    c. Supply-air temperature set point.
    d. Zone heating-temperature set point.
    e. Supply-air pressure set point.
    f. Economizer minimum position set point.
    g. Supply-air-pressure, high-limit set point.

7. Time-of-day control to cycle unit on and off.
8. Night-heat, morning warm-up cycle.
9. Power interruption restart mode.
10. Unit diagnostics and diagnostic code storage.
11. Dehumidification control with humidistat.
12. Building pressure control.
13. Unoccupied mode temperature setback and set forward with override thermostat.
14. Return air temperature limit.
15. Controller shall have volatile-memory backup.
16. Safety control operation:

    a. Smoke detectors: Stop fan and close outdoor air damper if smoke is detected.
    b. Provide additional contacts for alarm interface to fire alarm control panel.
    c. Fire alarm control panel interface: Provide control interface.
    d. Low discharge temperature: Stop fan and close outdoor air damper if supply air temperature is less than 40 deg F (4 deg. C).
    e. Defrost control for condenser coil: Pressure differential switch to initiate defrost sequence.

    f. Gas furnace operation:

        1) Occupied periods: Modulate burner to maintain discharge temperature.
        2) Unoccupied periods: Cycle burner to maintain setback temperature.

17. Interface requirements for HVAC instrumentation and control system:

    a. Interface relay for scheduled operation.
    b. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.

G. Sequence of Operation:

1. Rooftop unit to be supplied with all operating and safety controls to supply 55 deg F air at all times during occupied cycles. The supply air will be distributed to terminal units which are controlled by space thermostats (controls for terminal units are not provided by the RTU manufacturer).
2. RTU is indexed for occupied to unoccupied from a binary signal generated from the Building Automation System Operator's Work Station and DDC system.
3. Occupied cycle:

    a. The unit and all associated exhaust fans operate continuously
    b. The unit delivers room neutral air 68F (adjustable) to the building.
    c. The unit delivers 55F (adjustable) air to the building and modulates the supply volume in accordance with a pressure sensor 90% through the system. Terminal units regulate the delivery of air to each space.

4. Unoccupied cycle:

    a. The unit is cycled on a fully recirculated basis in the event the space temperature falls below 55 deg F or rises above 85 deg F or in the event the relative humidity exceeds 60 percent RH.
    b. The unit may be returned to occupied cycle through a 0-6 hour manual override switch located in the space.

5. The unit supplier shall be responsible for furnishing, installing, wiring, and adjusting 100 percent off all the controls required for the rooftop unit to perform the operating sequence. The indexing for the programmed occupied-unoccupied cycles shall be coordinated with ECC to receive the external input from the Building Automation System.

H. The Manufacturer/Supplier is responsible for including and providing the following related to data integration with and to the building automation system/environmental control system (Specification Section 23 09 00).

1. All hardware, firmware and software components required to provide the BACnet MS/TP protocol interface necessary to transmit the specified data points to the BAS system. The equipment manufacturer and/or equipment supplier is responsible for identifying and coordinating the required controls protocol with the successful ECC Contractor. The final result of the coordination shall be indicated on the written equipment submittal.
2. On-site technical labor to assist the ECC Contractor with the data integration and to verify the specified data points, including data values, change of state values and units and are communicated properly and completely to the BAS system. On-site technical assistance shall not be less than a minimum of 4 hours total time on the

job site for each piece of equipment installed with this time split over two separate site visits. Allow a minimum of 2 hours to assist the ECC Electrician and coordinate wiring terminations and a minimum of 2 hours to assist the ECC Programmer to confirm data connectivity. On-site technical assistance shall continue beyond these minimum times stated at no cost to the Owner nor revisions to the Contract amount nor schedule until such time as the Engineer of Record determines that the equipment operation, startup and graphics are satisfactory.

3. The equipment submittal shall state whether the equipment manufacturer or the equipment supplier is providing each of these items with personnel names and mobile phone numbers included in the submittal:

   a. On-site technical labor to assist the ECC Electrician.
   b. On-site technical labor to assist the ECC Programmer with data connectivity and graphics.

2.13 OUTDOOR AIR INTAKE

A. Height above roof as required.

B. Designed to resist all rain penetration at 100 percent economizer airflow.

2.14 ELECTRICAL

A. Power Connection: Provide for single connection of power to unit with unit mounted disconnect switch accessible from outside unit and control circuit transformer with built-in circuit breaker.

B. Service Outlets: Two (2) 115-V, GFCI type with weather cover.

C. Unit shall have a minimum interruption rating of 32 KA at 480V.

D. Variable frequency drives shall be provided in accordance with Division 26 sections.

2.15 ROOF CURB

A. Galvanized steel, insulated with metal insulation liner, gasketing and factory installed wood nailer; complying with NRCA standards; minimum height of 18 inches. Secure units to curbs and secure curbs to roof structure.

## PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units' level and plumb. Install according to ARI Guideline B.

B. Anchor units to structure.

C. Install seismic restraints.

## 3.2 CONNECTIONS

A. Install piping adjacent to unit to allow service and maintenance.

B. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to self-contained air-conditioners with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories."

C. Provide ductwork connections with 45-degree angle transition beginning from the casing inner surface. Fitting and shall be provided by mechanical contractor. AHU manufacturer to adjust opening to accept fitting and duct.

D. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.

E. Terminate return air duct through roof structure and insulate space between roof and bottom of unit with 2-inch- (50-mm) thick, acoustic duct liner.

F. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

G. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

## 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, 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.

C. Remove and replace malfunctioning units and retest as specified above.

## 3.4 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. Complete the following:

a. Inspect for visible damage to unit casing.
b. Inspect for visible damage to compressor, air-cooled outside coil and fans.
c. Inspect internal insulation.
d. Verify that labels are clearly visible.
e. Verify that clearances have been provided for servicing.
f. Verify that controls are connected and operable.
g. Verify that filters are installed.
h. Clean outside coil and inspect for construction debris.
i. Inspect for visible damage to furnace combustion chamber.
j. Clean furnace flue and inspect for construction debris.
k. Connect and purge gas line.
l. Adjust vibration isolators.
m. Inspect operation of dampers.
n. Lubricate bearings on fan.
o. Inspect fan wheel rotation for movement in correction direction without vibration and binding.
p. Adjust fan belts to proper alignment and tension.
q. Start unit according to manufacturer's written instructions:

1) Start refrigeration system in summer only.
2) Complete startup sheets and attach copy with Contractor's startup report.

r. Inspect and record performance of interlocks and protective devices; verify sequences.
s. Commission variable frequency drives for ramp settings, over/under voltage settings, auto restart, start on the fly and other settings as available.
t. Operate unit for an initial period as recommended or required by manufacturer.
u. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency. Adjust pilot to stable flame.

1) Measure gas pressure on manifold.
2) Measure combustion air temperature at inlet to combustion chamber.
3) Measure flue gas temperature at furnace discharge.
4) Perform flue gas analysis. Measure and record flue gas carbon dioxide and oxygen concentration.
5) Measure supply air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

v. Calibrate thermostats.
w. Adjust and inspect high temperature limits.
x. Inspect outside air dampers for proper stroke and interlock with return air dampers.
y. Start refrigeration system and measure and record the following:

1) Coil leaving air, dry and wet bulb temperatures.
2) Coil entering air, dry and wet bulb temperatures.
3) Outside air, dry bulb temperature.
4) Outside air coil, discharge air, dry bulb temperature.

z. Inspect controls for correct sequencing of heating, mixing damper, refrigeration and normal and emergency shutdown.

aa. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.

1) Supply air volume.
2) Return air volume.
3) Relief air volume.
4) Outside air intake volume.

bb. Simulate maximum cooling demand and inspect the following:

1) Compressor refrigerant suction and hot gas pressures.
2) Short circuiting of air through outside coil or from outside coil to outside air intake. Seal all coil bypasses.

cc. Verify operation of remote panel, including pilot light operation and failure modes.

Inspect the following:

1) High limit heat exchanger.
2) Warm up for morning cycle.
3) Freezestat operation.
4) Economizer to limited outside air changeover.
5) Alarms.

dd. 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 setpoints, building pressure control, scheduled unoccupied cycles and all other control features.

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 (2) 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 units. Refer to Division 1 Section "Demonstration and Training."

**END OF SECTION**

**SECTION 238110**
**UNITARY SPLIT HEAT PUMP SYSTEMS**

GENERAL

1.1. WORK INCLUDES

A. Summary:

1. Contractor provide:

a. Packaged unitary heat pump condensing units and accessories.
b. Packaged unitary heat pump furnace units and accessories.
c. Control of all components to meet the requirements of control sequences specified.

1.2. RELATED WORK

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

B. Specified elsewhere in the following Sections:

1. Section 23 0100 - Special Mechanical Requirements.
2. Section 23 2300 - Refrigerant Piping Systems.
3. Division 26 - Electrical Work.

1.3. QUALITY ASSURANCE

A. Units factory tested.

1.4. SUBMITTALS

A. Shop Drawings: Not required for Engineer/Architect review.

B. Samples: Not required for Engineer/Architect review.

C. Product data:

1. Provide the following information:

a. Performance data.
   1) Filter data.
   2) Coil data.
   3) Fan data including fan curves.
   4) Fan and casing sound levels.
   5) Electrical data.
   6) Accessories furnished.
b. Catalog information with dimensions, weights, loadings, required clearances, size and location of connections and accessories furnished.
c. Wiring diagrams.
d. Installation instructions.

2. In addition to the printed copies of the submittal, a portable document format (pdf) of the submittal shall be transmitted via email to the Engineer.

D. Project Information: Not required for Engineer/Architect review.

E. Contract Closeout Information:

1. Operating and maintenance data.
2. Owner instruction report.

F. Warranties: Provide one (1) year minimum material and labor warranty on all components from date of substantial completion.

1. Provide five (5) year material and labor warranty on compressors.

PART 2 - PRODUCTS

2.1. UNITARY SPLIT AIR CONDITIONER

A. Acceptable Manufacturers:

1. Outdoor heat pump condensing units:

a. Carrier.
b. Daikon.
c. Lennox.
d. Trane
e. York.

2. Indoor heat pump air handling units:

a. Carrier.
b. Daikon.
c. Lennox.
d. Trane
e. York.

3. Other manufacturers desiring approval comply with Division 1.

## 2.2. OUTDOOR HEAT PUMP CONDENSING UNIT

A. Condensing Unit: Air-cooled condensing unit, factory assembled, consisting of compressor, condenser coil and fan, and casing.

1. Units: CSA and UL approved; conforming to ARI Standard 210/240.
2. Operating range: 0-115 deg F outdoor with low ambient kits.
3. Factory installed filter drier.
4. Field or factory installed sight glass.
5. Exposed sweat refrigerant connections with re-useable service valves.

B. Compressor: Hermetic, scroll type mounted on rubber vibration isolators.

1. Motor: Wide operating range, dual voltage.
2. Internal spring isolation and 2-stage sound isolation.
3. Winding thermostat and current overload device coupled with pressure limiting valve.
4. Internal protection devices for:

   a. Motor overload.
   b. Locked rotor.
   c. Extreme voltage supply.
   d. Excessive winding temperatures.
   e. Extreme pressures.
   f. Loss of refrigerant charge.
   g. Compressor cycling.

5. Off cycle crankcase heater.

C. Controls: Provide controls in weather-tight control box behind accessible panel. Control circuit shall be 24 V. Microprocessor based defrost control shall initiate defrost cycle only to reduce compressor energy consumption. Provide anti-recycle timer to prevent short cycling. Provide hard start kit and outdoor thermostat.

D. Coil, Condenser: Seamless aluminum tubes, 3/8 IN OD, with aluminum fins mechanically bonded.

1. Two row.
2. Factory pressure and leak tested at 600 PSI.
3. Provide heavy duty protective grille on every side.

E. Fan, Condenser: Aluminum, aerodynamically designed, statically balanced.

1. Motor: Two-speed, single phase, direct drive, heavy duty, permanently lubricated, with built in thermal overload protection.
2. Mount fan and motor support to cabinet top.

3. Provide grille to protect fan.

F. Casing, Condensing Unit: 18 GA galvanized steel.

1. Finish: Phosphatized; epoxy resin primer; acrylic finish coat.
2. Removable end panel for access to components and connections.
3. Standard base size.
4. Mounting rails: Die formed; integral with base.
5. Drain holes in base pan.
6. Electrical and refrigeration connections in same location on units.

G. Accessories.

1. Provide four (4) 6” high equipment supports.

2.3. FURNACE UNIT

A. Casing: Suitable for upflow heat pump applications; consisting of fan, heat exchanger, evaporator coil, filter controls and casing.

1. UL approved as heating units; for installation in confined spaces with reduced clearances to combustible materials.
2. Wiring: Complete at factory.

a. Internal wiring: 105° C rated.
b. Low voltage wiring terminal strip.
c. Low and high voltage connections made from either side.

B. Heat Exchanger (GAS):

1. Condensing type.
2. Primary heat exchanger – aluminized steel construction.
3. Secondary heat exchanger Type 29-4C stainless steel construction.
4. UL approved.

a. Units shall contain a centrifugal power venter and blower fan with PSC motor. Motor shall be open drip-proof blower type with thermal overload protection.

C. Heating elements, (Electric): Open type nickel-chromium alloy.

5. UL approved.
6. Cover 70%, minimum, of air outlet area, minimize bypass air and reduce coil surface temperatures.

D. Heating Controls:

1. Igniter: silicon nitride type with adaptive heat up.

2. Dual solenoid combination gas valve and regulator. Gas valve opens when proper vent flow is sensed.
3. Control transformer: 24-volt.
4. Fan and limit safety controls.

E. Power Venter:

1. Induced draft type, purges heat exchanger before ignition.

F. Fan: Forward curved, centrifugal type, with locked blades.

1. Motor: Direct drive variable speed ECM motor with permanently lubricated bearings and separately isolated motor mounts.
2. Capacity: As required for heating and cooling.
3. Assembly mounted on casing slide rails for access and removal.

G. Filter: Throwaway type, 1" thick, mounted in filter grilles; sized to handle maximum CFM. Provide two additional sets of filters for each filter/grille.

H. Casing: G-90 steel, with cleaned and phosphatized, primed and baked enamel finish coat. Provide 1” thickness foil lined fiberglass insulation with an R value of 4.2.

I. Cooling Coil: Provide a factory tested A-frame coil with hydrophilic coating, complete with corrosion resistant drain pan and bolt on thermal expansion valve.

J. Controls:

1. Thermostat: Non-programmable auto heating/cooling, for remote mounting.
   Cooling: Single Stage

   Heating: Single Stage

## 2.4. HEAT PUMP AIR HANDLING UNIT

A. AHU: Indoor, packaged draw-thru air-handling unit for use in commercial heat pump split systems. Unit shall have a multi-position design and shall be capable 0f horizontal or vertical installation, on a floor or in a ceiling, with or without ductwork.

1. UL approved as heating units; for installation in confined spaces with reduced clearances to combustible materials.
2. Wiring: Complete at factory.

   a. Internal wiring: 105° C rated.
   b. Low voltage wiring terminal strip.

c. Low and high voltage connections made from either side.
3. All coils shall be designed and tested in accordance with ASHRAE 15 Safety Code for Mechanical Refrigeration, latest edition.
4. Unit insulation and adhesive shall comply with NFPA-90A requirements for flame spread and smoke generation.

B. Heating Elements, Electric: Open type nickel-chromium alloy.

1. UL approved.
2. Cover 70%, minimum, of air outlet area, minimize bypass air and reduce coil surface temperatures.
3. Heater assembly shall include contactors with 24 volt coils, power wiring, 24 volt control wiring terminal blocks, and a hinged access panel.
4. Single-point wiring connection.

C. Fan: Forward curved, centrifugal type, with locked blades.

1. Motor: Belt drive, ECM motor with permanently lubricated, sealed bearings and separately isolated motor mounts.
2. Capacity: As required for heating and cooling.
3. Inherent automatic-reset thermal overload protection.
4. Assembly mounted on casing slide rails for access and removal.

D. Filter: 2" thick, Merv 11, disposable filters mounted in side access racks; sized to handle maximum CFM. Provide one additional sets of filters.

E. Cabinet:

1. Constructed of galvanized steel.
2. Cabinet panels shall be fully insulated with 1” fire-retardant material. Insulation shall have a minimum R-Value of 4.2. Insulation shall contain an EPA-registered immobilized antimicrobial agent to effectively resist the growth 0f bacteria and fungi as proven by tests in accordance with ASTM standards G21 and 22.
3. Unit shall contain a corrosion-free condensate drain pan for both horizontal and vertical applications. Drain pans shall have connections on the right or left sides of unit to facilitate field connection. Drain pans shall have the ability to be sloped toward the right or left side of the unit to prevent standing water form accumulating in the pans.

F. Cooling Coil: Provide a factory tested direct-expansion coil with hydrophilic coating.

1. Copper tube with aluminum fins bonded to the tubes by mechanical expansion.
2. Coils shall have factory-installed thermostatic expansion valves (TXVs) for refrigerant control. The TXVs shall be capable of external adjustment.
3. Coils shall have a factory-installed bypass line and check valve assembly around the TXVs to allow liquid flow from the coil to the outdoor unit during

heating mode.

G. Controls:

1. Thermostat: Programmable multi-stage thermostat with 7-day clock, holiday scheduling, auto heating/cooling, for remote mounting.
2. Cooling: Single stage.
3. Heating: Multi-stage.
4. Heat pump:
   a. Electric – Stage 1.
   b. Electric – Stage 2.

5. Controls and control sequence:
   a. Compressor time guard shall prevent compressor start until it has been off for at least 5 minutes (approximately).
   b. Multi-staging (for heating): Higher stage heat is not enabled until preceding stage has been on for 15 minutes.
      Heating Stage 1: Heat pump operation

      Heating Stage 2: Drop heat pump and enable [Gas Heat] [Electric Heat] – 1

      Heating Stage 3: Add Electric Heat - 2

   c. Lock out electric heat for outdoor air temperature above 35° F (adjustable)

2.5. REFRIGERANT PIPING AND ELECTRICAL WORK

A. Refrigerant piping for quick connect installations: Pre-charged, factory assembled, in standard lengths.

1. Female couplings.
2. Suction line: Elastomeric closed cell insulated.
3. Provide gauge ports at condenser.

B. Refrigerant piping for field assembled piping: See Section 23 23 00.

C. Control wiring: Provide wiring between components for control functions. Provide separate conduits for low voltage (24 V) and line voltage (120/240 V) wiring.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which unitary heat pump condensing units and heat pump air handlers shall be installed.

B. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 GENERAL

A. Install unitary heat pump condensing units and heat pump air handlers where indicated, in accordance with equipment manufacturer's installation instructions, and with recognized industry practices, to insure that equipment complies with requirements and serves intended purposes.

B. Install unitary heat pump condensing units and heat pump air handlers with recommended clearances provided for service and maintenance.

C. Connect piping, wiring and control wiring.

3.3 ELECTRICAL CONNECTIONS

A. Ensure that HVAC equipment and components are wired properly, with rotation in direction indicated and intended for proper performance.

B. Furnish to Electrical Installer, manufacturer's wiring diagram and electrical requirements for installation of field-wiring required for equipment (including control panels); not work of this section.

3.4 FIELD QUALITY CONTROL

A. Upon completion of installation of HVAC equipment, and after motors have been energized with normal power source, test equipment to demonstrate compliance with requirements.

B. Where possible, field correct malfunctioning equipment, retest to demonstrate compliance. Replace equipment which cannot be satisfactorily corrected.

3.5 INSTALLATION OF UNITARY HEAT PUMP CONDENSING UNITS

A. Install condensing unit on six inch high equipment supports and secure unit and equipment supports to pad with anchor bolts.

B. Provide all necessary refrigerant piping, fittings, valves, etc., to provide a complete installation as indicated and as specified.

C. Provide the control devices furnished by the manufacturer, but not specified to be factory mounted in accordance with the manufacturer's instructions, complete with control wiring.

## 3.6 INSTALLATION OF UNITARY HEAT PUMP AIR HANDLERS

A. Contractor to coordinate with other work, including ductwork and electrical piping, as necessary to interface installation of equipment.

B. Coordinate the footprint of the unit with architectural, structural and electric components. Coordinate requirements for floor penetrations with other trades.

C. Provide for each direct expansion coil, all necessary refrigerant piping, fittings, valves, etc., to provide a complete installation as indicated and as specified. Install piping to allow service and maintenance.

D. Provide humidity condensate drain with P-trap and route condensate piping to floor drain or as otherwise indicated on the drawings. Trap shall be adequately sized to properly drain condensate.

E. Install remote thermostat and all control wiring.

## 3.7 INSTALLATION OF UNITARY CONDENSING UNITS

A. Install condensing unit secure unit to pad with anchor bolts.

B. Provide all necessary refrigerant piping, fittings, valves, etc., to provide a complete installation as indicated and as specified.

C. Provide the control devices furnished by the manufacturer, but not specified to be factory mounted in accordance with the manufacturer's instructions, complete with control wiring.

## 3.8 INSTALLATION OF UNITARY FURNACES

A. Contractor to coordinate with other work, including ductwork and electrical piping, as necessary to interface installation of equipment.

B. Coordinate the footprint of the unit with architectural, structural and electric

components. Coordinate requirements for floor penetrations with other trades.

C. Provide for each direct expansion coil, all necessary refrigerant piping, fittings, valves, etc., to provide a complete installation as indicated and as specified. Install piping to allow service and maintenance.

D. Provide humidity condensate drain with P-trap and route condensate piping to floor drain or as otherwise indicated on the drawings. Trap shall be adequately sized to properly drain condensate.

E. Install remote thermostat and all control wiring.

3.9 INSTALLATION OF UNITARY HEAT PUMP AIR HANDLERS

A. Contractor to coordinate with other work, including ductwork and electrical piping, as necessary to interface installation of equipment.

B. Coordinate the footprint of the unit with architectural, structural and electric components. Coordinate requirements for floor penetrations with other trades.

C. Provide for each direct expansion coil, all necessary refrigerant piping, fittings, valves, etc., to provide a complete installation as indicated and as specified. Install piping to allow service and maintenance.

D. Provide humidity condensate drain with P-trap and route condensate piping to floor drain or as otherwise indicated on the drawings. Trap shall be adequately sized to properly drain condensate.

E. Install remote thermostat and all control wiring.

**END SECTION**

**SECTION 238136**
**VARIABLE REFRIGERANT VOLUME AIR CONDITIONING**

## PART 1 - GENERAL

### 1.1 SUMMARY

A. The variable refrigerant volume (VRV) air conditioning system shall consist of multiple fan coil units, branch controller boxes, piping joints and headers and heat recovery condensing outdoor units all interconnected with a refrigeration distribution system using PID control. The outdoor units are direct expansion (DX), air-cooled heat recovery condensing units with variable speed driven compressors using R-410A refrigerant. All zones are each capable of operating separately with individual temperature control.

### 1.2 SUBMITTALS

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

B. Shop Drawings: Include plans, elevations, sections, details and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components and location and size of each field connection.
2. Furnished specialties and accessories.
3. Rated performance including discharge velocities and sound power characteristics and external static pressure capabilities.
4. Electrical power requirements, including voltage, phase and wiring configuration.
5. Electrical characteristics denoting disconnecting means locations.
6. Power diagrams and wiring diagrams (control and power).

C. Operation and maintenance data.

D. Field quality control reports.

E. Warranty: Sample of special warranty.

### 1.3 QUALITY ASSURANCE

A. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15 “Safety Standard for Refrigeration Systems”.

C. ASHRAE/IESNA Compliance: Applicable requirements to ASHRAE/IESNA 90.1-2013.

D. The units shall be listed by Electrical Laboratories (ETL) and bear the cETL label.

E. Performance: The outdoor units must meet or exceed the heating design capacities and cooling design capacities listed in the equipment schedule at the design outdoor ambient temperature and performance must be corrected for defrost.

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of VRV system that fail in materials or workmanship within specified warranty period.

1. Warranty period:

a. For all parts and labor: One (1) year from the date of Substantial Completion.
b. For compressor: Five (5) years from the date of Substantial Completion parts only warranty after the first year.

1.5 COORDINATION

A. Coordinate size, location and connection details with roof curbs, equipment supports and roof penetrations specified in Division 07 Section "Roof Accessories".

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Daikin AC.
2. LG.
3. Mitsubishi.
4. Trane.

2.2 HEAT RECOVERY CONDENSING UNIJTS

A. The heat recovery condensing units (HRCUs) shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers and capillaries, filters, shutoff valves, oil separators, service ports and refrigerant regulator.

B. The outdoor unit can be wired and piped with outdoor unit access from the left, right, rear or bottom.

C. The sound pressure level standard shall be no greater than 63 dB(A) at a distance of 10 feet on the roof.

D. The system will automatically restart operation after a power failure and will not cause any settings to be lost.

E. The unit shall incorporate an auto-charging feature and a refrigerant charge check function.

F. The following safety devices shall be included on the condensing unit, high pressure switch, control circuit fuses, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, overcurrent protection for the inverter and anti-recycling timers.

G. To ensure the liquid refrigerant does not flash when supplying to the various fan coil units, the circuit shall be provided with a sub-cooling feature.

H. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation.

I. The outdoor unit shall be capable of heating operation at -10 deg. F dry bulb ambient temperature without additional low ambient controls.

J. Unit Cabinet: The outdoor unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

K. Fan:

1. The condensing unit shall consist of one or more propeller type, direct driven fan motors that have multiple speed operation via a digitally commutating inverter.
2. The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type and be of high external static pressure. The fan shall be capable of providing 0.32 in. wg pressure.
3. The fan shall have a vertical discharge configuration.
4. The fan motor shall have inherent protection and permanently lubricated bearings.
5. The fan motor shall be provided with a fan guard to prevent contact with moving parts.

L. Condenser Coil:

1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.

M. Compressor:

1. The inverter scroll compressors shall be variable speed controlled which is capable of changing the speed to follow the variations in total cooling and

heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency or STD ON/OFF) shall be controlled to eliminate deviation from target value.

2. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll “G-type” with a maximum speed of 6,480 rpm.
3. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
4. The capacity control range shall be as low as 6% to 100%.
5. Each non-inverter compressor shall also be of the hermetically sealed scroll type.
6. Each compressor shall be equipped with a crank case heater, high pressure safety switch and internal thermal overload protector.
7. Oil separators shall be standard with the equipment together with an intelligent oil management system.
8. The compressor shall be spring mounted to avoid the transmission of vibration.
9. Units sized under 12 tons shall contain a minimum of 1 inverter driven compressor. In the case of multiple condenser modules, conjoined operation hours of the compressors shall be balanced by means of the duty cycling function, ensuring sequential starting of each module at each start/stop cycle, completion of oil return and completion of defrost for every 8 hours.

N. Electrical:

1. The unit electrical power shall be [**208**] [**480**] volt, 3 phase, 60 Hertz.
2. The control voltage between the indoor and outdoor unit shall be 16 VDC shielded, stranded 2 conductor cable.

## 2.3 BRANCH CONTROLLER BOX

A. Branch controller (BC) boxes shall be factory assembled, wired, piped and run tested.

B. When simultaneously heating and cooling, the units in heating mode shall energize their sub-cooling solenoid valve.

C. Unit Cabinet:

1. These units shall have a galvanized steel plate casing.
2. Each cabinet shall house multiple refrigeration control valves and a liquid gas separator.
3. The cabinet shall contain a tube in the tube heat exchanger.
4. The unit shall have sound absorption thermal insulation material made of flame and heat resistant foamed polyethylene.
5. Nominal sound pressure levels while operating shall be no greater than 43 dB (A).
6. Nominal sound pressure levels while stopping shall be no greater than 32 dB (A).

7. The cabinet shall have a condensate drain connection if required by the manufacturer.

D. Refrigerant Valves:

1. The unit shall be furnished with five (5) electronic expansion valves to control the direction of refrigerant flow.
2. The refrigerant connections must be of the braze type.

E. Electrical:

1. The unit electrical power shall be 208/230 volts, 1 phase, 60 Hertz.
2. The control voltage between the indoor and outdoor unit shall be 16 VDC, non-shielded, 2 conductor cable.

## 2.4 DUCTED FAN COIL UNITS

A. The unit shall be a ceiling concealed ducted indoor fan coil design that mounts above the ceiling with a 2-position, field adjustable return and a fixed horizontal discharge supply and shall have a modulating linear expansion device. The unit shall support individual control using DDC controllers.

B. The unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factor.

C. Unit Cabinet:

1. The unit shall be ceiling-concealed, ducted.
2. The cabinet panel shall have provisions for a field installed filtered outside air intake.

D. Fan:

1. The unit fan shall be an assembly with a direct driven fan(s) by a single motor. Multiple fans may be used for higher capacity units.
2. The indoor fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings.
3. The unit fan shall have capacity for a ducted air outlet system and ducted return air system to be field installed.

E. Filter: Return air shall be filtered by means of a factory installed MERV 5 filter installed at rear of unit.

F. Coil:

1. The indoor coil shall be of non-ferrous construction with smooth plate fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchanger.
3. All tube joints shall be brazed with phos-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A condensate pan and drain shall be provided under the coil.
6. The condensate shall be pumped with integral condensate pump capable of at least 20” lift.
7. Both refrigerant lines to the units shall be insulated.

G. Electrical: The unit electrical power shall be 208 volt, 1 phase and 60 Hertz.

2.5 CONTROLS

A. Operation of the system shall permit both individual cooling and individual heating of each fan coil simultaneously. Each fan or group of fan coils shall be able to provide set temperature independently via a local remote controller and through a BMS interface.

B. Branch controller (BC) boxes shall be located as shown on the drawings. The BC box shall consist of electronic expansion valves, refrigerant control piping and electronics to facilitate communications between the BC box and main processor and between the BC box and fan coils. The BC box shall control the operational mode of the subordinate fan coils.

1. All indoor units shall maintain the settings for: temperature setpoint, start/stop status, operating mode, fan speed, airflow direction in on-volatile memory each time they are changed. These settings shall not be lost upon a power loss event.
2. All indoor unit settings shall be adjustable through the BMS interface.
3. The entire system shall automatically restart upon a power loss event.
4. All indoor units shall be auto addressing.

C. Control Wiring Requirements:

1. All control wiring shall be done per the control wiring drawings provided on the drawings and in manufacturer’s installation instructions.
2. All control wiring shall be 16 awg, 2 conductor and stranded shielded cable.
3. All control voltage transformers shall be provided by the VRF equipment supplier.

D. Wall Mounted Temperature Sensor:

1. In all spaces, a wall mounted space temperature monitor/controller shall be mounted 46” above the finished floor to the center of the controller.
2. This monitor shall wire to the indoor unit that serves this space. Ducted units shall sense the temperature of the space at the wall sensor. Non-ducted units shall sense the temperature of the space on the fan coil unit return air.

E. Change Operation:

1. Start/stop, operation mode, temperature setting, fan speed and airflow direction.
2. Monitoring: Status, malfunction identification, malfunction code, filter sign, operation mode, temperature setting, fan speed and airflow direction.
3. Disable/enable wall mounted temperature sensors.
4. Allow user to define daily and weekly schedules.
5. Disable/enable contact based on occupied/unoccupied status.

F. BMS Interface: System shall be capable of full integration for all monitoring and setpoint modifications.

## 2.6 HVAC EQUIPMENT REQUIREMENTS

A. The equipment manufacturers shall bid job intent as described in specifications and drawings. The bid shall include all costs associated with manufacturer specific refrigerant piping, control wiring, electrical wiring and equipment cost. The equipment supplier shall provide to the mechanical engineer for review and to the bidding mechanical contractor a complete equipment data package. This package shall include, but is not limited to, equipment capacities at the design condition, power requirements, indoor units CFM/static pressures, fan curves, installation requirements and physical dimensions. All systems shall meet or exceed the heating and cooling design capacities at the design outdoor ambient temperature. Performance must be corrected for defrost.

B. The equipment supplier shall furnish a complete drawing package to the mechanical contractor prior to bid day for bidding and installation. The HVAC and electrical series design documents will be made available in electronic format for use by the equipment supplier in preparing their drawings. The equipment supplier shall provide all necessary refrigerant piping drawings, control wiring drawings and electrical wiring drawings.

C. The equipment supplier shall draft all piping circuits, components, overall building control schematic, detailed control wiring diagrams, system details and schedules for their system. The drawings shall convey all requirements to successfully install the equipment supplier’s system.

D. The submitted documents shall be complete system designs and show no less information than the HVAC equipment/controls contract bid documents.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. The system shall be installed by a factory trainer contractor.

B. Refrigerant piping distribution fittings and headers shall be furnished by the VRV manufacturer for contractor installation.

C. Install units’ level and plumb.

D. Install evaporator fan components using manufacturer's standard mounting devices securely fastened to building structure.

E. Install roof mounted, compressor/condenser components on equipment supports specified in Division 07 Section "Roof Accessories". Anchor units to supports with removable, cadmium-plated fasteners.

F. Install ground mounting, compressor/condenser components on 4-inch (100 mm) thick, reinforced concrete base, 4 inches (100 mm) larger on each side of the unit. Concrete reinforcement and formwork are specified in Division 03 Section "Cast-In-Place Concrete". Coordinate anchor installation with concrete base.

G. Install and connect precharged refrigerant tubing to component's quick connect fittings. Install tubing to allow access to unit.

H. Install seismic restraints.

I. Install fan coil units on restrained, spring isolators with a minimum static deflection of 1 inch (25 mm).

J. High/low pressure gas line, liquid and suction lines must be individually insulated between the outdoor and indoor units.

## 3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings and specialties.

B. Where piping is installed adjacent to the unit, allow space for service and maintenance of unit.

## 3.3 FIELD QUALITY CONTROL

A. Perform Tests and Inspections:

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. 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.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

## 3.4 DEMONSTRATION

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

1. The manufacturer shall provide 24 hours of on-site Owner training to be scheduled by the Owner. Sixteen hours (16) to be provided at startup and eight (8) hours to be provided 30 days later. The manufacturer shall provide two (2) days of training at the manufacturer's training center. The training shall include system diagnostics and troubleshooting and shall be a hands-on training class using a working system in the training center.

**END OF SECTION**

**SECTION 238219**
**FAN COIL UNITS**

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 fan-coil units and accessories.

1.3 DEFINITIONS

A. BAS: Building automation system.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. LEED Submittals:

1. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.
2. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."

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. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer installed and field installed wiring.
2. Manufacturer's color charts showing full range of color sections available.

D. Coordination Drawings: Floor plans, reflected ceiling plans, 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. Ceiling suspension components.
2. Structural members to which fan-coil units will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. Electrical conduit.
g. Smoke detectors, exit signs, security systems and other system components.

6. Perimeter moldings for exposed or partially exposed cabinets.

E. Manufacturer Seismic Qualification Certification: Submit certification that fan-coil units, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." 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.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For fan-coil units 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. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

## 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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

## 1.6 COORDINATION

A. Coordinate layout and installation of fan-coil units and suspension system components with other construction that penetrates or is supported by ceilings,

including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate size and location of wall sleeves for outdoor-air intake.

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. Final fan belts: Two (2) sets for belt-driven fan. Field installed and sized by the Testing, Adjusting, and Balancing Contractor. Sized as required to deliver the necessary airflow through the system accounting for all system losses.
2. Final fan sheave: One (1) set for each belt-driven fan. Field installed and sized by the Testing, Adjusting, and Balancing Contractor. Sized as required to deliver the necessary airflow through the system accounting for all system losses.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Airtherm; a Mestek Company.
2. Carrier Corporation.
3. Environmental Technologies, Inc.
4. Williams
5. International Environmental Corporation.
6. Johnson Controls.
7. Daikin International.
8. Trane.

B. Description: Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

C. Coil Section and Fan Section Insulation: [**1/2-inch thick, matte finish, closed cell foam**], [**1/2-inch fiberglass with foil faced lining**] complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916. [**Provide solid metal inner lining over all insulation exposed to the airstream.**]

1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.

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

D. Main and Auxiliary Drain Pans: **[Insulated galvanized steel with plastic liner.] [Stainless steel.]**. Fabricate pans and drain connections to comply with ASHRAE 62.1. Include secondary drain connection

E. Chassis: Galvanized steel where exposed to moisture. Floor-mounting units shall have leveling screws.

F. Cabinet: Steel with [**factory prime coating, ready for field painting**] [**baked-enamel finish in manufacturer's standard paint color as selected by Architect**].

1. Vertical Unit Front Panels: Removable, steel, with integral stamped steel discharge grille and channel-formed edges, cam fasteners, and insulation on back of panel.
2. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with integral stamped cast-aluminum discharge grilles.

3. Stack Unit Discharge and Return Grille: Aluminum double-deflection discharge grille, and louvered- or panel-type return grille; color as selected by Architect from manufacturer's standard colors. Return grille shall provide maintenance access to fan-coil unit.
4. Steel recessing flanges for recessing fan-coil units into ceiling or wall.

G. Outdoor-Air Wall Box: Minimum 0.1265-inch- (3.2-mm-) thick, aluminum, rain-resistant louver and box with integral eliminators and bird screen.

1. Louver Configuration: [**Horizontal**] [**Vertical**], rain-resistant louver.
2. Louver Material: Aluminum.
3. Bird Screen: 1/2-inch (13-mm) mesh screen on interior side of louver.
4. Decorative Grille: On outside of intake.
5. Finish: [**Anodized aluminum**] [**Baked enamel**], color as selected by Architect from manufacturer's [**standard**] [**custom**] colors.

H. Outdoor-Air Damper: Galvanized-steel blades with edge and end seals and nylon bearings; with [**electronic**] [**pneumatic**], [**two-position**] [**modulating**] actuators.

I. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Washable Foam: 70 percent arrestance and 3 MERV.
2. Glass Fiber Treated with Adhesive: 80 percent arrestance and 5 MERV.
3. Pleated Cotton-Polyester Media: 90 percent arrestance and 7 MERV.

J. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

K. Fan and Motor Board: Removable.

1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Motor: Permanently lubricated, multi-speed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
3. Wiring Termination: Connect motor to chassis wiring with plug connection.

L. Control devices and operational sequences are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."

M. BAS Interface Requirements:

1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at the central workstation.
3. Provide [**BACnet**] [**or**] [**LonWorks**] interface for central BAS workstation for the following functions:

    a. Adjust set points.
    b. Fan-coil-unit start, stop, and operating status.
    c. Data inquiry, including [**outdoor-air damper position,** ]supply- and room-air temperature[ **and humidity**].
    d. Occupied and unoccupied schedules.

N. Electrical Connection: Factory wire motors and controls for a single point electrical connection to power source. Mount components within a steel enclosure box with a removable cover.

1. Factory mounted transformer for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source. Minimum 50VA transformer size.
2. Wiring terminations: Fan and controls to terminal strip and terminal lugs to match quantities, sizes, and materials of branch circuit conductors. Enclose terminal lugs in terminal box sized according to NEMA 70.
3. Disconnect switch: Factory mounted, non-fused, disconnect switch. Single point power connection.
4. Refer to Drawings for additional accessories.

5. Fan speed controller: Unit mounted minimum 3 speed control switch with off position.
6. Fan speed controller: Unit mounted adjustable from 60% to 120% of scheduled conditions.

7. Condensate pan high level switch wired to shutdown fan.

O. Ducted Fan Coil Units:

1. Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color.

a. Supply-Air Plenum: Sheet metal plenum finished and insulated to match the chassis[ **with mill-finish, aluminum, double-deflection grille**].
b. Return-Air Plenum: Sheet metal plenum finished to match the chassis.

c. Mixing Plenum: Sheet metal plenum finished and insulated to match the chassis with outdoor- and return-air, formed-steel dampers.
d. Dampers: Galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.

2. Indoor Refrigerant Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), and brazed joints at fittings. Comply with AHRI 210/240, and leak test to minimum 450 psig (3105 kPa) for a minimum 300-psig (2070-kPa) working pressure. Include thermal expansion valve.

3. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multi-speed motor resiliently mounted in the fan inlet. Aluminum or painted steel wheels and painted steel or galvanized steel fan scrolls.

4. Belt-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the cabinet. Adjustable sheaves. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fan-coil units level and plumb.

B. Install fan-coil units to comply with NFPA 90A.

C. Suspend fan-coil units from structure with **[elastomeric][spring]** hangers. Vibration isolators are specified in other Division 23 Sections.

D. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

E. Do not operate fan coil units until Substantial Completion except for test, adjust, and balance. Turn off units after test, adjust, and balance is complete. Drain coils in vestibule units to prevent freezing of coils.

F. Install all fan coil units such that the bottom of the fan coil unit is no more than 12” above the finished ceiling. Maintain access to electrical disconnects. Maintain access to fan motors. Maintain access to filter housings. Do not install utilities below the fan coil unit.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Install piping adjacent to machine to allow service and maintenance.
2. Connect piping to fan-coil-unit.
3. Connect condensate drain to indirect waste.
    a. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.

B. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Division 23 Section "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

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:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

## 3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

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 Project during other than normal occupancy hours for this purpose.

## 3.6 CLEANING

A. After installing units, inspect unit cabinet for damage to finish. Remove paint splatters and other spots, dirt and debris. Repair damaged finish to match original finish.

B. After installing units, clean fan coil units internally according to manufacturer’s written instructions.

## 3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan-coil units. Refer to Division 1 Section "Demonstration and Training."

**END OF SECTION**

**SECTION 238239**
**UNIT HEATERS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cabinet unit heaters with centrifugal fans [**electric-resistance heating**] coils.
2. Propeller unit heaters with [**electric-resistance heating**] coils.
3. Wall and ceiling heaters with propeller fans and electric-resistance heating coils.
4. Combustion air heaters with steam coils.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. CWP: Cold working pressure.

C. PTFE: Polytetrafluoroethylene plastic.

D. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.

B. LEED Submittal:

1. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."

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. Plans, elevations, sections, and details.
2. Location and size of each field connection.

3. Details of anchorages and attachments to structure and to supported equipment.
4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
5. Location and arrangement of piping valves and specialties.
6. Location and arrangement of integral controls.
7. Wiring Diagrams: Power, signal, and control wiring.

D. Coordination Drawings: Floor plans, reflected ceiling plans, 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 unit heaters will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.

6. Perimeter moldings for exposed or partially exposed cabinets.

E. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.

F. Samples for Verification: Finish colors for each type of cabinet unit heater and wall and ceiling heaters indicated with factory-applied color finishes.

G. Manufacturer Seismic Qualification Certification: Submit certification that cabinet unit heaters, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." 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.

H. Field quality-control test reports.

I. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, 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 a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

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. Cabinet Unit Heater Filters: Furnish two spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 CABINET UNIT HEATERS

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

1. Electric cabinet heaters:

a. Berko Electric Heating.
b. Chromalox.
c. Indeeco.
d. Markel Products Company.
e. Q-Mark.
f. Trane.

2. Hydronic cabinet heaters:

a. Airtherm.
b. Carrier.
c. International Environmental Corporation.
d. Rosemex.
e. Sigma Products.
f. Sterling.
g. Trane.

B. Description: A factory-assembled and -tested unit complying with AHRI 440.

1. Comply with UL 2021.

C. Coil Section Insulation: ASTM C 1071; surfaces exposed to airstream shall be aluminum-foil facing to prevent erosion of glass fibers.

1. Thickness: 1 inch (25 mm).
2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F (0.037 W/m x K at 24 deg C) mean temperature.
3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Cabinet: Steel with **[factory prime coating, ready for field painting] [baked-enamel finish with manufacturer's standard paint, in color selected by Architect] [baked-enamel finish with manufacturer's custom paint, in color selected by Architect].**

1. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch- (1.35-mm-) thick, galvanized, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners. Front grille air inlet and air outlet.
2. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0528-inch- (1.35-mm-) thick, galvanized, sheet steel, removable panels secured with tamperproof cam fasteners and safety chain. Bottom panel grille for air inlet and air outlet.
3. Recessing Flanges: Steel, finished to match cabinet.
4. Control Access Door: Key operated.
5. Airflow configuration:

a. Air inlet: Front of cabinet, lower portion.
b. Air discharge: Front of cabinet, upper portion.

6. Base: Minimum 0.0528-inch- (1.35-mm-) thick steel, finished to match cabinet, 4 inches (100 mm) high with adjustable leveling bolts.

7. Extended Piping Compartment: 8-inch- (200-mm-) wide piping end pocket.
8. False Back: Minimum 0.0428-inch- (1.1-mm-) thick steel, finished to match cabinet.

E. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Glass Fiber Treated with Adhesive: 80 percent arrestance and 5 MERV.
2. Pleated: 90 percent arrestance and 7 MERV.
3. Cleanable aluminum mesh media, 1/2-inch thick.

F. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

G. Fan and Motor Board: Removable.

1. Fan: Forward curved, [**high static,**] double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Motor: Permanently lubricated, multi-speed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
3. Wiring Terminations: Connect motor to chassis wiring with plug connection.
4. Provide motor fusing for fans in units with electric heat.

H. Basic Unit Controls:

1. Control voltage transformer.

2. [**Wall-mounting**] [**Unit-mounted**] thermostat/sensor with the following features.

a. Heat-off switch.
b. Fan on-auto switch.
c. Manual fan speed switch, three speed, unit mounted and wired.
d. Adjustable deadband.
e. Concealed set point.
f. Concealed indication.
g. Deg F (Deg C) indication.
h. Two pole thermostat with an OFF position on the detail.

3. Unoccupied period override push button.

4. Data entry and access port.

a. Input data includes room temperature, and occupied and unoccupied periods.
b. Output data includes room temperature, supply-air temperature, entering-water temperature, operating mode, and status.

I. BAS Interface Requirements:

1. Interface relay for scheduled operation.

2. Interface relay to provide indication of fault at central workstation.

3. Interface shall be compatible for central BAS workstation and include the following functions:

    a. Adjust set points.
    b. Cabinet unit heater start, stop, and operating status.
    c. Data inquiry, including supply-air and room-air temperature.
    d. Occupied and unoccupied schedules.

J. Electrical Connection: Factory wire motors and controls for a single point electrical connection to power source. Provide factory mounted non-fused disconnect switch.

2.2 PROPELLER UNIT HEATERS

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

1. Electric heaters:

    a. Berko Electric Heating.
    b. Chromalox.
    c. Indeeco.
    d. Markel Products Company.
    e. Q-Mark.

B. Description: An assembly including casing, coil, fan, and motor in **[vertical] [and] [horizontal]** discharge configuration with adjustable discharge louvers. Minimum 18 gage steel casing.

C. Comply with UL 2021.

D. Comply with UL 823.

E. Cabinet: Removable panels for maintenance access to controls.

F. Cabinet Finish: Manufacturer's [**standard**] [**custom**] baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.

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

H. Discharge Louver: Adjustable fin diffuser for horizontal discharge units and conical diffuser for vertical discharge units.

I. Electric-Resistance Heating Elements: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch (4 mm). Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F (288 deg C) at any point during normal operation.

1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.

2. Wiring Terminations: Stainless-steel or corrosion-resistant material.

J. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi. Static and dynamic balance. Include fan guard.

K. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Type: Permanently lubricated, multispeed.
2. Automatic reset thermal overload protection.

L. Control Devices:

1. Unit-mounted, fan-speed switch.
2. Unit-mounted thermostat, two pole thermostat with an OFF position on the dial.
3. All internal wiring shall be by manufacturer; motor prewired to an electrical junction box.
4. Mount electrical components in galvanized enclosure with removable cover.

M. Provide single point electrical connection to power source with factory mounted non-fused disconnect switch.

## 2.3 WALL AND CEILING HEATERS

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

1. Berko Electric Heating; a division of Marley Engineered Products.
2. Chromalox, Inc.; a division of Emerson Electric Company.
3. Indeeco.
4. Markel Products; a division of TPI Corporation.
5. Marley Electric Heating; a division of Marley Engineered Products.
6. QMark Electric Heating; a division of Marley Engineered Products.

B. Description: An assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

C. Cabinet:

1. Front Panel: Stamped-steel louver with removable panels fastened with tamperproof fasteners.
2. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Surface-Mounting Cabinet Enclosure: Steel with finish to match cabinet.

E. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high temperature protection. Provide integral circuit breaker for overcurrent protection.

F. Fan: Aluminum propeller directly connected to motor.

1. Motor: Permanently lubricated, multispeed. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

G. Controls: Unit-mounted thermostat, two pole thermostat with an OFF position on the dial.

H. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

## 2.4 COMBUSTION AIR HEATERS

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

1. Armstrong.
2. L.J. Wing.
3. Marlo.

B. Description:

1. A factory assembled unit to heat outside air for the boiler room. Unit shall be capable of maintaining discharge air temperature regardless of fluctuations in inlet air temperature. Each unit will consist of a heater section containing an integral face and bypass coil consisting of built-in multiple alternate finned heating elements and bypasses. Separate dampers shall control the airflow through these face and bypass sections. Each set of dampers shall be interlocked and controlled by a separate [**electric**] damper motor. Actuator provided by the [**unit manufacturer.**][**ECC.**] Finned heating elements shall be fabricated of seamless return bend type 3/8" o.d. copper tubes with rectangular 0.010" thick aluminum fins. Each tube shall be secured to the headers by a brazed joint. The opposite end of the tubes shall be secured by channel shaped retainers that permit expansion and contraction. Finned elements shall be factory tested with 200 psig steam and 500 psig hydrostatic pressure. Unit shall have a propeller type fan driven by a TEFC motor with characteristics as scheduled. Casing and discharge shall be constructed of galvanized sheet metal.

C. Controls:

1. Unit shall be controlled by the Building Automation System with a room thermostat and overriding low limit thermostat to prevent the unit’s discharge temperature from falling below the desired minimum.

D. Discharge – Horizontal Units:

1. Unit shall have a discharge consisting of horizontal and vertical vanes for adjustable airflow projection and spread. Discharge shall be attached to and supported by flanged brackets bolted to the outlet of the unit for easy vane positioning.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for [**piping and**] electrical connections to verify actual locations before unit heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Division 7 Section "Joint Sealants."

B. Install cabinet unit heaters to comply with NFPA 90A.

C. Install propeller unit heaters level and plumb.

D. Suspend cabinet unit heaters from structure with elastomeric hangers and seismic restraints. Vibration isolators and seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

E. Suspend propeller unit heaters from structure with all-thread hanger rods and spring hangers. Hanger rods and attachments to structure are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

F. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

G. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.

D. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Division 23 Section "Air Duct Accessories."

E. Comply with safety requirements in UL 1995.

F. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of unit heater. Hydronic specialties are specified in Division 23 Section "Hydronic Piping."

G. Unless otherwise indicated, install union and gate or ball valve on steam-supply connection and union, strainer, steam trap, and gate or ball valve on condensate-return connection of unit heater. Steam specialties are specified in Division 23 Section "Steam and Condensate Heating Piping."

H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

## 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:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

## 3.5 ADJUSTING

A. Adjust initial temperature set points.

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 Project during other-than-normal occupancy hours for this purpose.

## 3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters. Refer to Division 1 Section "Demonstration and Training."

**END OF SECTION**

SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL SYSTEMS

GENERAL

**1.01** RELATED DOCUMENTS

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

**1.02** SUMMARY

A. Section Includes:

1. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
4. Grout.
5. Common electrical installation requirements.
6. Electrical demolition.
7. Cutting and patching for electrical construction.

**1.03** DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

**1.04** SUBMITTALS

A. Product Data: For sleeve seals.

**1.05** 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 used.

B. Comply with NFPA 70.

C. Include in the Work, as a part of the Bid Proposal, labor, materials, services, apparatus, drawings (in addition to the Contract Documents) as required to complete the intended work.

D. Work for the Project must be performed in accordance with Federal, State and Local Laws, Ordinances, Codes, Rules and Regulations, pertaining to the Work which are hereby made a part of the Contract Documents by reference, the same as if repeated herein in their entirety. Where Contract Documents exceed these requirements, the Contract Documents shall govern. In no case shall Work be installed contrary to or below the minimum legal standards.

**1.06** COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 8 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Firestopping."

**1.07** RECORD DRAWINGS

A. Contractor shall provide owner with a complete set of accurate Record Drawings for all work performed under this contract.

1. Record Drawings shall include all approved change orders and pertinent RFI responses.
2. Include actual dimensions of equipment furnished under this contractor where shown on the floor plans.
3. Record Drawings shall include work performed by all sub-contractors retained.
4. Record Drawings shall include the words “RECORD DRAWING” on each sheet.

B. Submission:

1. Submit one set of record Drawings for review by Engineer prior to submission of closeout documents. Record Drawings shall be submitted using the established submittal process.
2. Upon satisfactory review of the Record Drawing submittals by Engineer, provide three (3) copies in electronic format with closeout documents
3. Paper Record Drawings shall be printed full size using the same sheet size as the construction documents issued to the contractor with the contractor’s title block.
4. Electronic Record Drawings shall include multi-sheet PDF files combined and named by discipline].

PART 2 PRODUCTS

**2.01** 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.

B. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

1.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.
2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
3. Pressure Plates: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

1.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, non-corrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 2 - EXECUTION

2.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

2.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting 2”-3” extending out of both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 7 Section "Firestopping."

J. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

K. Above Ground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

L. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

2.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

2.4 CUTTING AND PATCHING

A. Refer to Division 2 for general cutting and patching requirements and procedures.

B. Cut, channel, chase and drill floors, walls, partitions, ceilings and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

C. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

2.5 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Firestopping."

2.6 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION 26 05 00

# SECTION 26 05 19
# LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

B. Related Sections include the following:

1. Division 27 Section "Communications Horizontal Cabling" for cabling used for voice and data circuits.

### 1.3 SUBMITTALS

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

B. Field quality-control test reports.

### 1.4 QUALITY ASSURANCE

A. Contractor with qualifications and minimum ten (10) years experience in installation, splicing and testing of low voltage power conductors may be considered at discretion of Architect/Engineer, as acceptable agency.

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 CONDUCTORS AND CABLES

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

1. Encore Wire.
2. Nexans.
3. Southwire Company.
4. United Copper Industries.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THW and THHN-THWN.

D. Multiconductor Cable: Comply with NEMA WC 70 for armored cable, Type AC, metal-clad cable, Type HCF with green ground, Type SO and Type USE with ground wire.

## 2.2 VARIABLE FREQUENCY DRIVE CABLE

A. Conductors between a VFD and the motor shall be a Tray Cable rated assembly of 3 phase conductors, 3 symmetrical full-size equipment ground conductors, and an overall spiral copper tape shield providing 100% shielding.

B. Installation: VFD cable shall be installed in raceway. Proper cable bending radius requirements must be followed to avoid damage to the cable. All cables must be installed and terminated per manufacturer instructions.

C. Installation of 6’ or less: VFD cable runs of 6 feet or less can be run without raceway, if Armored VFD cable is used, with UL listed termination fittings.

D. Listings. Cable shall meet the following standards:

1. 600V UL 1277 Type TC-ER per 2005 NEC Article 336; 1000V CSA AWM I/II A/B FT4; Bare Copper Conductors; Class B Stranding per ASTM; XLPE Insulation XHHW-2 Rated Circuit Conductors; 90°C Wet/Dry; Class I & II; Division 2 Hazardous Locations; UL 1685 Vertical Tray Flame Test; IEEE 1202/383 Vertical Tray Flame Test; UL Direct Burial; RoHS Compliant; CE Approved

2. Cables shall be:

   a. Belden Basics® VFD Cable

   b. Service Wire ServiceDrive® ASD/VFD Shielded Tray Drive Cable

## 2.3 CONNECTORS AND SPLICES

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

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

F. 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 MATERIAL APPLICATIONS

A. Feeders: Copper solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. The minimum conductor size shall be #12 AWG.

D. Voltage Drop: Branch circuit conductors shall be sized for a maximum voltage drop of 3 percent to comply with the requirements of ASHRAE Standard 90.1-2007. The following are minimum allowable conductor sizes based on circuit length. The circuit length shall be measured from the branch panelboard to the furthest device in that circuit. The phase and neutral conductors shall be sized as indicated on the entire length of that circuit unless a larger size conductor is indicated on the drawings.

1. Conductor sizes for 20A/1-Phase/120 volt circuits shall be as follows unless noted otherwise:

    a. Circuit length of 0 to 95 feet: #12 awg.
    b. Circuit length of 96 to 150 feet: #10 awg.
    c. Circuit length of 151 to 235 feet: #8 awg.
    d. Circuit length of 236 to 380 feet: #6 awg.

### 3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Feeders: Type THHN-THWN, single conductors in raceway.

B. Branch Circuits (minimum #12 AWG): Type THHN-THWN, single conductors in raceway Metal-clad cable, Type HCF with green ground conductor.

C. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh and strain relief device at terminations to suit application.

D. Class 1 Control Circuits: Type THHN-THWN, in raceway.

E. Class 2 Control Circuits: Type THHN-THWN, in raceway.

### 3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

G. Each branch circuit shall be provided with a dedicated neutral conductor. Sharing of the neutral conductor between multiple circuits will not be allowed.

H. A single raceway shall be limited to a maximum of six current carrying conductors.

## 3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

## 3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test feeder conductors for compliance with requirements.

    a. Megger Test for insulation integrity.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
    c. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    d. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.

3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 05 19

# SECTION 26 05 26
# GROUNDING AND BONDING FOR ELECTRICAL SYSTEM

## GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment, plus the following special applications:
   1. Common ground bonding system.

### 1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Ground rods.
   2. Grounding arrangements and connections for separately derived systems.
   3. Grounding for sensitive electronic equipment.

### 1.4 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 UL 467 for grounding and bonding materials and equipment.

## PART 2 - PRODUCTS

### 2.1 CONDUCTORS

A. Insulated Conductors: Tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

   1. Solid Conductors: ASTM B 3.
   2. Stranded Conductors: ASTM B 8.
   3. Tinned Conductors: ASTM B 33.
   4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
   5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
   6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Rectangular bars of annealed copper, 1/4” thick X 6” high X 18” long with holes, unless otherwise indicated; with insulators.

## 2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

## 2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch in diameter by 10 feet long.

# PART 3 - EXECUTION

## 3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.

B. Grounding Bus: Install in electrical and communication rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.
5. Water Service: Bolted connectors.
6. Fire Protection Service: Bolted connectors.
7. Natural Gas Service: Bolted connectors.

## 3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors for all electrical distribution, in addition to those required by NFPA 70 and as follows:
   1. Feeders and branch circuits.
   2. Lighting circuits.
   3. Receptacle circuits.
   4. Single-phase motor and appliance branch circuits.
   5. Three-phase motor and appliance branch circuits.
   6. Flexible raceway runs.
   7. Armored and metal-clad cable runs.
   8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
   9. Computer and rack-mounted electronic equipment circuits.
   10. Telecommunication Room: Ground bus as per this section and as shown on contract documents.
   11. Poles Supporting Outdoor Lighting Fixtures: Per pole manufacturer’s requirements.

## 3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.

   1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
   3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:

   1. Metal Water Service Pipe: Provide bonding as per NEC 250, install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
   3. Bond each above ground portion of gas piping system downstream from equipment shutoff valve.

E. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

F. Pull Boxes:

1. Provide grounding type bushings on conduit entrance into pull boxes. The equipment grounding conductor shall be bonded to the box via threaded, locking type ground bushing at the conduit entrance.

G. Junction Boxes and Device Boxes:

1. Bond junction boxes and device boxes to the equipment grounding conductor within the branch circuit serving the box via an approved method.

H. Panelboards:

1. Bond panelboards to the equipment grounding conductor within the feeder conduit by a threaded grounding type insulated bushing at the conduit entrance into the tub. The equipment grounding conductor shall continue from the bushing to the panelboard ground bus and be bonded.

## 3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
   a. Perform tests by fall-of-potential method according to IEEE 81 and submit test.

B. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

# SECTION 26 05 29
# HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

## 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.

### 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.

C. Comply with IBC and UBC.

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, provide product by one of the following:

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.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
5. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. 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.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Mechanical-Expansion Anchors: Insert-wedge-type, 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.

2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    1) Cooper 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. Equipment supports in this Article require calculation of load and strength for each component and detailing of each assembly. Coordinate specifications for each equipment support with structural engineer and with Drawings.

B. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

C. 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 in diameter. Support conduit within 10” from box and bend, maximum 10’ apart and minimum of one support for conduit length.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted 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. Single Conduits 1-1/2-Inch and Smaller: Conduit clamps for supporting single conduits shall be bolt type clamps. The use of spring type clamps will not be permitted. They shall apply for raceways serving branch circuits and low voltage systems above suspended ceilings and for fastening raceways for trapeze supports.

E. The use of powder-actuated fasteners will not be permitted.

## 3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. 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.

D. 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 Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
5. To Light Steel: Sheet metal screws.
6. 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.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

## 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. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors shall be a minimum of 10 bolt diameters from edge of the base. Chamfer concrete pad 3/4”.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 3 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

## 3.5 PAINTING

A. Touchup: Comply with requirements in Division 9 painting sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

SECTION 26 05 33
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

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. Raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
2. Surface raceway.
3. Conduit sleeve and firestop.
4. Core drill for electrical work.

B. Related Section includes the following:

1. Division 26 “Underground Ducts and Raceway for Electrical Systems.”

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. EPDM: Ethylene-propylene-diene terpolymer rubber.

D. FMC: Flexible metal conduit.

E. IMC: Intermediate metal conduit.

F. LFMC: Liquidtight flexible metal conduit.

G. LFNC: Liquidtight flexible nonmetallic conduit.

H. NBR: Acrylonitrile-butadiene rubber.

I. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members in the paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

D. Source quality-control test reports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70, 79.

C. Product shall be UL approved.

D. Comply with ANSI C2.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

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

1. AFC Cable Systems, Inc.
2. Alflex Inc., a unit of Southwire.
3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.
6. Republic Conduit, a unit of Tenaris.
7. Western Tube and Conduit Corporation.
8. Wheatland Tube Company.

B. Rigid Steel Conduit: ANSI C80.1.

C. Aluminum Rigid Conduit: ANSI C80.5.

D. IMC: ANSI C80.6.

E. PVC-Coated Steel Conduit: PVC-coated Rigid Steel Conduit.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040-inch, minimum.

F. EMT: ANSI C80.3.

G. FMC: Zinc-coated steel.

H. LFMC: Flexible steel conduit with PVC jacket and UL label.

I. Fittings for Conduit (Including all Types and Flexible and Liquidtight): NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
2. Fittings for EMT: Steel or die-cast, compression type.
3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.
4. Fittings for Rigid and Intermediate Steel Conduit: Threaded rigid steel conduit.
5. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

J. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

## 2.2 NONMETALLIC CONDUIT AND TUBING

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

1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. CANTEX Inc.
4. Dura-Line.
5. Electri-Flex Co.
6. Lamson & Sessions; Carlon Electrical Products.
7. Thomas & Betts Corporation.

B. ENT: NEMA TC 13.

C. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

D. LFNC: UL 1660.

E. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.

F. Fittings for LFNC: UL 514B.

## 2.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Dura-Line.
2. Endot Industries Inc.
3. Lamson & Sessions; Carlon Electrical Products.

B. Description: Comply with UL 2024; flexible type, approved for plenum installation.

## 2.4 METAL WIREWAYS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

1. Indoor, JIC type, minimum 16 gage, 14 gage for 6” X 6” or larger, finish with gray enamel finish.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Screw-cover type.

E. Finish: Manufacturer's standard enamel finish.

## 2.5 NONMETALLIC WIREWAYS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Hoffman.
2. Lamson & Sessions; Carlon Electrical Products

B. Description: 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. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

## 2.6 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.

1. Manufacturers: Subject to compliance with requirements, provide product by one of the following:

a. Thomas & Betts Corporation.
b. Walker Systems, Inc.; Wiremold Company (The).
c. Wiremold Company (The); Electrical Sales Division.

B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors.

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

a. Enduro Systems, Inc.; Composite Products Division.
b. Hubbell Incorporated; Wiring Device-Kellems Division.
c. Lamson & Sessions; Carlon Electrical Products.
d. Panduit Corp.
e. Walker Systems, Inc.; Wiremold Company (The).
f. Wiremold Company (The); Electrical Sales Division.

## 2.7 BOXES, ENCLOSURES, AND CABINETS

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

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Robroy Industries, Inc.; Enclosure Division.
9. Spring City Electrical Manufacturing Company.
10. Thomas & Betts Corporation.
11. Walker Systems, Inc.; Wiremold Company (The).

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1, minimum 4” X 4” X 2-1/8” deep. Provide with single gang plaster ring unless two gang plaster ring is specifically noted elsewhere to be provided.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover. Minimum 4” X 4” X 2-1/8” deep. Provide with single gang plaster ring unless two gang plaster ring is specifically noted elsewhere to be provided.

D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

E. Metal Floor Boxes: Sheet metal, fully adjustable, rectangular.

F. Nonmetallic Floor Boxes: Nonadjustable, round.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1 gasketed cover.

I. The box support bracket shall be with support leg to eliminate movement of box in wall. The box support shall be attached to metal stud by using screw gun. The box support shall have an offset for drywall.

J. Device rough-in boxes shall be securely and rigidly attached and supported plumb, level and true to the building lines using one of the following:

1. Screw Gun Box Brackets: Preset for metal stud 16” or 24” on center, depth set for 2-1/2” deep electrical box. Install using screw gun.
2. Box Mounting Bracket: Allow 4” or 4-11/16” boxes. Bendable leg serves as a bracket stabilizer.
3. Extension Plate Bracket: Allow outlet boxes 12” or 18” offset from either metal stud track or a stud. Allow 4” or 4-11/16” outlet boxes, 2-1/8” deep, bracket with bendable stabilizer leg for use on 2-1/2” and 3-1/2” metal studs for bracket sterilizer.

K. Hinged-Cover Enclosures: Continuous hinged door in front cover with flush latch and concealed hinge (door-in-door) unless otherwise indicated.

1. Metal Enclosures: NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

## PART 3 - EXECUTION

### 3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: Rigid steel conduit.
2. Concealed Conduit, Aboveground: Rigid steel conduit.
3. Underground Conduit: RNC, Type EPC-PVC, direct buried for utility power system, RNC Type EPC-40 in concrete encased for standby power system.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified herein, unless otherwise indicated:
1. Exposed in Mechanical Room: EMT.
2. Below Grade: PVC Coated IMC.
3. Branch Circuit: EMT, HCF.
4. Concrete Wall/Column: GRC.
5. Refrigerated Area: GRC.
6. Panel Feeder: EMT.
7. Equipment Feeder, 2” and larger: EMT.
8. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, electric solenoid, or motor-driven equipment): LFMC.
9. Damp or Wet Locations: Rigid steel conduit.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

E. Do not install aluminum conduits in contact with concrete.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches 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 System" and "Vibration and Seismic Controls for Electrical Work."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit within finished walls and ceilings, unless otherwise indicated.

H. Raceways embedded in slabs or below slab inside the building envelope are not permitted unless shown on Contract Documents.

I. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including bushing for size No. 6 AWG and larger conductors.

K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

L. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic, as follows:

1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.
2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

M. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with 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.

N. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures, use LFMC for equipment subject to vibration, noise transmission, or movement; transformers, motors and damp/wet location.

O. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

P. Set metal floor boxes level and flush with finished floor surface.

Q. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

## 3.3 DEVICE ROUGH-IN BOX

A. Finish plates shall not span different types of wall finishes either vertically or horizontally. Plates shall cover mortar joints and cut openings completely.

B. Outlet, junction and pull boxes, and their covers shall have corrosion protection suitable for the atmosphere in which they are installed. Provide gaskets for all boxes installed outside and other wet or damp locations (tunnels, crawl spaces, pits, etc.).

C. Outlet boxes shall be protected to prevent entrance of plaster, and debris shall be thoroughly cleaned from the box prior to installation of conductors.

D. Single gang opening outlet boxes shall be mounted with the long axis vertical unless otherwise noted for horizontal mounting. Three or more gang boxes shall be mounted with the long axis horizontal.

E. Finish plates shall be a type designed, intended, and appropriate for the use and location.

F. Existing outlet boxes are being reused, provide extension rings compatible with new wall surfaces or finishes.

G. Provide outlet box with barrier for grouped or ganged light switched where voltage between adjacent switches exceeds 300 volt AC per NEC Article 380.

H. Provide outlet box with barrier and separate conduit feed for switches grouped or ganged where connected to utility power and standby power.

## 3.4 METAL RACEWAY

A. Metal raceway duct shall be installed level and true to building construction lines such that removable or hinged covers can be operated to be fully accessible.

B. Routing shall be pre-planned by the Contractor to assure right-of-way and accessibility; routing indicated by Contract Documents shall be considered schematic in nature and may require job site alteration to avoid interference.

C. Metal raceway duct shall be adequately supported at not more than 5'-0" intervals. The support accessories shall be of the same manufacturer as metal raceway.

D. Metal raceway duct penetrations of walls shall be unbroken lengths, scaled to the wall opening; dead ends shall be closed with manufactured closures.

E. Metal raceway duct to be installed surface mounted; flush in wall or in floor as indicated by the Contract Documents.

F. Provide approved wall flanges and fully seal all penetrations of fire and smoke rated walls and partitions, cutting and patching as needed.

G. Provide divider to compartment the metal raceway duct as indicated by Contract Documents.

## 3.5 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Division 31 Section "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.
    b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

5. Warning Tape: Bury warning tape approximately 12 inches above direct-buried conduits or duct bank placing them 24 inches o.c. Align tape along the width and along the centerline of conduit.

## 3.6 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 "Firestopping."

END OF SECTION 26 05 33

# SECTION 26 05 39
# UNDERFLOOR RACEWAYS FOR ELECTRICAL SYSTEMS

## 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. Flat-top, single-channel, underfloor raceways.
2. Flat-top, multichannel, underfloor raceways.
3. Flush, flat-top underfloor raceways.
4. Cellular metal underfloor raceways.
5. Trench-type underfloor raceways.
6. Service fittings.

### 1.3 DEFINITIONS

A. Flush Outlet: Underfloor raceway outlet installed so the top of the fixed portions of the receptacles, jacks, and connector assemblies is located approximately at the surface of the floor or floor covering, and with the bodies of connected plugs exposed above the surface of the floor.

B. Flush Underfloor Raceway: Rectangular cross-section, flat-top raceway installed with the top of the raceway flush with the surface of the concrete in which it is embedded.

C. Header Raceway: Rectangular cross-section, single-channel or multichannel, underfloor raceway arranged as feeder raceway to bring wires and cables to service raceways from panelboards and communication terminal components.

D. Recessed Outlet: Underfloor raceway outlet installed with the top of the fixed portion of the connector assemblies located below the surface of the floor or floor covering and arranged to receive plug connectors with the bodies of the plugs concealed below the floor level.

E. Service Raceway: Underfloor distribution raceway providing direct connection to service fittings using preset or after-set inserts.

F. Trench Header: Trench-type raceway arranged as feeder raceway to bring wires and cables to service raceways from panelboards and communication terminal equipment.

G. Underfloor Raceway: A conduit, duct, or cell assembly, or trench located within the floor material or with its top at the floor surface.

1.4 SUBMITTALS

A. Product Data: For underfloor raceway components, fittings, and accessories.

B. Shop Drawings: For underfloor raceways. Include floor plans, assembly drawings, sections, and details.

1. Identify components and accessories such as expansion-joint assemblies, straight raceway lengths, preset and after-set inserts, and service fittings.
2. Provide dimensions locating raceway header and distribution elements. Include spacing between preset inserts and between preset inserts and ends of duct runs, walls, columns, junction boxes, and header duct connections.
3. Show connections between raceway elements and relationships between components and adjacent structural and architectural elements including slab reinforcement, floor finish work, permanent partitions, architectural module lines, and pre-tensioning or post-tensioning components.
4. Indicate height of preset inserts, junction boxes, and raceways coordinated with depth of concrete slab and floor fill.
5. Indicate thickening of slabs where required for adequate encasement of raceway components.
6. Document coordination of exposed components with floor-covering materials to ensure that fittings and trim are suitable for indicated floor-covering material.
7. Revise locations from those indicated in the Contract Documents, as required to suit field conditions and to ensure a functioning layout. Identify proposed deviations from the Contract Documents.
8. Show details of connections and terminations of underfloor raceways at panelboards and communication terminal equipment in equipment rooms, wire closets, and similar spaces.
9. Identify those cells of cellular floor deck that are to be connected and fitted for the following underfloor distribution:

    a. Power.
    b. Voice.
    c. Data.
    d. Signal.
    e. Communications.

C. Samples: For typical underfloor raceway products, in specified finish, including the following:

1. Service fittings and flush and recessed outlet and junction-box covers.
2. A section of each service raceway configuration with specified preset insert and service fitting installed.
3. A junction box of each size and type for use with underfloor raceway.
4. A section of each header raceway configuration, complete with provisions for connection with service raceway.
5. A section of trench-type raceway, complete with cover and required trim.
6. A junction box of each size and type, complete with cover and trim.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For underfloor raceways, 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 locating preset inserts and for installing afterset inserts.

1.5 QUALITY ASSURANCE

A. Source Limitations for Electrified Cellular Steel Floor-Deck Components: Obtain electrical components such as preset inserts, after-set inserts, service fittings, header ducts, and trench header ducts from the cellular steel floor-deck manufacturer.

B. Source Limitations: Obtain underfloor raceway components for each system through one source from single manufacturer.

C. 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.

D. Comply with NFPA 70.

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. After-set Inserts: Furnish quantity equal to 10 percent of service fittings installed.
2. After-set Inserts: Furnish quantity equal to 5 percent of each type of preset insert installed.
3. Service Fittings: Furnish 3 of each type of service fitting indicated for each 100 feet of distribution raceway or active-floor-cell length.
4. Outlet Blanking Covers: Furnish quantity equal to 10 percent of each type of floor opening installed for outlets.

B. Furnish one electronic instrument(s) as recommended by underfloor raceway manufacturer for detecting and locating preset inserts in metal raceway under floor covering and up to 3/8 inch of concrete fill.

C. Furnish one set(s) of tools needed for installing after-set inserts in underfloor service raceway, including the following:

1. Electric Drill: Variable speed, 1/2-inch capacity.
2. Hole Saw: Diamond bit, 2-inch size.
3. Insert installation tool.

PART 2 - PRODUCTS

2.1 FLAT-TOP, SINGLE-CHANNEL, UNDERFLOOR RACEWAYS

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

1. Square D; Schneider Electric.
2. Thomas & Betts Corporation; Steel City Division.
3. Walker Systems, Inc.; a Wiremold company.

B. Description:

1. Material: Steel.

2. Cross-Section Shape: Rectangular.
3. Number of Levels: One.
4. Minimum Bending Radius for Communication Cables: Combination of raceways, fittings, inserts, junction boxes, service fittings, and mounting and connection arrangements for wiring devices and jacks shall provide a 2-inch minimum bending radius for communication cables.

C. Service Raceways: Fitted with preset inserts.

1. Nominal Raceway Dimensions:

a. Depth: 1-1/2 inches.
b. Power Service Raceway Width: 3-1/2 inches.
c. Communication Service Raceway Width: 6-1/2 inches.

2. Number of Single-Channel Raceways per Run: Two unless otherwise indicated.
3. Preset Inserts: Rectangular.

a. Spacing: 24 inches o.c.
b. Size: Rectangular dimensions as required to accommodate mounting and connection of flush-mounted, duplex receptacle or dual communication-jack or connector service fitting.
c. Size: 2 inches in diameter.
d. Equip each insert with a disposable cover and select insert height so cover is 1/8 inch below surface of concrete.
e. Arrange insert for optional attachment of flush-, surface-, or wiring- extension service fitting to replace disposable cover.

D. Header Raceways: Single channel, without preset inserts (blank raceway).

1. Nominal Raceway Dimensions:

a. Depth: 1-1/2 inches.
b. Power Header Raceway Width: 3-1/2 inches.
c. Communication Header Raceway Width: 3-1/2 inches.

2. Arrangement: In same plane as service raceways.
3. Connections: Arranged to connect with service raceways at single-level junction boxes.

## 2.2 FLAT-TOP, MULTICHANNEL, UNDERFLOOR RACEWAYS

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

1. Square D; Schneider Electric.
2. Thomas & Betts Corporation; Steel City Division.

B. Description:

1. Material: Steel.
2. Cross-Section Shape: Rectangular.
3. Number of Longitudinal Channels: Two, separated by steel wall(s).
4. Number of Levels: One.

5. Minimum Bending Radius for Communication Cables: Combination of raceways, fittings, inserts, junction boxes, service fittings, and mounting and connection arrangements for wiring devices and jacks shall provide a 2-inch minimum bending radius for communication cables.

C. Service Raceways: Fitted with preset inserts.

1. Nominal Raceway Dimensions:

a. Depth: 1-3/8 inches.
b. Power Service Channel Width: 3-1/2 inches.
c. Communication Service Channel Width: 3-1/2 inches.

2. Preset Inserts:

a. Spacing: 24 inches o.c.
b. Size: Dimensions as required to accommodate mounting and connection of flush- and surface-mounted, single and multiple-system service fittings or to connect to wiring extensions for feeding wall outlets for power and communications.
c. Equip each insert with a disposable cover arranged for installation with top 1/8 inch below surface of concrete.
d. Arrange inserts for optional attachment of flush-, surface-, or wiring-extension service fitting to replace disposable cover. Arrange brackets, mountings, barriers, and floor access covers to support, isolate, and provide access to flush outlet-mounting connector, jack, and receptacle devices.

D. Header Raceways: Multichannel, without preset inserts (blank raceway).

1. Nominal Raceway Dimensions:

a. Header Raceway Depth: Same as service raceways.
b. Power Header Channel Width: 3-1/2 inches.
c. Communication Header Channel Width: 3-1/2 inches.

2. Arrangement: In same plane as service raceways.
3. Connections: Arranged to connect with service raceways at two-level junction boxes.

## 2.3 FLUSH, FLAT-TOP UNDERFLOOR RACEWAYS

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:

C. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:

1. Walker Systems, Inc.; a Wiremold company.

D. Description:

1. Material: Steel.
2. Cross-Section Shape: Rectangular, multichannel, separated by steel wall(s).

3. Listed and labeled for installation with top flush with concrete floor.
4. Number of Levels: One.

E. Service Raceways: Fitted with preset inserts.

1. Number of Longitudinal Channels per Multichannel Raceway: Two.
2. Number of Single-Channel Raceways per Run: Two unless otherwise indicated.
3. Nominal Channel Dimensions: 3 inches wide by 1-1/4 inches deep.
4. Preset Inserts: Threaded opening with removable steel plug that is flush with top of raceway when screwed in place.

    a. Spacing: [24 inches o.c., full length of each service raceway.
    b. Arrangement: Stagger insert locations on parallel raceways or channels to accommodate placement of adjacent service fittings.
    c. Size: 1-5/8-inch diameter.

F. Header Raceways: Raceways same as service raceways except without preset inserts (blank raceway).

1. Nominal Channel Dimensions: Same as service raceways.
2. Arrangement: In same plane as service raceways.
3. Connections: Arranged to connect with service raceways at junction boxes.

## 2.4 CELLULAR METAL UNDERFLOOR RACEWAYS

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:

C. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:

1. HH Robertson; Division of CENTRIA.
2. Walker Systems, Inc.; a Wiremold company..

D. Service Raceways: Fitted with preset inserts.

1. Material: Steel.
2. Number of Longitudinal Cells: Three, separated by steel walls.
3. Nominal Dimensions of Cells:

    a. Overall Depth: 1-1/4 inches unless otherwise indicated.
    b. Cross-Sectional Area of Cells: Power cells: 5-1/2 sq. in; communication system cells: 16 sq. in.

4. Minimum Bending Radius for Communication Cables: Combination of raceways, fittings, inserts, junction boxes, service fittings, and mounting and connection arrangements for wiring devices and jacks shall provide a 2-inch minimum bending radius for communication cables.
5. Preset Inserts: Rectangular-shaped metal housing assemblies arranged to provide electrical outlet access to each cell of each raceway designated for service raceway use. Inserts shall be provided throughout the entire length of each such raceway.

a. Spacing: 24 inches o.c.
b. Include housing and connecting provisions for a flush or recessed, single-, double-, or triple-system service fitting.
c. Include mounting and connecting provisions for a surface, single- or multiple-system service fitting.
d. Include connecting provisions for a wiring-extension service fitting to feed wall outlets.
e. Equip each insert with a disposable cover plate arranged for installation with top 1/8 inch below surface of concrete. Arrange insert to receive a flush-, recessed-, or wiring-extension service fitting to replace disposable top.

E. Header Assembly: A junction box and raceway arrangement arranged to feed wires and cables to service raceways.

1. Three-compartment junction box connecting blank, multicell cellular header raceway (no inserts) with cellular service raceways.

a. Arrange junction box in the center of a 60-inch length of header raceway.
b. Cellular header raceway shall have same dimensions as service raceways.
c. Provide capability for service raceways to be run in both directions from intersection with header raceway.

2. Three-compartment junction box preassembled with blank, flat-top, multichannel header raceway (no inserts) and fitted to connect with cellular service raceway at right angles to header raceway.

a. Arrange junction box in the center of a 60-inchlength of header raceway.
b. Provide capability for service raceways to be run in both directions from intersection with header raceway.

## 2.5 TRENCH-TYPE UNDERFLOOR RACEWAYS

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:

C. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:

1. HH Robertson; Division of CENTRIA.
2. Square D; Schneider Electric.
3. Thomas & Betts Corporation; Steel City Division.
4. Walker Systems, Inc.; a Wiremold company.

D. Trench: Steel, shop or factory welded and fabricated to indicated sizes. Include the following features:

1. Slab Depth Adjustment: Minimum of minus 1/8 inch to plus 5/8 inch before and during concrete placement.
2. Cover Supports: Height adjustable, with leveling screws to rigidly support cover assembly.

3. Screed Strip: Extruded aluminum along both edges at proper elevation without requiring shim material.
4. Trim Strip: Select to accommodate floor finish material.
5. Partitions: Arranged to separate channels and isolate wiring of different systems.

E. Cover Plates: Removable, steel plates, 1/4 inch thick, each weighing 60 lb or less with full gasket attached to side units. Fabricate intermediate supports to limit unsupported spans to [15 inches or less. Fabricate covers with appropriate depth recess to receive indicated floor finish.

## 2.6 SUPPORTS, FITTINGS, AND HARDWARE

A. Supports, fittings, and hardware shall be compatible with raceway and outlet system and shall be listed for use with raceway systems and components specified.

B. Supports: Adjustable for height and arranged to maintain alignment and spacing of raceways during concrete placement. Include hold-down straps.

C. Raceway Fittings: Couplings, expansion-joint sleeves, cross-under offsets, vertical and horizontal elbows, grounding screws, adapters, end caps, and other fittings suitable for use with basic components to form a complete installation.

## 2.7 JUNCTION BOXES

A. Description: Manufacturer's standard enclosure for indicated type, quantity, arrangement, and configuration of raceways at each raceway junction, intersection, and access location. Include the following accessories and features:

1. Mounting brackets.
2. Escutcheons and holders to accommodate surrounding floor covering.
3. Means for leveling and height adjustment more than 3/8 inch before and after concrete is placed.
4. Raceway Openings: For underfloor raceways and conduits arranged to accommodate raceway layout.
5. Covers shall have appropriate depth recess to receive specific floor finish material.
6. Partitions to separate wiring of different systems.

## 2.8 SERVICE FITTINGS

A. Exposed Parts Finish: Brass.

B. Flush, Single-System Service Fitting for Round Inserts: Include mounting and cover to support and provide access to single connector, jack, or receptacle device; mounted flush with floor within body of insert.

1. Connector, Jack, and Receptacle Devices: Single modular type; complying with Division 16 Sections "Wiring Devices" and "Voice and Data Communication Cabling."
2. Power Receptacle Outlet: Suitable for 20-A device.

C. Flush, Single System Service Fitting for Rectangular Inserts: Include mounting, hinged cover, and trim to support and provide access to connector, jack, or receptacle devices mounted flush with floor within insert.

1. Connector, Jack, and Receptacle Devices: Modular type; complying with Division 16 Sections "Wiring Devices" and "Voice and Data Communication Cabling."
2. Power Receptacle Rating: 20 A, 120 V unless otherwise indicated.

D. Surface-Mounted Service Fitting: Modular pedestal type, with locking attachment matched to insert floor opening.

1. Power-outlet, double-faced, surface-mounted unit for duplex receptacle on both sides.
2. Power-outlet, single-faced, surface-mounted unit for duplex receptacle on one side.
3. Communication-outlet, double-faced, surface-mounted unit.

    a. Include bushed openings on both sides; 1-inch minimum diameter; insulated with nonconducting material.
    b. Include provisions for modular dual fiber-optic connector assembly on both sides.
    c. Include provisions for modular dual jack-connector assembly, rated for Category 6 on both sides.

4. Communication-outlet, single-faced, surface-mounted unit with bushed opening on one side; 1-inch minimum diameter; insulated with nonconducting material.
5. Combination surface-mounted unit for duplex receptacle on one side and with communication cable connection provision on opposite side.

    a. Communication Side: Include bushed opening; 1-inch minimum diameter; insulated with nonconducting material.
    b. Communication Side: Include provisions for modular dual fiber-optic connector assembly.
    c. Communication Side: Include provisions for modular dual jack-connector assembly, rated for Category 6.

E. Flush-Mounted Service Fittings: Modular fittings compatible with preset inserts and shall include covers, provisions for receptacles jacks and connector assemblies and wiring extensions to wall-mounted outlets, and associated device plates for indicated systems. Include flush handhole covers, recessed to suit floor finish material. Internally mounted, modular, receptacle, jack and connector assemblies shall comply with requirements in Division 16 Sections "Wiring Devices" and "Voice and Data Communication Cabling."

1. Duplex convenience receptacle.
2. Duplex telephone-data outlets.
3. Double duplex convenience receptacles.
4. Duplex convenience receptacle and duplex telephone-data outlets.
5. Double duplex telephone-data outlets.
6. Duplex communication jack, rated for Category 6.
7. Duplex fiber-optic communication connector.
8. Wiring-Extension Service Fittings: Arrangement of brackets and mountings to support, and provide access to wiring or cabling of a cell, and to connect the cable or raceway that extends the system to an individual wall outlet. Provide for connection of Type MC cable for power extensions, and FMC for communication system extensions.

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.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install raceways aligned and leveled and, unless otherwise indicated, parallel or perpendicular to building walls.

B. Arrange supports to attain proper elevation, alignment, and spacing of raceways. Install supports securely at ends and at intervals not to exceed 60 inches, to prevent movement during concrete pour.

C. Level raceway components with finished slab and make adjustments for floor finishes.

D. Adjust supports to maintain a 1/16- to 3/8-inch finished concrete cover over preset inserts.

E. Remove burrs, sharp edges, dents, and mechanical defects.

F. Cap or plug boxes, insert- and service-fitting openings, and open ends of raceways.

G. Seal raceways, cells, junction boxes, and inserts to prevent water, concrete, or foreign matter from entering raceways before and during pouring slab or placing fill. Tape joints, or seal with compound, as recommended in writing by underfloor raceway manufacturer.

H. Junction Boxes: Install tops level and flush with finished floor. Install blank closure plates or plugs to close unused junction-box openings. Grout boxes in place to prevent movement during construction. Place top covers in inverted position during construction to prevent damage to surface of cover. Reinstall covers in proper position prior to final acceptance of Work.

I. After-set Inserts: Cut, hole saw, and drill slab and raceways to allow for installation.

J. Ground underfloor raceway components.

K. Install a marker at the center of the last insert of each cell and channel of each straight run of metal underfloor service raceway to locate the insert and identify the system.

1. Install markers at last inserts on both sides of permanent walls and at first inserts adjacent to each junction box.
2. Install markers flush at screed line before pouring slab or placing fill. Extend marker with grommeted screw when floor covering is placed. Do not extend through carpet.
3. Use slotted-head screw to identify electrical power; use Phillips-head screw to identify conventional communications.
4. Use another distinctive screw head to identify third system such as special-purpose wiring.

L. Level raceway components with finished slab and make adjustments in raceway component elevation to accommodate indicated floor finishes.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Perform visual inspection of interior of each [unction box and section of trench raceway to verify absence of dirt, dust, construction debris, and moisture. Replace damaged and malfunctioning components.
2. Perform point-to-point tests of ground continuity and resistance of ground path between the most remote accessible fitting on each branch of each underfloor raceway system and the main electrical distribution grounding system.

a. Determine cause and perform correction of any point-to-point resistance value that exceeds 0.05 ohms.

3.4 CLEANING

A. Clean and swab out underfloor raceways, inserts, and junction boxes after finish has been applied to floor slab, and remove foreign material, dirt, and moisture. Leave interiors clean and dry.

END OF SECTION 26 05 39

SECTION 26 05 43
UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

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. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs.
2. Handholes and boxes.

1.3 DEFINITION

A. RNC: Rigid nonmetallic conduit.

B. GRC: Galvanized rigid steel conduit.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
2. Accessories for handholes and boxes.
3. Warning tape.
4. Warning planks.

B. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Cover design.
3. Grounding details.
4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

C. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C 858.

D. Source quality-control test reports.

E. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to handholes, and as approved by Architect.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ARNCO Corp.
2. Beck Manufacturing.
3. Cantex, Inc.
4. CertainTeed Corp.; Pipe & Plastics Group.
5. Condux International, Inc.
6. ElecSys, Inc.
7. Electri-Flex Company.
8. IPEX Inc.

9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT; a division of Cable Design Technologies.
11. Spiraduct/AFC Cable Systems, Inc.

B. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type DB-60-PVC, ASTM F 512, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.

C. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."
3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches in size, manufactured from 6000-psi concrete.

    a. Color: Red dye added to concrete during batching.
    b. Mark each plank with "ELECTRIC" in 2-inch high, 3/8-inch deep letters.

## 2.3 PRECAST CONCRETE HANDHOLES AND BOXES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Carder Concrete Products.
2. Christy Concrete Products.
3. Elmhurst-Chicago Stone Co.
4. Oldcastle Precast Group.
5. Riverton Concrete Products; a division of Cretex Companies, Inc.
6. Utility Concrete Products, LLC.
7. Utility Vault Co.
8. Wausau Tile, Inc.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
3. Cover Legend: Molded lettering, As indicated for each service.
4. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.

    a. Extension shall provide increased depth of 12 inches.
    b. Slab: Same dimensions as bottom of enclosure and arranged to provide closure.

6. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

    a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
    b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
    c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

7. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

## 2.4 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.

1. Color: Green.
2. Configuration: Units shall be designed for flush burial and have [open] [closed] [integral closed] bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, As indicated for each service.
6. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
7. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Armorcast Products Company.
    b. Carson Industries LLC.
    c. CDR Systems Corporation.
    d. NewBasis.

C. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Armorcast Products Company.
    b. Carson Industries LLC.
    c. Christy Concrete Products.

d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

D. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Carson Industries LLC.
b. Christy Concrete Products.
c. Nordic Fiberglass, Inc.

E. High-Density Plastic Boxes: Injection molded of high-density polyethylene or copolymer-polypropylene. Cover shall be polymer concrete.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Carson Industries LLC.
b. Nordic Fiberglass, Inc.
c. PenCell Plastics.

## 2.5 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Non-concrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

# PART 3 - EXECUTION

## 3.1 UNDERGROUND DUCT APPLICATION

A. Underground Ducts for Power and Communication: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

## 3.2 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.

3. Units in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 or Polymer concrete units, SCTE 77, Tier 8 structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin or high-density plastic, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

## 3.3 EARTHWORK

A. Excavation and Backfill: Comply with Division 22 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turfs and Grasses" and "Plants."

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 1 Section "Cutting and Patching."

## 3.4 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to handhole.
3. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical/Common Work Results for Communications/Common Work Results for Electronic Safety and Security."

F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

G. Pulling Cord: Install 100-lbf test nylon cord in ducts, including spares.

H. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

    a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.

3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
7. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
8. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.
    b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

9. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

I. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 22 Section "Earth Moving" for pipes less than 6 inches in nominal diameter.
4. Install backfill as specified in Division 22 Section "Earth Moving."
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 22 Section "Earth Moving."
6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.
7. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.
8. Set elevation of bottom of duct bank below the frost line.
9. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.
    b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

10. Warning Planks: Bury warning planks approximately 12 inches above direct-buried ducts and duct banks, placing them 24 inches o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.

## 3.5 INSTALLATION OF CONCRETE HANDHOLES, AND BOXES

A. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891, unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
3. Install handholes with bottom below the frost line, minimum 30” below grade.
4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
5. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

D. Waterproofing: Apply waterproofing to exterior surfaces of handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 7 Section "Thermoplastic Sheet Waterproofing." After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

E. Dampproofing: Apply dampproofing to exterior surfaces of handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 7 Section "Bituminous Dampproofing." After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

F. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

G. Field-Installed Bolting Anchors in Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

## 3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line, minimum 30” below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in asphalt paving and subject to occasional, non-deliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000 psi, 28-day strength, complying with Division 3 Section "Cast-in-Place Concrete," with a troweled finish.
2. Dimensions: 10 inches wide by 12 inches deep.

## 3.7 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

## 3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

## 3.9 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 26 05 43

# SECTION 26 05 53
# IDENTIFICATION FOR ELECTRICAL SYSTEMS

## 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.

### 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:

a. Utility power - Black letters on a white field.
b. Standby Power: White letters on a red 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.

### 2.2 CONDUCTOR AND 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.

### 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. Metal-Backed, Butyrate Warning Signs: Weather-resistant, non-fading, 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.

C. 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 42."

## 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 for utility power and white letters on a red background for standby power. Minimum letter height shall be 3/8 inch.

## 2.7 DEVICE, RECEPTACLE AND SWITCH LABELS

A. Label shall be self-adhesive vinyl and shall be computer or machine printed. Minimum size shall be1/4” label with 1/8” letter.

1. Label background shall be clear or match to device plate.
2. Black letter for normal power.
3. Red letter for emergency power.
4. Legend: Indicates panel and circuit number.

B. Special Receptacles:

1. Special purpose receptacles shall include an engraved or embossed legend appropriate for load serviced and labeled as specified in Paragraph A.
2. Receptacles not available with factory red color for emergency power circuits shall be identified with engraved or embossed label with the word “EMERGENCY POWER.”

## 2.8 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.

## PART 3 - EXECUTION

### 3.1 APPLICATION

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Feeder and Branch Circuits: Identify with preprinted self-adhesive vinyl label.

B. Accessible Raceway for Standby System: Identify with self-adhesive vinyl tape and comply with NFPA 70-700.9(A).

C. Color for Printed Legend: The following color codes are general. Verify with Owner's standard before implementation. If Owner's do not have the standard then following these standards.

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.

D. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use marker tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

E. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use marker tape. Identify each ungrounded conductor according to source and circuit number.

F. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source and circuit number.

G. 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.

H. 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.

I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with white letters on a red 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.
c. Emergency power system.

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.

J. 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.

K. 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 on each power and system equipment/panel power equipment. Label shall include device identification and source.

1. Labeling Instructions:

a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where 2 lines of text are required, use labels 2 inches high.
b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

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. Disconnect switches.
g. Enclosed circuit breakers.
h. Motor starters.
i. Push-button stations.
j. Power transfer equipment.
k. Contactors.
l. Remote-controlled switches, dimmer modules, and control devices.
m. Power-generating units.
n. Voice and data cable terminal equipment.
o. Television/audio components, racks, and controls.

p. Fire-alarm control panel and annunciators.
q. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
r. Monitoring and control equipment.
s. Uninterruptible power supply equipment.
t. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.
u. Audio/paging system.
v. Video surveillance.

3. Equipment Schedule:

a. Panelboards shall include correct, typewritten circuit directory cards identifying load served by branch circuit protective devices.

## 3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. 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.

G. Color-Coding for Phase Identification, 600 V and Less: Use the colors listed below for 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. 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.

H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

I. 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 or concrete envelope exceeds 16 inches overall.

J. Painted Identification: Prepare surface and apply paint according to Division 9 painting Sections.

END OF SECTION 26 05 53

# SECTION 26 05 73
# OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

## 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 computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.

B. Series rated protective devices are not permitted unless noted otherwise.

### 1.3 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: For coordination-study specialist.

D. Other Action Submittals: The following submittals shall be made prior to the approval process for system protective devices has been completed. Submittals shall be in digital form.

1. Coordination-study input data, including completed computer program input data sheets.
2. Study and Equipment Evaluation Reports.
3. Coordination-Study Report (TCC Graphs).

### 1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

## PART 2 - PRODUCTS

### 2.1 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers:

1. Basis-of-Design Product: SKM Systems Analysis, Inc.

### 2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:

a. Arcing faults.
b. Simultaneous faults.
c. Explicit negative sequence.
d. Mutual coupling in zero sequence.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

### 3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 16 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams,

overcurrent protective device submittals, input and output data, and recommended device settings.

2. Impedance of utility service entrance.
3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:

    a. Circuit-breaker and fuse-current ratings and types.
    b. Relays and associated power and current transformer ratings and ratios.
    c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
    d. Generator kilovolt amperes, size, voltage, and source impedance.
    e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
    f. Busway ampacity and impedance.
    g. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    d. Generator thermal-damage curve and decrement curves.
    e. Ratings, types, and settings of utility company's overcurrent protective devices.
    f. Special overcurrent protective device settings or types stipulated by utility company.
    g. Time-current-characteristic curves to be coordinated for entire system.
    h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
    i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
    j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.
    k. TCC curve showing branch protective devices coordinated with upstream devices.

## 3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:

1. Distribution panelboard.
2. Branch circuit panelboard.
3. At each automatic transfer switch.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 242.

1. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
2. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:

1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

F. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

## 3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.

1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
2. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

   a. Device tag.
   b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
   c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
   d. Fuse-current rating and type.
   e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

   a. Device tag.
   b. Voltage and current ratio for curves.
   c. Three-phase and single-phase damage points for each transformer.
   d. No damage, melting, and clearing curves for fuses.
   e. Cable damage curves.
   f. Transformer inrush points.
   g. Maximum fault-current cutoff point.

F. Completed data sheets for setting of overcurrent protective devices.

END OF SECTION 26 05 73

# SECTION 26 09 23
# LIGHTING CONTROL DEVICES

## 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. Time switches.
2. Outdoor photoelectric switches.
3. Indoor occupancy sensors.
4. Outdoor motion sensors.
5. Lighting contactors.

### 1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

### 1.4 SUBMITTALS

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

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. 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.

### 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.

1.6 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, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

A. Product: Subject to compliance with requirements, provide a comparable product by one of the following:

1. Area Lighting Research, Inc.; Tyco Electronics.
2. Grasslin Controls Corporation; a GE Industrial Systems Company.
3. Intermatic, Inc.
4. Leviton Mfg. Company Inc.
5. Lightolier Controls; a Genlyte Company.
6. Lithonia Lighting; Acuity Lighting Group, Inc.
7. Paragon Electric Co.; Invensys Climate Controls.
8. Square D; Schneider Electric.
9. TORK.
10. Watt Stopper (The).

B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.

1. Contact Configuration: SPST.
2. Contact Rating: 20-A ballast load, 120/240-V ac.
3. Programs: 8 channels; each channel shall be individually programmable with 8 on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.
4. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
5. Astronomic Time: All channels.
6. Battery Backup: For schedules and time clock.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

A. Product: Subject to compliance with requirements, provide a comparable product by one of the following:

1. Area Lighting Research, Inc.; Tyco Electronics.
2. Grasslin Controls Corporation; a GE Industrial Systems Company.
3. Intermatic, Inc.
4. Lithonia Lighting; Acuity Lighting Group, Inc.
5. Novitas, Inc.
6. Paragon Electric Co.; Invensys Climate Controls.
7. Square D; Schneider Electric.
8. TORK.
9. Watt Stopper (The).

B. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
2. Time Delay: 15-second minimum, to prevent false operation.
3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

## 2.3 INDOOR OCCUPANCY SENSORS

A. Product: Subject to compliance with requirements, provide a comparable product by one of the following:

1. Hubbell Lighting.
2. Leviton Mfg. Company Inc.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Sensor Switch, Inc.
5. TORK.
6. Watt Stopper (The).

B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
4. Mounting:

    a. Sensor: Suitable for mounting in any position on a standard outlet box.
    b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
    c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.
7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.

C. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.

1. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. in..
2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch high ceiling.
3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot high ceiling.

D. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch high ceiling.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch high ceiling.
4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch high ceiling.
5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot high ceiling in a corridor not wider than 14 feet.

E. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch high ceiling.

## 2.4 OUTDOOR MOTION SENSORS (PIR)

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

1. Bryant Electric; a Hubbell Company.
2. Hubbell Lighting.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Paragon Electric Co.; Invensys Climate Controls.
5. TORK.
6. Watt Stopper (The).

B. Performance Requirements: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F, rated as raintight according to UL 773A.

1. Operation: Turn lights on when sensing infrared energy changes between background and moving body in area of coverage; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2. Mounting:

a. Sensor: Suitable for mounting in any position on a standard outdoor junction box.
b. Relay: Internally mounted in a standard weatherproof electrical enclosure.
c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

3. Bypass Switch: Override the on function in case of sensor failure.
4. Automatic Light-Level Sensor: Adjustable from 1 to 20 fc; keep lighting off during daylight hours.

C. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.

D. Detection Coverage: Up to 52.5 feet, with a field of view of 270 degrees.

E. Individually Mounted Sensor: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.

1. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
2. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

## 2.5 LIGHTING CONTACTORS

A. Product: Subject to compliance with requirements, provide a comparable product by one of the following:

1. Allen-Bradley/Rockwell Automation.
2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
3. Eaton Electrical Inc.; Cutler-Hammer Products.
4. GE Industrial Systems; Total Lighting Control.
5. Grasslin Controls Corporation; a GE Industrial Systems Company.
6. Hubbell Lighting.
7. Lithonia Lighting; Acuity Lighting Group, Inc.
8. MicroLite Lighting Control Systems.
9. Square D; Schneider Electric.
10. TORK.
11. Watt Stopper (The).

B. Description: Electrically operated and electrically held, combination type with non-fused disconnect, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

2.6 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multi-conductor cable with stranded-copper conductors not smaller than No. 22 AWG. Comply with requirements in Division 26 Section "Low Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multi-conductor cable with stranded-copper conductors not smaller than No. 16 AWG. Comply with requirements in Division 26 Section "Low Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 SWITCH INSTALLATION

A. Mounting Height: +46” A.F.F. to center.

B. Wall Mounted Occupancy Sensor: +46” A.F.F. to center.

3.4 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

## 3.5 IDENTIFICATION

A. Identify components and power and control wiring according to Division 16 Section "Electrical Identification."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

## 3.6 FIELD QUALITY CONTROL

A. The Electrical Contractor shall ensure that control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the Contract Documents and Manufacturer’s Requirements. Coordinate with the requirements of the following sections:

1. Division 26 Section “Interior Lighting”.

B. 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 operation of each lighting control device, and adjust time delays.

C. Lighting control devices that fail tests and inspections are defective work.

## 3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

## 3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 26 09 23

# SECTION 26 24 16
# PANELBOARDS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

B. Surge Protection Devices (SPD):

1. See drawings for SPD requirement for panelboards.

### 1.3 DEFINITIONS

A. SPD: Surge Protection Devices.

### 1.4 SUBMITTALS

A. Product Data: For each type of panelboard, switching and 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. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Devices shall be fully rated for available fault current.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on log-log graph paper, include selectable ranges for each type of overcurrent protective device.

C. Field Quality-Control Reports:

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.

D. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

E. 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 that allows adjustments.

## 1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. 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.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Handle and prepare panelboards for installation according to NECA 407 and NEMA PB 1.

## 1.7 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

## 1.8 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, encumbrances to workspace clearance requirements, and adjacent surfaces.

Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Flush- and surface-mounted cabinets as per schedule in Contract Documents.

1. Rated for environmental conditions at installed location.

    a. Indoor dry and clean locations: NEMA 250, Type 1.
    b. Outdoor locations: NEMA 250, Type 3R.
    c. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
    d. Other wet or damp indoor locations: NEMA 250, Type 4.

2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
3. Finishes:

    a. Panels and trim: Steel factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    b. Back boxes: Galvanized steel.

4. Directory Card: Inside panelboard door with protective cover.
5. Panel TUB/enclosure shall be wider than standard width, however, not more than 26 inches wide for branch circuit panelboards.

B. Incoming Mains Location: Top and bottom as per schedule and also coordinate with the contractor.

C. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment ground bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

D. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Main and neutral lugs: Mechanical type.
2. Ground lugs and bus configured terminators: Mechanical type.

E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

F. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Coordinate with serving utility.

## 2.2 DISTRIBUTION PANELBOARDS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Hinged Front Cover: Entire front trim hinged to box with standard door within hinged trim cover.

D. Mains: Circuit breaker or lugs only as per Panelboard Schedule.

E. Branch Overcurrent Protective Devices for Circuit-Breaker: Plug-in where individual positive locking device requires mechanical release for removal OR 100 A trip size and above with adjustable magnetic instantaneous trip adjustable from range 1-10.

F. SPD: Provide where indicated on drawings or specified elsewhere.

G. Additions and alterations to existing panelboards shall be manufactured by the manufacturer of the panelboard or shall be UL listed for the application.

## 2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only as per Panelboard Schedule.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Hinged Front Cover: Entire front trim hinged to box with standard door within hinged trim cover.

## 2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Molded-Case Circuit Breaker (MCCB): Comply with 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 instantaneous trip setting for circuit-breaker trip sizes 100 A and larger.
2. Field changeable trip circuit breakers: RMS sensing with front-mounted, field-changeable trip unit or rating plug (adjustable, magnetic trip setting, minimum to maximum).
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings for 400A frame and larger:

    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. Ground fault equipment protection (GFEP) circuit breakers: Class B ground-fault protection (30-mA trip).
5. Molded case circuit breaker (MCCB) features and accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    c. Ground fault protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    d. Multi-pole units enclosed in a single housing or factory assembled to operate as a single unit.
    e. Handle padlocking device: Fixed attachment, for locking circuit-breaker handle in on or off position.
    f. Handle clamp: Loose attachment, for holding circuit-breaker handle in on position.

## 2.5 PANELBOARD SUPPRESSORS

A. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, wired-in solid-state, parallel-connected with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and as specified in Division 26 Section "Surge Protection Devices":

## 2.6 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407 and NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to NECA 407 and NEMA PB 1.1.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

C. Mount top of trim 90 inches above finished floor unless otherwise indicated. Top mat switch or circuit breaker in "on" position shall not be higher than 75 inches above finished floor or grade.

D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

E. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker settings per arc flash and short circuit coordination study.

F. Install filler plates in unused spaces.

G. For recessed or semi-recessed panelboards, stub two (2) 1-1/2-inch empty conduits from 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. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

E. Label each panelboard with the following information:

1. Panel designation.
2. Voltage, phase, wire.
3. Fed from, circuit number.
4. Short circuit rating.
5. Arc flash PPE category.
6. Feeder size (conduit, wire, ground).

## 3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual, mechanical inspection and electrical test as follows:

a. Certify compliance with test parameters.

2. Circuit Breakers, Insulated-Case/Molded-Case:

a. Visual and Mechanical Inspection:

1) Compare equipment nameplate data with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Inspect anchorage and alignment.
4) Verify the unit is clean.
5) Operate the circuit breaker to insure smooth operation.
6) Inspect bolted electrical connections for high resistance using bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer’s published data or Table 100.12.
7) Inspect operating mechanism, contacts, and arc chutes in unsealed units.
8) Verify correct operation of any auxiliary features such as trip and pickup indicators, electrical close and trip operation, trip-free and anti-pump functions.

b. Electrical Tests:

1) Perform adjustments for final setting in accordance with coordination study.
2) Verify correct operation of any auxiliary features such as trip and pickup indicators, electrical close and trip operation, trip-free and anti-pump function.

3) Verify operation of charging mechanism.
4) Test insulation resistance for each panelboard bus, component, connecting supply, feeder and control circuit.
5) Test continuity of each circuit.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
4. 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 panelboard. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

5. Panelboards shall be considered defective if they do not pass test and inspections.

D. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

## 3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges per arc flash and short circuit coordination study.

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.

END OF SECTION 26 24 16

# SECTION 26 27 26
# WIRING DEVICES

## 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. Receptacles,
2. Receptacles with integral AFCI, and associated device plates.
3. Receptacles with integral GFCI, and associated device plates.
4. Twist-locking receptacles.
5. Receptacles with integral USB Charging ports
6. Wall-box motion sensors.
7. Snap switches and wall-box dimmers.
8. Solid-state fan speed controls.
9. Wall-switch and exterior occupancy sensors.
10. Pendant cord-connector devices.
11. Cord and plug sets.
12. Floor service outlets.
13. Communications outlet.
14. Safety type receptacle (tamperproof).

### 1.3 DEFINITIONS

A. AFCI: Arc fault circuit interrupter

B. EMI: Electromagnetic interference.

C. GFCI: Ground-fault circuit interrupter.

D. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

E. RFI: Radio-frequency interference.

F. TVSS: Transient voltage surge suppressor.

G. UTP: Unshielded twisted pair.

H. ST: Safety type (tamperproof).

1.4 SUBMITTALS

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

B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices, a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated, Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand, Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

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

a. Cooper 5351 (single), 5352 (duplex).

b. Hubbell HBL5351 (single), CR5352 (duplex).
c. Leviton 5891 (single), 5352 (duplex).
d. Pass & Seymour 5381 (single), 5352 (duplex).

C. USB Charging Receptacles,

1. Products: Specification Grade Tamper resistant 20 A Duplex Receptacle with 2 USB charging ports

a. Cooper. TR7756
b. Hubbell. USB20x2
c. Leviton. T5832
d. Pass & Seymour TR5362USB

2.3 SAFETY TYPE (TAMPER-RESISTANT) RECEPTACLES

A. Tamper-Resistant Specification grade duplex receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

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

a. Cooper TR8300.
b. Hubbell HBL8300SG.
c. Leviton 8300-SGG.
d. Pass & Seymour 63H.

2.4 GFCI RECEPTACLES

A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

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

a. Cooper GF20.
b. Hubbell GF 5352.
c. Leviton 8898.
d. Pass & Seymour 2084.

C. Duplex AFCI Convenience Receptacles, 125 V, 20 A:

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

a. Cooper AF20.
b. Hubbell AF 5352.
c. Leviton 8898.
d. Pass & Seymour 2084.

## 2.5 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.

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

a. Cooper L520R.
b. Hubbell HBL2310.
c. Leviton 2310.
d. Pass & Seymour L520-R.

## 2.6 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.

1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

## 2.7 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

## 2.8 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

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

a. Cooper 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
b. Hubbell HBL1221 (single pole), HBL1222 (two pole), HBL1223 (three way), HBL1224 (four way).
c. Leviton 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
d. Pass & Seymour 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

C. Pilot Light Switches, 20 A:

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

    a. Cooper 2221PL for 120 V and 277 V.
    b. Hubbell HPL1221PL for 120 V and 277 V.
    c. Leviton 1221-PLR for 120 V, 1221-7PLR for 277 V.
    d. Pass & Seymour PS20AC1-PLR for 120 V.

2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

## 2.9 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.

1. 600W; dimmers shall require no derating when ganged with other devices. Illuminated when "OFF."

## 2.10 OCCUPANCY SENSORS

A. Wall-Switch Sensors:

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

    a. Hubbell ATD1600WRP.
    b. Leviton ODW12-MRW.
    c. Watt Stopper (The) DT-200.

2. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft.

B. Exterior Occupancy Sensors:

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

    a. Leviton PS200-10.
    b. Watt Stopper (The) EW-100-120.

2. Description: Passive-infrared type, 120/277 V, weatherproof, adjustable time delay up to 15 minutes, 180-degree field of view, and 110-foot detection range. Minimum switch rating: 1000W.

## 2.11 WALL PLATES

A. 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: Smooth, high-impact thermoplastic.
3. Material for Unfinished Spaces: Smooth, high-impact thermoplastic.
4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant thermoplastic with lockable cover.

2.12 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Rectangular, solid brass with satin finish.

D. Power Receptacle: NEMA WD 6 configuration 5-20R, ivory finish, as per Contract Documents unless otherwise indicated.

E. Voice and Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 Category 6 jacks for UTP cable.

2.13 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: As selected by Architect, unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

1. Receptacles: 18 inches A.F.F. to center unless noted otherwise.

2. Switches/dimmer/wall occupancy sensor: 46 inches A.F.F. to center unless noted otherwise.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

F. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

## 3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black letter for utility power and red letter for standby power filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

## 3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
2. Test Instruments: Use instruments that comply with UL 1436.
3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. AFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
6. Using the test plug, verify that the device and its outlet box are securely mounted.
7. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Test straight blade hospital-grade convenience outlets for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz.

END OF SECTION 26 27 26

# SECTION 26 28 13
# FUSES

## 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 and controllers.
2. Spare-fuse cabinets.

### 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. 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 NEMA FU 1.

D. Comply with NFPA 70.

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, Division of Eaton.
2. Mersen.
3. Reliance.
4. S&C.
5. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

2.3 SPARE-FUSE CABINET

A. Cabinet: Wall-mounted, 0.05-inch thick steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch high letters on exterior of door.
4. Fuse Pullers: For each size of fuse.

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. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Motor Branch Circuits: Class RK1, time delay.

B. Other Branch Circuits: Class RK1, time delay.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s).

3.4 IDENTIFICATION

A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 26 28 13

# SECTION 26 28 16
# ENCLOSED SWITCHES AND CIRCUIT BREAKERS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes the following individually mounted, enclosed switches and circuit breakers:

1. Fusible switches.
2. Non-fusible switches.
3. Molded-case circuit breakers.
4. Molded-case switches.
5. Enclosures.

### 1.3 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. HD: Heavy duty.

C. RMS: Root mean square.

D. SPDT: Single pole, double throw.

### 1.4 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. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. 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.

D. Manufacturer's field service report.

E. 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 "Operation and Maintenance Data," 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.

## 1.5 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. 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.

## 1.6 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.

## 1.7 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.

# 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. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
3. Siemens Energy & Automation, Inc.
4. Square D/Group Schneider.

B. Fusible Switch, 600A and Smaller: NEMA KS 1, Type HD, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Non-fusible Switch, 600A and Smaller: NEMA KS 1, Type HD, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.

## 2.3 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

A. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
3. Moeller Electric Corporation.
4. Siemens Energy & Automation, Inc.
5. Square D/Group Schneider.

B. Molded-Case Circuit Breaker: NEMA AB 1, 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 instantaneous trip setting for circuit-breaker frame sizes 150 A and larger.
2. Circuit Breakers with Rating Plug: RMS sensing with field changeable rating plug for 250A and larger frame.
3. Circuit Breakers Electronic Trip: RMS sensing; field-changeable rating plug; with the following field-adjustable settings:
    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. GFCI Circuit Breakers: Single- and two-pole configurations with 30-mA trip sensitivity.
5. Lugs: Mechanical style suitable for number, size, trip ratings, and conductor material.
6. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

7. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
8. Auxiliary Switch: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
9. Fault protection function.

C. Molded-Case Switches: Molded-case circuit breaker with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

1. Lugs: Mechanical style suitable for number, size, trip ratings, and material of conductors.
2. Application Listing: Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage. Provide "dummy" trip unit where required for proper operation.
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. Provide "dummy" trip unit where required for proper operation.
5. Auxiliary Switch: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

## 2.4 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. 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 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.

## 3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 26 Section "Identification for Electrical Systems."

## 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. 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.

C. Perform the following field tests and inspections and prepare test reports:
1. Perform each electrical test and visual and mechanical inspection. 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. Infrared Scanning:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Open or remove doors or panels so connections are accessible to portable scanner.
b. Follow-Up Infrared Scanning: Perform an additional follow-up infrared scan of each unit 11 months after date of Substantial Completion.
c. 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 enclosed switches and circuit breakers included and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

## 3.5 ADJUSTING

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

## 3.6 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 26 28 16

# SECTION 26 32 13
# ENGINE GENERATORS

## 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 200 KW, 250 KVA at 0.8 P.F. packaged engine-generator sets for standby power supply and shall comply with Tier III requirement with the following features:

1. Gas engine.
2. Unit-mounted cooling system.
3. Remote-mounting control and monitoring.
4. Performance requirements for sensitive loads.
5. Load banks test.
6. Outdoor enclosure

B. Related Sections include the following:

1. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

### 1.3 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

B. Standby Rating: Power output rating equal to the power the generator set delivers continuously under normally varying load factors for the duration of a power outage.

C. Steady-State Voltage Modulation: The uniform cyclical variation of voltage within the operational bandwidth, expressed in Hertz or cycles per second.

### 1.4 SUBMITTALS

A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:

1. Thermal damage and decrement curve for generator.
2. Time-current characteristic curves for generator protective device.

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. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
4. Wiring Diagrams: Power, signal, and control wiring.
5. Battery and charger data.
6. Provide calculation for the following:

a. Battery and charger size calculation.

C. Source quality-control test reports.

1. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
2. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
3. Report of sound generation.
4. Report of exhaust emissions showing compliance with applicable regulations.
5. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For packaged engine generators 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. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

F. Warranty: Special warranty specified in this Section.

## 1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Source Limitations: Obtain packaged generator sets and auxiliary components 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 ASME B15.1.

F. Comply with NFPA 37.

G. Comply with NFPA 70.

H. Comply with UL 2200.

I. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

J. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

## 1.6 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 5 to 40 deg C.
2. Relative Humidity: 0 to 95 percent.
3. Altitude: Sea level to 1000 feet (300 m).

## 1.7 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

## 1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

## 1.9 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

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. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:

1. Caterpillar; Engine Div.
2. Cummins Power Generation; Industrial Business Group.
3. Generac Power Systems, Inc.
4. Kohler Co.; Generator Division.
5. Spectrum Detroit Diesel.

2.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

C. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated, with capacity as required to operate as a unit as evidenced by records of prototype testing.
2. Output Connections: Three-phase, four wire.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of components.

D. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.

3. Steady-State Frequency Operational Bandwidth: 0.25 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
6. Start and Load Transfer Time: Comply with NFPA 110, Type 10, system requirements (load transfer under 10 seconds).
7. Excitation System: Performance shall be unaffected by voltage distortion caused by non-linear load. Provide permanent magnet excitation for power source to voltage regulator.

## 2.3 ENGINE

A. Fuel: Natural gas.

B. Rated Engine Speed: 1800 rpm.

C. Output Connections:

1. Frequency drop acceptable to load.
2. Stable frequency regulating.
3. Accept 100 percent block load.
4. Frequency dip acceptable to load.

D. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Engine Fuel System:
1. Natural Gas System:

a. Carburetor.
b. Secondary Gas Regulators: One for each fuel type.
c. Fuel-Shutoff Solenoid Valves: One for each fuel source.
d. Flexible Fuel Connectors: One for each fuel source.

F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

G. Governor: Adjustable isochronous, with speed sensing.

1. Electronic type, steady-state speed band at 60 Hz, 0.25 percent of rated frequency from no load to full load.
2. Shall comply with NFPA 110 requirements for block load capacity.
3. Manual speed adjustment available while engine is running.

H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition and rated for 115 deg F ambient temperature.
3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

    a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and non-collapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with two clamps to suit piping and equipment connections.

I. Muffler/Silencer: Critical grade, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

1. Minimum sound attenuation of 25 dB at 500 Hz.
2. Sound level measured at a distance of 23 feet from exhaust discharge after installation is complete shall be 85 dBA or less.

J. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

K. Battery System: 24-V electric, with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified and shall have 90 second adjustable cycle cranking for crank rest period. Adjusted for 3 cranking cycles of 15 seconds "ON" and 15 seconds "OFF" with over-ranking relay.
4. Battery: Seal lead acid adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least three times without recharging. Battery shall include flame arrestor caps, and intercell connectors with insulators. Battery shall carry 3 year warranty.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:

a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

## 2.4 GENERATOR CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, contacts from remote automatic transfer switches initiate starting and stopping of generator set. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

B. Manual Starting System Sequence of Operation: Switching "ON-OFF" switch on the generator control panel to the "ON" position starts generator set. The "OFF" position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.

C. Configuration: Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator circuit breaker, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers.

D. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:

1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
8. Ammeter-voltmeter, phase-selector switch(s).
9. Generator-voltage adjusting rheostat.
10. Start-stop switch.
11. Overspeed shutdown device and shutdown alarm.
12. Coolant high-temperature shutdown device and shutdown alarm.
13. Coolant low-level shutdown device and shutdown alarm.
14. Oil low-pressure shutdown device and shutdown alarm.
15. Generator overload.

16. Ground fault indication (main breaker).

E. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

F. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Control panel shall include Ethernet port for interface with building automation on RS 485 and TCP/IP connection for all alarm and status function.

G. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

H. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

## 2.5 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, electronic-trip type; 80 percent rated; complying with UL 489.

1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
2. Trip Settings: Selected to coordinate with generator thermal damage curve.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.
5. Ground fault indication/alarm only.

B. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

## 2.6 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H, rated at maximum 115 deg Celsius rise over a 40 deg Celsius ambient at 100 percent rating.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Instrument Transformers: Mounted within generator enclosure.

G. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

1. Voltage band widths shall not exceed ±0.5 percent and ±1 percent of their mean value for constant loads from no load to full load.

H. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

I. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

## 2.7 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

C. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

## 2.8 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a non-slip 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: Standard neoprene].
2. Durometer Rating: 50.
3. Number of Layers: Four.

B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. 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- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

## 2.9 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

## 2.10 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Full load run.
3. Maximum power.
4. Voltage regulation.
5. Transient and steady-state governing.
6. Single-step load pickup.
7. Safety shutdown.
8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
9. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch on 4-inch high concrete base. Secure sets to anchor bolts installed in concrete bases.

D. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified in Division 22 Section "Hydronic Piping."

1. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Division 22 Section "Hydronic Piping."

E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

C. Connect engine exhaust pipe to engine with flexible connector.

D. Connect fuel piping to engines with a gate valve and union and flexible connector.

1. Natural gas piping, valves, and specialties for gas distribution outside the building are specified in Division 2 Section "Natural Gas Distribution."

E. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Division 26 Section "Low Voltage Electrical Power Conductors and Cables."

## 3.4 IDENTIFICATION

A. Identify system components according to Division 26 Section "Identification for Electrical Systems."

## 3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Perform tests recommended by manufacturer. Certify compliance with test parameters.
2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

    a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    c. Verify acceptance of charge for each element of the battery after discharge.
    d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.

D. Coordinate tests with tests for transfer switches and run them concurrently.

E. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

F. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

G. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

I. Remove and replace malfunctioning units and retest as specified above.

J. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

K. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

## 3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 1 Section "Demonstration and Training."

## 3.7 LOAD BANK FOR GENERATOR TESTING

A. Description: Permanent, outdoor, weatherproof, remote-controlled, forced-air-cooled, resistive unit capable of providing a balanced 3-phase, delta-connected load to generator set at 100 percent rated-system capacity, at 80 percent power factor, lagging for six (6) hours. Unit may be composed of separate resistive and reactive load banks controlled by a common control panel. Unit shall be capable of selective control of load in 25 percent steps and with minimum step changes of approximately 5 and 10 percent available.

END OF SECTION 26 32 13

# SECTION 26 36 00
# TRANSFER SWITCHES

## 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 transfer switches rated 600 V and less, including the following:

1. Automatic transfer switches.
2. Remote annunciation and control systems.

B. Related Sections include the following:
1. Division 26 Sections "Packaged Engine Generators".

### 1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product 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. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

### 1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Source Limitations: Obtain automatic transfer switches and remote annunciator and control panels 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 NEMA ICS 1.

E. Comply with NFPA 70.

F. Comply with NFPA 99.

G. Comply with NFPA 110.

H. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.5 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:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Construction Manager's written permission.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Caterpillar; Engine Div.
2. Emerson; ASCO Power Technologies, LP.
3. Generac Power Systems, Inc.
4. GE Zenith Controls.
5. Kohler Power Systems; Generator Division.
6. Onan/Cummins Power Generation; Industrial Business Group.
7. Russelectric, Inc.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
2. Shall be a minimum of 18 cycle rated and tested.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

G. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

H. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

I. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

J. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

## 2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

E. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

F. Include the following functions and characteristics for automatic closed transition transfer switches:

1. Fully automatic make-before-break operation.
2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.
3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.

    a. Initiation occurs without active control of generator.
    b. Controls ensure that closed-transition load transfer closure occurs only when the 2 sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.

4. Failure of power source serving load initiates automatic break-before-make transfer.

G. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

H. Automatic Transfer-Switch Features:

1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
b. Push-button programming control with digital display of settings.
c. Integral battery operation of time switch when normal control power is not available.

I. Include the following functions and characteristics for bypass/isolation switches:

1. Comply with requirements for Level 1 equipment according to NFPA 110.
2. Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources.
3. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. While isolated, interlocks prevent transfer-switch operation, except for testing or maintenance.
4. Drawout Arrangement for Transfer Switch: Provide physical separation from live parts and accessibility for testing and maintenance operations.
5. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.
6. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.
7. Operability: Constructed so load bypass and transfer-switch isolation can be performed by 1 person in no more than 2 operations in 15 seconds or less.
8. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.
9. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.
10. Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

J. Terminal provisions for a remote contact which opens to signal, the CTTS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or

retransfer to normal. Both of these inhibit signals can be activated through the keypad or serial port.

K. One set of double pole, double throw contacts that operate when normal source voltage is available and one set of double pole, double throw contacts that operate when emergency source voltage is available.

L. Load shedding circuit initiated by the removal of the control voltage to a relay to match generator capacity to the load. Relay de-energization transfer load to the normal source, regardless of its acceptability. 24 VDC customer supplied control voltage.

M. Two toggle switches to permit selection of manual or automatic retransfer to normal. Manual is automatically bypassed if emergency fails while normal is available. Open first switch for manual mode, momentarily close second switch to retransfer to normal. Includes red pilot light to indicate manual position.

N. The power monitor shall flush mount to an enclosure.

1. The power monitor shall be equipped with an continuous duty, LCD backlit display to provide local access to the following metered quantities:

    a. Current, per phase RMS and neutral (if applicable).
    b. Current unbalance percentage.
    c. Voltage, phase-to-phase and phase-to-neutral.
    d. Voltage unbalance percentage.
    e. Real power, per phase and 3-phase total.
    f. Apparent power, per phase and 3-phase total.
    g. Reactive power, per phase and 3-phase total.
    h. Power factor, 3-phase total and per phase.
    i. Frequency.
    j. Accumulated energy (MWH, MVAH and MVARH).

2. Displaying each of the power monitor quantities shall be accomplished through the use of menu scroll buttons.
3. Reset of the following electrical parameters shall be allowed from the front of the power monitor:
4. All reset and setup functions shall provide a means for protection against unauthorized/accidental changes.
5. The power monitor shall be connected to power management system through RS485 serial port and/or TCP/IP Ethernet port without translator.
6. Power monitor shall include the following:

    a. Accurate to 1% measured, 2% computed values and display resolution to .1%. Voltage and current for all phases are sampled simultaneously to assure high accuracy in conditions of low power factor or large harmonics waveform distortions.
    b. Capable of operating at frequencies of 45 to 66 Hz and over a control power input voltage range of 20 to 32 VDC.
    c. Interfaced with a communications module to permit information to be sent to remote location for display, analysis and logging.
    d. Accept inputs from industry standard instrument transformers (120 VAC secondary PT’s and 5A secondary CTS). Direct phase voltage connections, 600 VAC and under, shall be possible without the use of PT’s.
    e. Monitor shall be applied in 3-phase, three and four wire circuits. A fourth CT input shall be available to measure neutral or ground current.

f. All setup parameters required by the power monitors shall be stored in non-volatile memory and retained in the event of a control power interruption.
g. The following metered readings shall be communicated by the power monitor, via serial communication:
    1) Current, per phase RMS and neutral (if applicable).
    2) Current unbalance percentage.
    3) Voltage, phase-to-phase and phase-to-neutral.
    4) Voltage unbalance percentage.
    5) Real power (kW), per phase and 3-phase total.
    6) Apparent power (kVA), per phase and 3-phase total.
    7) Reactive power (kVAR), per phase and 3-phase total.
    8) Power factor, 3-phase total and per phase.
    9) Frequency.
    10) Accumulated energy (MWH, MVAH and MVARH).
    11) Accumulated real energy kWh.
    12) Accumulated reactive energy KVAH.
    13) Accumulated apparent energy KVARH.
h. Monitors shall be equipped with the following I/O:
    1) Provide eight (8) solid state status inputs.
    2) Provide four (4) relay output contacts.

## 2.4 REMOTE ANNUNCIATOR AND CONTROL SYSTEM

A. Functional Description: Include the following functions for indicated transfer switches:

1. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
2. Indication of switch position.
3. Indication of switch in test mode.
4. Indication of failure of digital communication link.
5. Key-switch or user-code access to control functions of panel.
6. Control of switch-test initiation.

B. Remote Annunciation and Control Panel: Solid-state components. Include the following features:

1. Controls and indicating lights grouped together for each transfer switch.
2. Label each indicating light control group. Indicate transfer switch it controls, location of switch, and load it serves.
3. Digital Communication Capability: Matched to that of transfer switches supervised.
4. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.

## 2.5 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Panel Mounting: Flush in wall, unless otherwise indicated.

B. Identify components according to Division 26 Section "Identification for Electrical Systems."

C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

    a. Check for electrical continuity of circuits and for short circuits.
    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c. Verify that manual transfer warnings are properly placed.
    d. Perform manual transfer operation.

4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.

c. Verify time-delay settings.
d. Verify pickup and dropout voltages by data readout or inspection of control settings.
e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
f. Test closed transition unit functional modes and related automatic transfer switch operations.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. 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 transfer switches and related equipment as specified below. Refer to Division 1 Section "Demonstration and Training."

B. Coordinate this training with that for generator equipment.

END OF SECTION 26 36 00

# SECTION 26 43 13
# SURGE PROTECTION DEVICES

## 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 surge protection devices for low-voltage power equipment.

B. Related Sections include the following:

1. Division 26 Section “Panelboards.”

### 1.3 DEFINITIONS

A. ATS: Acceptance testing specifications.

B. Inominal: Nominal discharge current.

C. MCOV: Maximum continuous operating voltage.

D. SCCR: Short circuit current rating.

E. SPD: Surge protection device.

F. VPR: Voltage protection rating.

### 1.4 SUBMITTALS

A. Product Data: Provide information for each type of product indicated. Information shall be specific to the products being supplied for the project and shall include the following:

1. Rated capacities: Illustrating compliance with the values stated in this section.
2. Unit dimensions and weights.
3. Mounting provisions.
4. Wiring diagrams including, but not limited to, recommended breaker size, recommended wire size, recommended lead length and recommended wire type.
5. Installation instructions.
6. Accessories.

B. Product Certificates: Provide documentation, signed by product manufacturer, certifying compliance with the following standards:

1. UL 1449 – 3rd Edition.

2. NEC Article 285 – latest edition compliant.
3. Provide test reports demonstrating compliance with UL 1449-3 for tested Inominal, tested SCCR and tested MCOV.
4. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

C. Field quality-control test reports, including the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

D. Operation and Maintenance Data: For surge protection devices to include in emergency, operation, and maintenance manuals.

E. Warranties: Special warranties specified in this Section.

## 1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain surge protection devices and accessories through one source 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 IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."

D. Comply with NEMA LS 1, "Low Voltage Surge Protection Devices."

E. Comply with UL 1449 – 3rd Edition, “Standard for Safety for Surge Protective Devices”.

F. SPD shall be UL listed and labeled.

## 1.6 PROJECT CONDITIONS

A. Service Conditions: Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:

1. Operating Temperature: 30 to 120 deg F.
2. Humidity: 0 to 85 percent, non-condensing.
3. Altitude: Less than 20,000 feet above sea level.

## 1.7 COORDINATION

A. Coordinate location of field-mounted surge protection devices to allow adequate clearances for maintenance as per manufacturer’s recommendation and maintaining NEC working clearance requirements.

B. Coordinate surge protection device ratings with the AIC rating of the equipment being protected. The rating of the surge protection device must be equal to or greater than the rating of the protected equipment.

C. Coordinate size of overcurrent protection and wiring serving surge protection devices. Provide according to manufacturer's recommendation. Provide special low impedance conductors in locations where manufacturer's recommended lead length cannot be achieved.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fails in materials or workmanship within ten years from date of Project Substantial Completion. The warranty shall cover unlimited replacement of surge protection devices or components during the warranty period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Field Mounted (External) Surge Protection Devices:

1. Advanced Protection Technologies.
2. Current Technology.
3. Emerson Network Power Surge Protection.
4. LEA International.

B. Integral Mounted Surge Protection Devices:

1. Eaton Corporation; Cutler-Hammer, Inc.
2. General Electric Company.
3. Siemens Energy and Automation, Inc.
4. Square D; Schneider Electric.

2.2 SUPPRESSORS DESCRIPTION

A. Surge Protection Device Description: Sine-wave-tracking type with the following features and accessories:

1. MOV shall be configured in each L-N, L-G and N-G mode and shall be rated for unit rating.
2. Fabrication using bolted lugs for internal wiring.
3. Integral disconnect switch or feeder breaker which allows to remove device for replacement without shutdown of panel/switchboard.
4. Arrangement with bus/wire connections to phase buses, neutral bus, and ground bus.
5. LED indicator lights for power and protection status.
6. Audible alarm, with silencing switch, to indicate when protection has failed.
7. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
8. Surge-event operations counter.
9. Voltage reading (all phases).

B. UL 1449-3 Tested Inominal: 20 KA.

C. UL 1449-3 Tested SCCR: 200 KA.

D. UL 1449-3 Tested MCOV:

1. 208Y/120V: 150V.

E. Protection Modes: The voltage protection rating (VPR) per UL 1449 3rd Edition 6KV/20KA testing shall be as follows:

1. 208/120-volt, 3 phase, 4 wire system:

a. L-N, L-G and N-G: 650V-850V.
b. L-L: 1,100V, 1,300V.

F. Fuses:

1. All protection modes shall be internally individually fused. The fuses $I^2t$ capacity shall allow the suppressor's maximum rated transient current to pass through the suppressor without fuse operation. If the rated $I^2t$ of the fuse is exceeded, the fuse shall open and clear both high and low impedance fault conditions. All overcurrent devices shall be monitored including those on the N-G mode and will provide indication of suppressor component failure or operability. Internal protection shall be included to protect against overheating for temporary over voltage condition.

G. Short Circuit Rating:

1. The SPD shall be marked with a short circuit rating and shall not be installed at a point on the system where the available fault current is in excess of that rating.

## 2.3 SUPPRESSORS

A. Distribution Panelboards SPD:

1. Minimum surge current rating: 100 KA per mode/200 KA per phase.
2. Connection AWG: Per manufacturer.
3. Overcurrent Protection (Breaker): Per manufacturer.
4. Shall comply to Category Type “2.”
5. Provide SPD in separate enclosure. Provide with an integral disconnect allowing the unit to be replaced without interruption of the electrical equipment.

B. Panelboard SPD:

1. Minimum surge current rating: 80 KA per mode/160 KA per phase.
2. Connection AWG: Per manufacturer.
3. Overcurrent Protection (Breaker): Per manufacturer.
4. Shall comply to Category Type “2.”
5. Provide SPD in separate enclosure. Provide with an integral disconnect allowing the unit to be replaced without interruption of the electrical equipment.

2.4 CONDUCTORS AND CABLES

A. Comply with the requirements of Division 26 Section “Low Voltage Electrical Power Conductors and Cables”.

B. Where recommended by the manufacturer based on installation details, provide special low impedance cables complying with ANSI/IEEE Standards.

2.5 ENCLOSURES

A. NEMA 250, with type matching the enclosure of panel or device being protected.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive SPD for compliance with installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SURGE PROTECTION DEVICES

A. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.

B. Install devices for non-service entrance switchboards, motor control centers, distribution panels, panelboard and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

C. Install wiring according to Division 26 Section “Low Voltage Electrical Power Conductors and Cables”.

1. Where installation will not allow for manufacturer’s recommended lead length to be achieved, provide special low impedance conductors approved by the manufacturer.

D. Provide multi-pole circuit breaker as a dedicated disconnect for suppressor within equipment being protected, where applicable, unless otherwise indicated.

E. For external type SPD units, mount and anchor per Division 26 Section “Hangers and Supports for Electrical Systems”.

3.3 IDENTIFICATION

A. Identify components and wiring according to Division 26 Section “Identification for Electrical Systems”.

## 3.4 PLACING SYSTEM INTO SERVICE

A. Do not energize the source until surge protection devices are installed, connected and tested.

## 3.5 FIELD QUALITY CONTROL

A. Engage a Professional Engineer or a certified Power Quality Professional with a minimum of five (5) years experience to certify the installation of the SPD. The PE or CPQ shall verify for proper installation of the SPD and provide a report of the findings.

B. Testing: Perform the following field tests and inspections and prepare test reports:

1. After installing surge protection devices, but before electrical circuitry has been energized, test for compliance with requirements.
2. Complete startup checks according to manufacturer's written instructions.
3. Perform each visual and mechanical inspection and electrical test as follows. Certify compliance with test parameters.

    a. Compare equipment nameplate data with drawings and specifications.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, grounding and clearances.
    d. Verify the arresters are clean.
    e. Inspect bolted electrical connections for high resistance by calibrated torque-wrench method in accordance with manufacturer’s published data or Table 100.12.
    f. Verify that ground lead on each device is individually attached to a ground bus or ground electrode.
    g. Perform insulation resistance tests. Use manufacturer’s recommended values.

C. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 43 13

# SECTION 26 51 00
# INTERIOR LIGHTING

## 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, lamps, and drivers.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.

B. Related Sections include the following:

1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Division 26 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.

### 1.3 DEFINITIONS

A. CRI: Color-rendering index.

B. CU: Coefficient of utilization.

C. LED: Light emitting diode

D. LER: Luminaire efficacy rating.

E. Luminaire: Complete lighting fixture, including driver housing if provided.

F. RCR: Room cavity ratio.

G. RFI: Radio Frequency interference.

H. SSL: Solid State lighting.

I. THD: Total harmonic distortion.

1.4 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

   A. Physical description of lighting fixture including dimensions.
   B. Emergency lighting units including battery and charger.
   C. LED driver
   D. Energy-efficiency data.
   E. Life, output, and energy-efficiency data for lamps.
   F. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, drivers, and accessories identical to those indicated for the lighting fixture as applied in this Project.

B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.

C. Product Certificates: For each type of driver for bi-level and dimmer-controlled fixtures, signed by product manufacturer.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

F. Warranties: Special warranties specified in this Section.

1.5 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. 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 NFPA 70.

1.6 WARRANTY

A. Special Warranty for Emergency Lighting 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.

   A. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
   B. Warranty Period for Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

B. Special warranty period for Solid State Lighting (SSL) and LED light fixtures: Manufacturer's standard form in which driver manufacturer agrees to repair or replace SSL lighting Lamps, Drivers and related components that fail in materials or workmanship within specified warranty period.

A. Warranty Period for SSL (LED) lighting: Five years from date of Substantial Completion.

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.

A. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
B. Drivers: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
C. LED fixtures: 1 of each type 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:

B. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
B. Basis-of-Design Product: The design for each lighting fixture is based on the product series. Subject to compliance with requirements, provide either the light series named product or a comparable product by one of the other manufacturers specified.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. SSL (LED) fixtures comply with UL 8750.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.

F. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

A. White Surfaces: 85 percent.
B. Specular Surfaces: 83 percent.
C. Diffusing Specular Surfaces: 75 percent.
D. Laminated Silver Metallized Film: 90 percent.

G. Plastic Diffusers, Covers, and Globes:

A. 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 indicated.
b. UV stabilized.

2.3 Solid State Lighting (SSL) Light Emitting Diode (LED) Fixtures:

A. White LED fixtures for general illumination shall have been tested by the US Dept. of Energy's CALiPER program, IES LM-79, LM-80, and TM-21
B. Color temperature: As indicated on light fixture schedule.
C. All LED Fixtures shall have a minimum coloring rendering index of .80.
D. All LED luminaires shall have been designed around the LED source.
E. All LEDs in one fixture type shall be from the same batch
F. All LED fixtures shall be compatible with dimming systems.
G. LED fixtures shall be equipped with wiring disconnect device to disconnect both line and neutral conductors to the LED driver.
H. LED systems shall be modular and allow for separate replacement of the LEDs and drivers.
I. LED fixtures with non-replaceable components are permitted only as scheduled.
J. Warranty: Minimum 5-year manufacturer warranty on LED lamps and drivers.

2.4 EXIT SIGNS

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:
A. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

a. Battery: Sealed, maintenance-free, nickel-cadmium type.
b. Charger: Fully automatic, solid-state type with sealed transfer relay.
c. 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. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
f. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

## 2.5 EMERGENCY LIGHTING UNITS

A. Description: Self-contained units complying with UL 924.

A. Battery: Sealed, maintenance-free, nicad type.
B. Charger: Fully automatic, solid-state type with sealed transfer relay.
C. 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.
D. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
E. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
F. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an

## 2.6 FIELD QUALITY CONTROL

A. The Electrical Contractor shall ensure that control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the Contract Documents and Manufacturer's Requirements. Coordinate with the requirements of the following sections:

A. Division 26 Section "Lighting Control Devices".

B. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

C. 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.

END OF SECTION 26 51 00

# SECTION 26 56 00
# EXTERIOR LIGHTING

## 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 drivers.
2. Luminaire-mounted photoelectric relays.
3. Poles and accessories.

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. LED: Light Emitting diode

C. Luminaire: Complete lighting fixture, including driver housing if provided.

D. Pole: Luminaire support structure, including tower used for large area illumination.

E. SSL Solid State Lighting

F. 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. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.

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. 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. Drivers, 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.

B. Shop Drawings:

1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
2. Wiring Diagrams: Power and control wiring.

C. 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.

D. Qualification Data: For agencies providing photometric data for lighting fixtures.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

G. 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. 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 C2, "National Electrical Safety Code."

D. 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.

## 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. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

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 12 months 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.

## 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. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
2. Drivers: 10 for every 100 of each type and rating installed. Furnish at least one of each type.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

A. In Exterior Lighting Device Schedule where titles below are column or row headings that 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 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 re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping 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.

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: Match Architect's sample of manufacturer's standard color.

M. 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.

## 2.3 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

A. Comply with UL 773 or UL 773A.

B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.

1. Relay with locking-type receptacle shall comply with NEMA C136.10.
2. Adjustable window slide for adjusting on-off set points.

## 2.4 LED LAMPS AND DRIVERS

A. Comply with applicable UL Standards: UL 1598, UL8750

B. LED Lamps shall be field replaceable modules. Non-repairable fixtures shall not be used.

C. LED Drivers shall be field replaceable and integrated with fixture housing for thermal management. Non-repairable fixtures shall not be used.

D. LED lighting fixtures shall be as shown in fixture schedule

E. Medium base self-contained Lamp and driver installed in fixtures designed for incandescent lamping shall have fixture labeled to indicate lamping.

## 2.5 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

A. 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.

B. 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.

C. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

D. 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.

E. 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."

F. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4.

## 2.6 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); 1-piece construction up to 40 feet in height with access handhole in pole wall.

1. Shape: Round, tapered.
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1. Adapter fitting welded to pole and bracket, then bolted together with galvanized-steel bolts.
2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
3. Match pole material and finish.

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 for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

E. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

F. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

G. Factory-Painted Finish: 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. Interior Surfaces of Pole: One coat of bituminous paint or otherwise treat for equal corrosion protection.
3. 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 by Architect from manufacturer's standard selection.

## 2.7 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 (ASTM B 209M), 5052-H34 marine sheet alloy with access handhole in pole wall.

1. Shape: Round, tapered.

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 for Electrical Systems," 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 luminaire.

F. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
1. 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.

a. Color: As selected by Architect from manufacturer's full range.

## 2.8 POLE ACCESSORIES

A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

# PART 3 - EXECUTION

## 3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. 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.

C. 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.

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. Grout void between pole base and foundation. Use non-shrink or expanding concrete grout firmly packed to fill space.
2. Install base covers, unless otherwise indicated.
3. 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.

## 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 "Raceway and Boxes for Electrical Systems." 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 for Electrical Systems."

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 for Electrical Systems."

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.

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-64, "Photometric Measurements of Parking Areas."

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 26 56 00

# SECTION 27 05 00
# COMMON WORK RESULTS FOR COMMUNICATIONS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Communications equipment coordination and installation.
2. Sleeves for pathways and cables.
3. Sleeve seals.
4. Grout.
5. Common communications installation requirements.

### 1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

### 1.4 SUBMITTALS

A. Product Data: For sleeve seals.

### 1.5 COORDINATION

A. Coordinate arrangement, mounting, and support of communications 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 pathways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 8 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Firestopping."

1.6 RECORD DRAWINGS

A. Contractor shall provide owner with a complete set of accurate Record Drawings for all work performed under this contract.

1. Record Drawings shall include all approved change orders and pertinent RFI responses.
2. Include actual dimensions of equipment furnished under this contractor where shown on the floor plans.
3. Record Drawings shall include work performed by all sub-contractors retained.
4. Record Drawings shall include the words “RECORD DRAWING” on each sheet.

B. Submission:

1. Submit one set of record Drawings for review by Engineer prior to submission of closeout documents. Record Drawings shall be submitted using the established submittal process.
2. Upon satisfactory review of the Record Drawing submittals by Engineer, provide three (3) copies in electronic format with closeout documents
3. Electronic Record Drawings shall include multi-sheet PDF files combined and named by discipline.

PART 2 - PRODUCTS

2.1 SLEEVES FOR PATHWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches (400 mm), thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

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

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Hilti.

d. Metraflex Co.
e. Pipeline Seal and Insulator, Inc.
f. Specified Technologies, 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 pathway or cable.
3. Pressure Plates: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## 2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

# PART 3 - EXECUTION

## 3.1 COMMON REQUIREMENTS FOR 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 communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

## 3.2 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 3 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 7 Section "Joint Sealants."

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 7 Section "Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

## 3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

## 3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Firestopping."

END OF SECTION 27 05 00

# SECTION 27 11 00
# COMMUNICATIONS EQUIPMENT ROOM FITTINGS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Telecommunications mounting elements.
2. Backboards.
3. Telecommunications equipment racks and cabinets.
4. Telecommunications service entrance pathways.
5. Grounding.

B. Related Sections:

1. Division 27 Section "Communications Cabling" for voice and data cabling associated with system panels and devices.
2. Division 28 Section "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

### 1.3 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. BICSI: Building Industry Consulting Service International.

C. LAN: Local area network.

D. RCDD: Registered Communications Distribution Designer.

### 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 for equipment racks and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

C. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

## 1.5 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of Commercial Installer, Level2.
2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

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. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

D. Grounding: Comply with ANSI-J-STD-607-A.

## 1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and work above ceilings is complete.

## 1.7 COORDINATION

A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

## PART 2 - PRODUCTS

### 2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.

B. Cable Support: NRTL labeled. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots fasten cable ties to brackets.

1. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
2. Support brackets with cable tie slots for fastening cable ties to brackets.
3. Lacing bars, spools, J-hooks, and D-rings.
4. Straps and other devices.

C. Cable Trays:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Cable Management Solutions, Inc.
   b. Cablofil Inc.
   c. Cooper B-Line, Inc.
   d. Cope - Tyco/Allied Tube & Conduit.
   e. GS Metals Corp.

2. Cable Tray Materials: Metal, suitable for indoors and protected against corrosion by [electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inch.

   a. Basket Cable Trays: [6 inches wide and 2 inches. Wire mesh spacing shall not exceed 2 by 4 inches.

D. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems.

1. Outlet boxes shall be minimum 2-gang box, 2-3/4” deep with plaster ring.

### 2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm).

### 2.3 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

B. Telecommunications Main Bus Bar:

1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide with 9/32-inch holes spaced 1-1/8 inches apart.
3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

C. Comply with ANSI-J-STD-607-A.

2.4 LABELING

A. Comply with TIA/EIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

3.2 INSTALLATION

A. Install underground entrance pathway complying with Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Comply with NECA 1.

C. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

D. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.

E. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Firestopping."

B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

## 3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-B. Comply with requirements in Division 26 Section "Identification for Electrical Systems." Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

B. See Division 27 Section "Communications Horizontal Cabling" for additional identification requirements.

C. Labels shall be preprinted or computer-printed type.

END OF SECTION 27 11 00

# SECTION 27 15 00
# COMMUNICATIONS CABLING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Pathways.
2. UTP cabling.
3. 50/125-micrometer, optical fiber cabling.
4. Coaxial cable.
5. Cable connecting hardware, patch panels, and cross-connects.
6. Telecommunications outlet/connectors.
7. Cabling system identification products.
8. Cable management system.

B. Related Sections:

1. Division 28 Section "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

### 1.3 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. BICSI: Building Industry Consulting Service International.

C. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

D. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

E. EMI: Electromagnetic interference.

F. IDC: Insulation displacement connector.

G. LAN: Local area network.

H. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

I. RCDD: Registered Communications Distribution Designer.

J. UTP: Unshielded twisted pair.

## 1.4 CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.

1. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
2. Horizontal cabling shall contain no more that one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
3. Bridged taps and splices shall not be installed in the horizontal cabling.
4. Splitters shall not be installed as part of the optical fiber cabling.

B. A work area is approximately 100 sq. ft. and includes the components that extend from the telecommunications outlet/connectors to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet in the horizontal cross-connect.

## 1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

## 1.6 SUBMITTALS

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

1. For cable, include the following installation data for each type used:

a. Nominal OD.
b. Minimum bending radius.
c. Maximum pulling tension.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. Cabling administration drawings and printouts.
3. Wiring diagrams to show typical wiring schematics, including the following:

a. Cross-connects.
b. Patch panels.
c. Patch cords.

4. Cross-connects and patch panels. Detail mounting assemblies and show elevations and physical relationship between the installed components.

5. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

    a. Vertical and horizontal offsets and transitions.
    b. Clearances for access above and to side of cable trays.
    c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
    d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For splices and connectors to include in maintenance manuals.

## 1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.

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. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

D. Grounding: Comply with ANSI-J-STD-607-A.

## 1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cables to determine the continuity of the strand end to end. Use optical loss test set.
2. Test each pair of UTP cable for open and short circuits.

## 1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.11 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.12 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Patch-Panel Units: One of each type.
2. Connecting Blocks: One of each type.
3. Device Plates: One of each type.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.

B. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

C. Cable Trays:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Cable Management Solutions, Inc.
b. Cablofil Inc.

c. Cooper B-Line, Inc.
d. Cope - Tyco/Allied Tube & Conduit.
e. GS Metals Corp.

D. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."

1. Outlet boxes shall be 2-gang box, 2-3/4” deep with plaster ring.

## 2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements in Division 06 Section "Rough Carpentry" for plywood backing panels.

## 2.3 UTP CABLE

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

1. Belden CDT Inc.; Electronics Division.
2. Berk-Tek; a Nexans company.
3. CommScope, Inc.
4. Draka USA.
5. Genesis Cable Products; Honeywell International, Inc.
6. Mohawk; a division of Belden CDT.
7. Nordex/CDT; a subsidiary of Cable Design Technologies.
8. Superior Essex Inc.
9. SYSTIMAX Solutions; a CommScope, Inc. brand.
10. 3M.
11. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description: 100-ohm, 4-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

a. Multipurpose: Type MP or MPG.
b. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
c. Multipurpose, Riser Rated: Type MPR, complying with UL 1666.

## 2.4 UTP CABLE HARDWARE

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

1. American Technology Systems Industries, Inc.
2. Dynacom Corporation.

3. Hubbell Premise Wiring.
4. KRONE Incorporated.
5. Leviton Voice & Data Division.
6. Molex Premise Networks; a division of Molex, Inc.
7. Nordex/CDT; a subsidiary of Cable Design Technologies.
8. Panduit Corp.
9. Siemon Co. (The).
10. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

D. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

E. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

F. Patch Cords: Factory-made, four-pair cables in 36-inch lengths; terminated with eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.

## 2.5 OPTICAL FIBER CABLE

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

1. Berk-Tek; a Nexans company.
2. CommScope, Inc.
3. Corning Cable Systems.
4. General Cable Technologies Corporation.
5. Mohawk; a division of Belden CDT.
6. Nordex/CDT; a subsidiary of Cable Design Technologies.
7. Optical Connectivity Solutions Division; Emerson Network Power.
8. Superior Essex Inc.
9. SYSTIMAX Solutions; a CommScope, Inc. brand.
10. 3M.
11. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description: Multimode, 50/125-micrometer, 24 strand fiber, nonconductive, tight buffer, optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.

2. Comply with TIA/EIA-568-B.3 for performance specifications.
3. Comply with TIA/EIA-492AAAA-A for detailed specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

    a. General Purpose, Nonconductive: Type OFN or OFNG.
    b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
    c. Riser Rated, Nonconductive: Type OFNR, complying with UL 1666.
    d. General Purpose, Conductive: Type OFC or OFCG.
    e. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262.
    f. Riser Rated, Conductive: Type OFCR, complying with UL 1666.

5. Conductive cable shall be steel armored type.
6. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
7. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

C. Jacket:

1. Jacket Color: Aqua for 50/125-micrometer cable.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

## 2.6 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ADC.
2. American Technology Systems Industries, Inc.
3. Berk-Tek; a Nexans company.
4. Corning Cable Systems.
5. Dynacom Corporation.
6. Hubbell Premise Wiring.
7. Molex Premise Networks; a division of Molex, Inc.
8. Nordex/CDT; a subsidiary of Cable Design Technologies.
9. Optical Connectivity Solutions Division; Emerson Network Power.
10. Siemon Co. (The).

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in 36-inch (900-mm) lengths.

D. Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
2. Quick-connect, simplex and duplex, Type LC connectors. Insertion loss not more than 0.75 dB.

3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

## 2.7 COAXIAL CABLE

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

1. Alpha Wire Company.
2. Belden CDT Inc.; Electronics Division.
3. Coleman Cable, Inc.
4. CommScope, Inc.
5. Draka USA.

B. Cable Characteristics: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.

C. RG-11/U: NFPA 70, Type CATV.

1. No. 14 AWG, solid, copper-covered steel conductor.
2. Gas-injected, foam-PE insulation.
3. Double shielded with 100 percent aluminum polyester tape and 60 percent aluminum braid.
4. Jacketed with sunlight-resistant, black PVC or PE.
5. Suitable for outdoor installations in ambient temperatures ranging from minus 40 to plus 85 deg C.

D. RG-6/U: NFPA 70, Type CATV or CM.

1. No. 16 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
2. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
3. Jacketed with black PVC or PE.
4. Suitable for indoor installations.

E. RG59/U: NFPA 70, Type CATV.

1. No. 20 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
2. Double shielded with 100 percent aluminum polyester tape and 40 percent aluminum braid.
3. PVC jacket.

F. RG59/U (Plenum Rated): NFPA 70, Type CMP.

1. No. 20 AWG, solid, copper-covered steel conductor; foam fluorinated ethylene propylene insulation.
2. Double shielded with 100 percent aluminum-foil shield and 65 percent aluminum braid.
3. Copolymer jacket.

G. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70 "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:

1. CATV Cable: Type CATV.

2. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
3. CATV Riser Rated: Type CATVR, complying with UL 1666.
4. CATV Limited Rating: Type CATVX.

## 2.8 COAXIAL CABLE HARDWARE

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

1. Aim Electronics; a brand of Emerson Electric Co.
2. Leviton Voice & Data Division.
3. Siemon Co. (The).

B. Coaxial-Cable Connectors: Type BNC, 75 ohms.

## 2.9 CONSOLIDATION POINTS

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

1. American Technology Systems Industries, Inc.
2. Chatsworth Products, Inc.
3. Dynacom Corporation.
4. Hubbell Premise Wiring.
5. Molex Premise Networks; a division of Molex, Inc.
6. Nordex/CDT; a subsidiary of Cable Design Technologies.
7. Ortronics, Inc.
8. Panduit Corp.
9. Siemon Co. (The).

B. Description: Consolidation points shall comply with requirements for cable connecting hardware.

1. Number of Terminals per Field: One for each conductor in assigned cables.
2. Number of Connectors per Field:
   a. One for each four-pair conductor group of indicated cables, plus 25 percent spare positions.
3. Mounting: Recessed in ceiling.
4. NRTL listed as complying with UL 50 and UL 1863.
5. When installed in plenums used for environmental air, NRTL listed as complying with UL 2043.

## 2.10 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.

B. Workstation Outlets: Four -port-connector assemblies mounted in multigang faceplate.

1. Plastic Faceplate: High-impact plastic. Coordinate color with Division 26 Section "Wiring Devices."

2. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.

    a. Flush mounting jacks, positioning the cord at a 45-degree angle.
3. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.11 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

2.12 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-B and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

2.13 CABLE MANAGEMENT SYSTEM

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

1. iTRACS Corporation.
2. Telsoft Solutions.

B. Description: Computer-based cable management system, with integrated database and graphic capabilities.

C. Document physical characteristics by recording the network, TIA/EIA details, and connections between equipment and cable.

D. Information shall be presented in database view, schematic plans, or technical drawings.

1. AutoCAD drawing software shall be used as drawing and schematic plans software.

E. System shall interface with the following testing and recording devices:

1. Direct upload tests from circuit testing instrument into the personal computer.
2. Direct download circuit labeling into labeling printer.

2.14 SOURCE QUALITY CONTROL

A. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

B. Factory test UTP cables according to TIA/EIA-568-B.2.

C. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.

D. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

E. Cable will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

### 3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

### 3.3 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

C. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 3 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. MUTOA shall not be used as a cross-connect point.
5. Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors:

    a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
    b. Locate consolidation points for UTP at least 49 feet from communications equipment room.

6. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
8. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
11. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
12. In the communications equipment room and workstation outlet, install a 10-foot long service loop on each end of cable.
13. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, “Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.

2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-B.3.
2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 fee long not less than 12 inches in diameter below each feed point.

G. Outdoor Coaxial Cable Installation:

1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches.

H. Group connecting hardware for cables into separate logical fields.

I. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.

## 3.5 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Firestopping."

B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

## 3.6 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

## 3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-B. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Administration Class: 4.
2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.

C. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

D. Paint and label colors for equipment identification shall comply with TIA/EIA-606-B for Class 4 level of administration.

E. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-B. Furnish electronic record of all drawings, in software and format selected by Owner.

G. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-B.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

## 3.8 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
2. Visually confirm Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

5. Optical Fiber Cable Tests:

a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
b. Link End-to-End Attenuation Tests:

1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

6. UTP Performance Tests:

a. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:

1) Wire map.
2) Length (physical vs. electrical, and length requirements).
3) Insertion loss.
4) Near-end crosstalk (NEXT) loss.
5) Power sum near-end crosstalk (PSNEXT) loss.
6) Equal-level far-end crosstalk (ELFEXT).
7) Power sum equal-level far-end crosstalk (PSELFEXT).
8) Return loss.
9) Propagation delay.
10) Delay skew.

7. Optical Fiber Cable Performance Tests: Perform optical fiber end-to-end link tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.3.
8. Coaxial Cable Tests: Conduct tests according to Division 27 Section "Master Antenna Television System."
9. Final Verification Tests: Perform verification tests for UTP and optical fiber systems after the complete communications cabling and workstation outlet/connectors are installed.

a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

B. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets. Include training in cabling administration software.

END OF SECTION 27 15 00

**SECTION 27 60 00**
**SYSTEM ROUGH-IN REQUIREMENTS**

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 miscellaneous raceway system as shown or implied on the Contract Documents for the following systems:

1. Communication horizontal cabling.
2. Voice, data, dictation, patient information and patient monitoring system.
3. Access control.
4. Video surveillance.
5. Cable Antenna (CATV) antenna television system.

B. Related Sections include the following:

1. Division 26 Section “Grounding and Bonding Electrical Systems.”
2. Division 26 Section “Raceway and Boxes for Electrical Systems.”
3. Division 26 Section “Cable Trays for Electrical Systems.”
4. Division 26 Section “Identification for Electrical Systems.”

PART 2 - PRODUCTS

2.1 MATERIALS

A. Raceway shall be EMT with compression fitting and conduit bushing at both ends. Rough-in box will be minimum 2-1/4” deep. Minimum size shall be as follows:

1. Communication horizontal cabling: 1” conduit trade size.
2. Access control system: 3/4" trade size.
3. Video surveillance: 3/4" trade size.
4. CATV: 3/4" trade size.

B. Rough-In Box:

1. Communication horizontal cabling rough-ins shall be 2-gang, deep rough-in box with single plaster ring and two blank plate.
2. Access control rough-ins shall be 2-gang, deep rough-in box with single gang plaster ring and two gang coverplate as required by equipment supplier.
3. CCTV rough-ins shall be 2-gang, deep rough-in box having a solid barriered 20 ampere duplex power receptacle in one gang and opening for coax and nurse call cable. Cover plate for the rough-in box to be coordinated with Owner.

4. Video surveillance rough-ins shall be 2-gang deep outlet box with single gang plaster ring and two gang plate having 3/8" bushed opening. Coordinate plate opening with Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Raceways shall be installed from outlets to accessible area above ceiling (outside return air plenum) as indicated by Contract Documents. Conduit shall terminate with bushing.

B. Outlet mounting height shall be as follows unless indicated otherwise by Contract Documents:

1. Communication horizontal cables: +18" above finished floor to center and 2” above back splash, wall mounted telephone at +46" AFF unless noted otherwise.
2. Access control at +46" above finished floor to center unless noted otherwise.
3. CATV with 120 VAC duplex outlet: 18” below finished ceiling to center unless otherwise noted on plans.
4. Video surveillance: 18” below finished ceiling to center unless otherwise noted on plans.

C. Provide nylon pullcord in raceway system.

END OF SECTION 27 60 00

# SECTION 28 05 00
# COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Electronic safety and security equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
4. Grout.
5. Common electronic safety and security installation requirements.

### 1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

### 1.4 SUBMITTALS

A. Product Data: For sleeve seals.

### 1.5 COORDINATION

A. Coordinate arrangement, mounting, and support of electronic safety and security equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electronic safety and security items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 8 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Firestopping."

## 1.6 RECORD DRAWINGS

A. Contractor shall provide owner with a complete set of accurate Record Drawings for all work performed under this contract.

1. Record Drawings shall include all approved change orders and pertinent RFI responses.
2. Include actual dimensions of equipment furnished under this contractor where shown on the floor plans.
3. Record Drawings shall include work performed by all sub-contractors retained.
4. Record Drawings shall include the words “RECORD DRAWING” on each sheet.

B. Submission:

1. Submit one set of record Drawings for review by Engineer prior to submission of closeout documents. Record Drawings shall be submitted using the established submittal process.
2. Upon satisfactory review of the Record Drawing submittals by Engineer, provide three (3) copies in electronic format with closeout documents
3. Electronic Record Drawings shall include multi-sheet PDF files combined and named by discipline.

# PART 2 - PRODUCTS

## 2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

## 2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.

c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
3. Pressure Plates: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## 2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

# PART 3 - EXECUTION

## 3.1 COMMON REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY 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 electronic safety and security equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

## 3.2 SLEEVE INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY PENETRATIONS

A. Electronic safety and security penetrations occur when raceways, pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 7 Section "Joint Sealants."

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 7 Section "Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using [**steel**] [**cast-iron**] pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

## 3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

## 3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electronic safety and security installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Firestopping."

END OF SECTION 28 05 00

# SECTION 28 05 13
# CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. UTP cabling.
2. 50/125 micrometer, multimode optical fiber cabling.
3. Coaxial cabling.
4. RS-232 cabling.
5. RS-485 cabling.
6. Low-voltage control cabling.
7. Control-circuit conductors.
8. Fire alarm wire and cable.
9. Identification products.

### 1.3 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. BICSI: Building Industry Consulting Service International.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

F. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

G. RCDD: Registered Communications Distribution Designer.

H. UTP: Unshielded twisted pair.

### 1.4 SUBMITTALS

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

1. For coaxial cable, include the following installation data for each type used:

a. Nominal OD.
b. Minimum bending radius.
c. Maximum pulling tension.

B. Shop Drawings: Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

1. Vertical and horizontal offsets and transitions.
2. Clearances for access above and to side of cable trays.
3. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
4. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For wire and cable to include in maintenance manuals.

## 1.5 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

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.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
2. Test each pair of UTP cable for open and short circuits.

## 1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install UTP, optical fiber, and coaxial cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. Support of Open Cabling: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

B. Cable Trays:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Cable Management Solutions, Inc.
b. Cablofil Inc.
c. Cooper B-Line, Inc.
d. Cope - Tyco/Allied Tube & Conduit.
e. GS Metals Corp.

2. Cable Tray Materials: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inch thick.

a. Basket Cable Trays: 6 inches wide and 2 inches deep. Wire mesh spacing shall not exceed 2 by 4 inches.

C. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels in Division 06 Section "Rough Carpentry".

2.3 UTP CABLE

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

1. Belden CDT Inc.; Electronics Division.
2. Berk-Tek; a Nexans company.
3. CommScope, Inc.
4. Draka USA.
5. Genesis Cable Products; Honeywell International, Inc.
6. KRONE Incorporated.
7. Mohawk; a division of Belden CDT.
8. Nordex/CDT; a subsidiary of Cable Design Technologies.
9. Superior Essex Inc.

10. SYSTIMAX Solutions; a CommScope, Inc. brand.
11. 3M.
12. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description: 100-ohm, 4-pair UTP, formed into 25-pair binder groups covered with a blue thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

    a. Communications, General Purpose: Type CM or CMG.
    b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
    c. Communications, Riser Rated: Type CMR, complying with UL 1666.
    d. Communications, Limited Purpose: Type CMX.
    e. Multipurpose: Type MP or MPG.
    f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
    g. Multipurpose, Riser Rated: Type MPR, complying with UL 1666.

## 2.4 UTP CABLE HARDWARE

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

1. American Technology Systems Industries, Inc.
2. Dynacom Corporation.
3. Hubbell Premise Wiring.
4. KRONE Incorporated.
5. Leviton Voice & Data Division.
6. Molex Premise Networks; a division of Molex, Inc.
7. Nordex/CDT; a subsidiary of Cable Design Technologies.
8. Panduit Corp.
9. Siemon Co. (The).
10. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.

C. Connecting Blocks: 110-style for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

## 2.5 OPTICAL FIBER CABLE

A. Following:

1. Berk-Tek; a Nexans company.
2. CommScope, Inc.
3. Corning Cable Systems.
4. General Cable Technologies Corporation.
5. Mohawk; a division of Belden CDT.

6. Nordex/CDT; a subsidiary of Cable Design Technologies.
7. Optical Connectivity Solutions Division; Emerson Network Power.
8. Superior Essex Inc.
9. SYSTIMAX Solutions; a CommScope, Inc. brand.
10. 3M.
11. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description: Multimode, 50/125-micrometer,24 -fiber, nonconductive, tight buffer, optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-492AAAA-B for detailed specifications.
3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

    a. General Purpose, Nonconductive: Type OFN or OFNG.
    b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
    c. Riser Rated, Nonconductive: Type OFNR, complying with UL 1666.
    d. General Purpose, Conductive: Type OFC or OFCG.
    e. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262.
    f. Riser Rated, Conductive: Type OFCR, complying with UL 1666.

4. Conductive cable shall be steel armored type.
5. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
6. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

C. Jacket:

1. Jacket Color: Aqua for 50/125-micrometer cable.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

## 2.6 OPTICAL FIBER CABLE HARDWARE

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

1. ADC.
2. American Technology Systems Industries, Inc.
3. Berk-Tek; a Nexans company.
4. Corning Cable Systems.
5. Dynacom Corporation.
6. Hubbell Premise Wiring.
7. Molex Premise Networks; a division of Molex, Inc.
8. Nordex/CDT; a subsidiary of Cable Design Technologies.
9. Optical Connectivity Solutions Division; Emerson Network Power.
10. Siemon Co. (The).

B. Cable Connecting Hardware: Meet the Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.

1. Quick-connect, simplex and duplex, Type LC connectors. Insertion loss not more than 0.75 dB.
2. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.7 COAXIAL CABLE

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

1. Alpha Wire Company.
2. Belden CDT Inc.; Electronics Division.
3. Coleman Cable, Inc.
4. CommScope, Inc.
5. Draka USA.

B. General Coaxial Cable Requirements: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.

C. RG-11/U: NFPA 70, Type CATV.

1. No. 14 AWG, solid, copper-covered steel conductor.
2. Gas-injected, foam-PE insulation.
3. Double shielded with 100 percent aluminum polyester tape and 60 percent aluminum braid.
4. Jacketed with sunlight-resistant, black PVC or PE.
5. Suitable for outdoor installations in ambient temperatures ranging from minus 40 to plus 85 deg C.

D. RG59/U: NFPA 70, Type CATVR.

1. No. 20 AWG, solid, silver-plated, copper-covered steel conductor.
2. Gas-injected, foam-PE insulation.
3. Triple shielded with 100 percent aluminum polyester tape and 95 percent aluminum braid; covered by aluminum foil with grounding strip.
4. Color-coded PVC jacket.

E. RG-6/U: NFPA 70, Type CATV or CM.

1. No. 16 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
2. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
3. Jacketed with black PVC or PE.
4. Suitable for indoor installations.

F. RG59/U: NFPA 70, Type CATV.

1. No. 20 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
2. Double shielded with 100 percent aluminum polyester tape and 40 percent aluminum braid.
3. PVC jacket.

G. RG59/U (Plenum Rated): NFPA 70, Type CMP.

1. No. 20 AWG, solid, copper-covered steel conductor; foam fluorinated ethylene propylene insulation.
2. Double shielded with 100 percent aluminum-foil shield and 65 percent aluminum braid.
3. Copolymer jacket.

H. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655, and with NFPA 70 "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:

1. CATV Cable: Type CATV.
2. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
3. CATV Riser Rated: Type CATVR, complying with UL 1666.
4. CATV Limited Rating: Type CATVX.

## 2.8 COAXIAL CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Aim Electronics; a brand of Emerson Electric Co.
2. Leviton Voice & Data Division.
3. Siemon Co. (The).

B. Coaxial-Cable Connectors: Type BNC, 75 ohms.

## 2.9 RS-232 CABLE

A. Standard Cable: NFPA 70, Type CM.

1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Polypropylene insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. PVC jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Plastic insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. Plastic jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

## 2.10 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CM.

1. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.

2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262, Flame Test.

## 2.11 LOW-VOLTAGE CONTROL CABLE

A. Paired Lock Cable: NFPA 70, Type CMG.

1. 1 pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated, Paired Lock Cable: NFPA 70, Type CMP.

1. 1 pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

C. Paired Lock Cable: NFPA 70, Type CMG.

1. 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

D. Plenum-Rated, Paired Lock Cable: NFPA 70, Type CMP.

1. 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Plastic jacket.
5. Flame Resistance: NFPA 262, Flame Test.

## 2.12 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, in raceway complying with UL 83.

B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway complying with UL 83.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or TF, complying with UL 83.

## 2.13 FIRE ALARM WIRE AND CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Comtran Corp.
2. Draka USA.
3. Genesis Cable Products; Honeywell International, Inc.
4. Rockbestos-Suprenant Cable Corporation.
5. West Penn Wire/CDT; a division of Cable Design Technologies.

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG and size as recommended by system manufacturer.

D. 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. Multi-conductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

## 2.14 IDENTIFICATION PRODUCTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brady Corporation
2. HellermannTyton.
3. Kroy LLC.
4. Panduit Corp.

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

## 2.15 SOURCE QUALITY CONTROL

A. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

B. Factory test UTP cables according to TIA/EIA-568-B.2.

C. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.

D. Factory sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

E. Cable will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.

B. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

C. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." for installation of conduits and wireways.

D. Install manufactured conduit sweeps and long-radius elbows whenever possible.

E. Pathway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 3 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

F. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

### 3.2 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
9. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-B.3.
2. Cable shall be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 72 inches long shall be neatly coiled not less than 12 inches in diameter below each feed point.

G. Outdoor Coaxial Cable Installation:

1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches.

H. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.

## 3.3 FIRE ALARM WIRING INSTALLATION

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceway and Boxes for Electrical Systems."

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring Method:

1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
2. Fire-Rated Cables: Use of 2-hour, fire-rated fire alarm cables, NFPA 70, Types MI and CI, is not permitted.
3. Signaling Line Circuits: Power-limited fire alarm cables shall not be installed in the same cable or raceway as signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different

colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

G. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

H. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

## 3.4 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, No. 14 AWG.
2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

## 3.5 CONNECTIONS

A. Comply with requirements in Division 28 Section "Fire Detection and Alarm" for connecting, terminating, and identifying wires and cables.

## 3.6 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Firestopping."

B. Comply with TIA/EIA-569-A, "Firestopping" Annex A.

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

## 3.7 GROUNDING

A. For communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

## 3.8 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

## 3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

4. Optical Fiber Cable Tests:

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Multimode Link Measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
        2) Attenuation test results for links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

C. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 28 05 13

# SECTION 28 13 00
# ACCESS CONTROL

## 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. The work in this section shall be provided under separate contract and is included for general guidance purposes only.

B. This Section includes a security access system consisting of a Central Station, one or more networked workstation computers, operating system and application software, and field-installed Controllers connected by a high-speed electronic data transmission network. The security access system shall have the following:

1. Access Control:

   a. Regulating access through doors.
   b. Anti-passback.
   c. Visitor assignment.
   d. Time and attendance.
   e. Surge and tamper protection.
   f. Secondary alarm annunciator.
   g. Credential cards and readers.
   h. Biometric identity verification equipment.
   i. Enrollment center.
   j. Push-button switches.
   k. RS-232 ASCII interface.
   l. Credential creation and credential holder database and management.
   m. Monitoring of field-installed devices.
   n. Reporting.

2. Security:

   a. Real-time guard tour.
   b. Time and attendance.
   c. Key tracking.
   d. Video and camera control.
   e. Interface with paging, elevator control and video surveillance (CCTV) systems.

C. Related Sections include the following:

1. Division 28 Section "Video Surveillance" for interface devices and communications protocol to integrate motion detection and video camera selection and positioning into security access system.

1.3 DEFINITIONS

A. ABA Track: Magnetic stripe that is encoded on track 2, at 75-bpi density in binary-coded decimal format; for example, 5-bit, 16-character set.

B. CCTV: Video surveillance system.

C. Central Station: A PC with software designated as the main controlling PC of the security access system. Where this term is presented with initial capital letters, this definition applies.

D. Controller: An intelligent peripheral control unit that uses a computer for controlling its operation. Where this term is presented with an initial capital letter, this definition applies.

E. CPU: Central processing unit.

F. Credential: Data assigned to an entity and used to identify that entity.

G. dpi: Dots per inch.

H. DTS: Digital Termination Service: A microwave-based, line-of-sight communications provided directly to the end user.

I. File Server: A PC in a network that stores the programs and data files shared by users.

J. GFI: Ground fault interrupter.

K. Identifier: A credential card, keypad personal identification number or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

L. I/O: Input/Output.

M. LAN: Local area network.

N. LED: Light-emitting diode.

O. Location: A Location on the network having a PC-to-Controller communications link, with additional Controllers at the Location connected to the PC-to-Controller link with RS-485 communications loop. Where this term is presented with an initial capital letter, this definition applies.

P. PC: Personal computer. This acronym applies to the Central Station, workstations, and file servers.

Q. PCI Bus: Peripheral component interconnect; a peripheral bus providing a high-speed data path between the CPU and peripheral devices (such as monitor, disk drive, or network).

R. PDF: (Portable Document Format.) The file format used by the Acrobat document exchange system software from Adobe.

S. RF: Radio frequency.

T. ROM: Read-only memory. ROM data are maintained through losses of power.

U. RS-232: A TIA/EIA standard for asynchronous serial data communications between terminal devices. This standard defines a 25-pin connector and certain signal characteristics for interfacing computer equipment.

V. RS-485: A TIA/EIA standard for multipoint communications.

W. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

X. TWAIN: (Technology without an Interesting Name.) A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.

Y. UPS: Uninterruptible power supply.

Z. WAN: Wide area network.

AA. WAV: The digital audio format used in Microsoft Windows.

BB. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.

CC. Windows: Operating system by Microsoft Corporation.

DD. Workstation: A PC with software that is configured for specific limited security system functions.

EE. WYSIWYG: (What You See Is What You Get.) Text and graphics appear on the screen the same as they will print.

## 1.4 SYSTEM DESCRIPTION

A. System shall consist of a PC-based Central Station, one or more networked PC-based workstations, and field-installed Controllers, connected by a high-speed electronic data transmission network.

1. System Software: Based on 32-bit, Microsoft Windows workstation operating system and application software. Software shall have the following capabilities:

a. Graphical user interface to show pull-down menus and a menu tree format that complies with interface guidelines of Microsoft Windows operating system.
b. System license shall be for the entire system and shall include capability for future additions that are within the indicated system size limits specified in this Section.
c. System shall have open architecture that allows importing and exporting of data and interfacing with other systems that are compatible with Microsoft Windows operating system.
d. Password-protected operator login and access.

B. Network(s) connecting PCs and Controllers shall consist of one or more of the following:

1. Direct-connected, RS-232 cable from the COM port of the Central Station to the first Controller, then RS-485 to interconnect the remainder of the Controllers at that Location.

## 1.5 PERFORMANCE REQUIREMENTS

A. Security access system shall use a single database for access-control and credential-creation functions.

B. System Network Requirements:

1. Interconnect system components and provide automatic communication of status changes, commands, field-initiated interrupts, and other communications required for proper system operation.
2. Communication shall not require operator initiation or response, and shall return to normal after partial or total network interruption such as power loss or transient upset.
3. System shall automatically annunciate communication failures to the operator and identify the communication link that has experienced a partial or total failure.

C. Field equipment shall include Controllers, sensors, and controls. Controllers are classified as alarm-annunciation or entry-control type.

D. System Response to Alarms: Field device network shall provide a system end-to-end response time of 1 second(s) or less for every device connected to the system All graphics shall be displayed, including graphics-generated map displays, on the console monitor within 5 seconds of alarm receipt at the security console. This response time shall be maintained during system heavy load.

E. False Alarm Reduction: The design of Controllers shall contain features to reduce false alarms. Equipment and software shall comply with SIA CP-01.

F. Error Detection: A cyclic code error detection method shall be used which shall detect single- and double-bit errors, burst errors of eight bits or less, and at least 99 percent of all other multibit and burst error conditions. Interactive or product error detection codes alone will not be acceptable. A message shall be in error if one bit is received incorrectly. System shall retransmit messages with detected errors. A two-digit decimal number shall be operator assignable to each communication link representing the number of retransmission attempts. System shall monitor the frequency of data transmission failure for display and logging.

G. Data Line Supervision: System shall initiate an alarm in response to opening, closing, shorting, or grounding of data transmission lines.

H. Door Hardware Interface: Coordinate with Division 08 Sections that specify door hardware required to be monitored or controlled by the security access system. The Controllers in this Section shall have electrical characteristics that match the signal and power requirements of door hardware. Integrate door hardware specified in Division 08 Sections to function with the controls and PC-based software and hardware in this Section.

## 1.6 SUBMITTALS

A. Product Data: For each type of product indicated. Include operating characteristics, furnished specialties, and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.

B. Shop Drawings:

1. Diagrams for cable management system.

2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.
3. Wiring Diagrams. Show typical wiring schematics including the following:

    a. Workstation outlets, jacks, and jack assemblies.
    b. Patch cords.
    c. Patch panels.

4. Cable Administration Drawings: As specified in Part 3 "Identification" Article.
5. Battery and charger calculations for Central Station, workstations, and Controllers.

C. Project planning documents as specified in Part 3.

D. Samples: For workstation outlets, jacks, jack assemblies, and faceplates for color selection and evaluation of technical features.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data" include the following:

1. Microsoft Windows software documentation.
2. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each PC.
3. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files of the hard-copy submittal.
4. System installation and setup guides, with data forms to plan and record options and setup decisions.

## 1.7 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

1. Cable installer must have on staff a registered communication distribution designer certified by Building Industry Consulting Service International.

B. Source Limitations: Obtain Central Station, workstations, Controllers, Identifier readers, and all software 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, "National Electrical Code."

E. Comply with SIA DC-01 and SIA DC-03 and SIA DC-07.

## 1.8 DELIVERY, STORAGE, AND HANDLING

A. Workstations, and Controllers:

1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F, and not more than 80 percent relative humidity, noncondensing.
2. Open each container; verify contents against packing list, and file copy of packing list, complete with container identification for inclusion in operation and maintenance data.
3. Mark packing list with designations that have been assigned to materials and equipment for recording in the system labeling schedules that are generated by cable and asset management system specified in Part 2.
4. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

## 1.9 PROJECT CONDITIONS

A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg F and a relative humidity of 20 to 80 percent, non-condensing.
2. Interior, Controlled Environment: System components, except central-station control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, non-condensing. NEMA 250, Type 1 enclosure.
3. Interior, Uncontrolled Environment: System components installed in non-temperature-controlled interior environments shall be rated for continuous operation in ambient conditions of 0 to 122 deg F dry bulb and 20 to 90 percent relative humidity, non-condensing. NEMA 250, Type 3R enclosures.
4. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of minus 30 to plus 122 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph and snow cover up to 24 inches (610 mm) thick. NEMA 250, Type 4X enclosures.
5. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
6. Corrosive Environment: For system components subjected to corrosive fumes or vapors, provide NEMA 250, Type 4X enclosures.

## 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. Laser Printers: Three toner cassettes and one replacement drum unit.
2. Credential card blanks, ready for printing. Include enough credential cards for all personnel to be enrolled at the site plus additional 25 percent for future use.

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 SECURITY ACCESS SYSTEM

A. Manufacturers:
1. Andover Controls Corporation; a Balfour Beatty Company.
2. CASI-RUSCO; Subsidiary of SLC Technologies; Division of Berwind Group.
3. Checkpoint Systems, Inc.
4. Hirsch Electronics.
5. Keyscan Inc.
6. Matrix Systems, Inc.
7. NexWatch; Member of Ademco Group; a Honeywell Company.
8. Northern; Member of Ademco Group; a Honeywell Company.
9. Radionics; Division of Detection Systems.

2.3 APPLICATION SOFTWARE

A. System Software: Based on 32-bit, Microsoft Windows operating system and application software. Software shall have the following features:

1. Multiuser multitasking to allow independent activities and monitoring to occur simultaneously at different workstations.
2. Graphical user interface to show pull-down menus and a menu tree format.
3. Capability for future additions within the indicated system size limits.
4. Open architecture that allows importing and exporting of data and interfacing with other systems that are compatible with operating system.
5. Password-protected operator login and access.

B. Peer Computer Control Software: Shall detect a failure of a central computer, and shall cause the other central computer to assume control of all system functions without interruption of operation. Drivers shall be provided in both central computers to support this mode of operation.

C. Application Software: Interface between the alarm annunciation and entry-control Controllers, to monitor sensors and DTS links, operate displays, report alarms, generate reports, and help train system operators. Software shall have the following functions:

1. Resides at the workstations, and Controllers as required to perform specified functions.
2. Operate and manage peripheral devices.
3. Manage files for disk I/O, including creating, deleting, and copying files; and automatically maintain a directory of all files, including size and location of each sequential and random-ordered record.
4. Import custom icons into graphics views to represent alarms and I/O devices.

5. Globally link I/O so that any I/O can link to any other I/O within the same Location, without requiring interaction with the host PC. This operation shall be at the Controller.
6. Globally code I/O links so that any access-granted event can link to any I/O with the same Location without requiring interaction with the host PC. This operation shall be at the Controller.
7. Messages from PC to Controllers and Controllers to Controllers shall be on a polled network that utilizes check summing and acknowledgment of each message. Communication shall be automatically verified, buffered, and retransmitted if message is not acknowledged.
8. Selectable poll frequency and message time-out settings shall handle bandwidth and latency issues for TCP/IP, RF, and other PC-to-Controller communications methods by changing the polling frequency and the amount of time the system waits for a response.
9. Automatic and encrypted backups for database and history backups shall be automatically stored at the central control PC and at a selected workstation and encrypted with a nine-character alphanumeric password, which must be used to restore or read data contained in backup.
10. Operator audit trail for recording and reporting all changes made to database and system software.

D. Workstation Software:

1. Password levels shall be individually customized at each workstation to allow or disallow operator access to program functions for each Location.
2. Workstation event filtering shall allow user to define events and alarms that will be displayed at each workstation. If an alarm is unacknowledged (not handled by another workstation) for a preset amount of time, the alarm will automatically appear on the filtered workstation.

E. Controller Software:

1. Controllers shall operate as an autonomous intelligent processing unit. Controllers shall make decisions about access control, alarm monitoring, linking functions, and door locking schedules for its operation, independent of other system components. Controllers shall be part of a fully distributed processing control network. The portion of the database associated with a Controller and consisting of parameters, constraints, and the latest value or status of points connected to that Controller, shall be maintained in the Controller.
2. Functions: The following functions shall be fully implemented and operational within each Controller:

    a. Monitoring inputs.
    b. Controlling outputs.
    c. Reporting of sensor and output status to Central Station on request.
    d. Executing Controller resident programs.
    e. Diagnosing.

3. Controller Operations at a Location:

    a. Location: Up to 64 Controllers connected to RS-485 communications loop. Globally operating I/O linking and anti-passback functions between Controllers within the same Location without workstation intervention. Linking and anti-passback shall remain fully functional within the same Location even when the workstations are off line.
    b. The Controllers at each Location shall be connected to a memory buffer with a capacity to store up to 10,000 events; there shall be no loss of transactions in system history files until the buffer overflows.

c. Buffered events shall be handled in a first-in-first-out mode of operation.

4. Individual Controller Operation:

a. Controllers shall transmit alarms, status changes, and other data to the Central Station when communications circuits are operable. If communications are not available, Controllers shall function in a stand-alone mode and operational data, including the status and alarm data normally transmitted to the Central Station, shall be stored for later transmission to the Central Station. Storage capacity for the latest 1024 events shall be provided at each Controller.
b. Card-reader ports of a Controller shall be custom configurable for at least 120 different card-reader or keypad formats. Multiple reader or keypad formats may be used simultaneously at different Controllers or within the same Controller.
c. Controllers shall provide a response to card-readers or keypad entries in less than 0.25 seconds, regardless of system size.
d. Controllers that are reset, or powered up from a nonpowered state, shall automatically request a parameter download and reboot to its proper working state. This shall happen without any operator intervention.
e. Initial Startup: When Controllers are brought on-line, database parameters shall be automatically downloaded to them. After initial download is completed, only database changes shall be downloaded to each Controller.
f. Failure Mode: On failure for any reason, Controllers shall perform an orderly shutdown and force Controller outputs to a predetermined failure mode state, consistent with the failure modes shown and the associated control device.
g. Startup After Power Failure: After power is restored, startup software shall initiate self-test diagnostic routines, after which Controllers shall resume normal operation.
h. Startup After Controller Failure: On failure, if the database and application software are no longer resident, Controllers shall not restart, but shall remain in the failure mode until repaired. If database and application programs are resident, Controllers shall immediately resume operation. If not, software shall be restored automatically from the Central Station.

5. Communications Monitoring:

a. System shall monitor and report status of RS-485 communications loop of each Location.
b. Communication status window shall display which Controllers are currently communicating, a total count of missed polls since midnight, and which Controller last missed a poll.
c. Communication status window shall show the type of CPU, the type of I/O board, and the amount of RAM memory for each Controller.

6. Operating systems shall include a real-time clock function that maintains seconds, minutes, hours, day, date, and month. The real-time clock shall be automatically synchronized with the controllers at least once a day to plus or minus 10 seconds. The time synchronization shall be automatic, without operator action and without requiring system shutdown.

F. PC-to-Controller Communications:

1. Workstation communications shall use the following:

a. Direct connection using serial ports of the PC.
b. TCP/IP LAN network interface cards.
c. Dial-up modems for connections to Locations.

2. Serial Port Configuration: Each serial port used for communications shall be individually configurable for "direct communications," "modem communications incoming and outgoing," or "modem communications incoming only"; or as an ASCII output port.
3. Multiport Communications Board: Use if more than two serial ports are needed.

    a. Expandable and modular design. Use a 4-, 8-, or 16-serial port configuration that is expandable to 32 or 64 serial ports.
    b. Connect the first board to an internal PCI bus adapter card.

4. Direct serial, TCP/IP, and dial-up communications shall be alike in the monitoring or control of system, except for the connection that must first be made to a dial-up Location.
5. TCP/IP network interface card shall have an option to set the poll frequency and message response time-out settings.
6. PC-to-Controller and Controller-to-Controller communications (direct, dial-up, or TCP/IP) shall use a polled-communication protocol that checks sum and acknowledges each message. All communications shall be verified and buffered and retransmitted if not acknowledged.

G. Direct Serial or TCP/IP PC-to-Controller Communications:

1. Communication software on the PC shall supervise the PC-to-Controller communications link.
2. Loss of communications to any Controller shall result in an alarm at all PCs running the communications software.
3. When communications are restored, all buffered events shall automatically upload to the PC, and any database changes shall be automatically sent to the Controller.

H. Dial-up Modem PC-to-Controller Communications:

1. Communication software on the PC shall supervise the PC-to-Controller communications link during dial-up modem connect times.
2. Communication software shall be programmable to routinely poll each of the remote dial-up modem Locations, collecting event logs and verifying phone lines at time intervals that are operator selectable for each Location.
3. System shall be programmable for dialing and connecting to all dial-up modem Locations and for retrieving the accrued history transactions on an automatic basis as often as once every 10 minutes and up to once every 9999 minutes.
4. Failure to communicate to a dial-up Location three times in a row shall result in an alarm at the PC.
5. Time offset capabilities shall be present so that Locations in a different geographical time zone than the host PC will be set to, and maintained at, the proper local time. This feature shall allow for geographical time zones that are ahead of or behind the host PC.
6. The Controller connected to a dial-up modem shall automatically buffer all normal transactions until its buffer reaches 80 percent of capacity.
7. Alarms shall be reported immediately.
8. Dial-up modems shall be provided by manufacturer of the system. Modems used at the Controller shall be powered by the Controller. Power to the modem shall include battery backup if the Controller is so equipped.

I. Controller-to-Controller Communications:

1. Controller-to-Controller Communications: RS-485, 4-wire, point-to-point, regenerative (repeater) communications network methodology.
2. RS-485 communications signal shall be regenerated at each Controller.

J. Database Downloads:

1. All data transmissions from PCs to a Location, and between Controllers at a Location, shall include a complete database checksum to check the integrity of the transmission. If the data checksum does not match, a full data download shall be automatically retransmitted.
2. If a Controller is reset for any reason, it shall automatically request and receive a database download from the PC. The download shall restore data stored at the Controller to their normal working state and shall take place with no operator intervention.

K. Operator Interface:

1. Inputs in system shall have two icon representations, one for the normal state and one for the abnormal state.
2. When viewing and controlling inputs, displayed icons shall automatically change to the proper icon to display the current system state in real time. Icons shall also display the input's state, whether armed or bypassed, and if the input is in the armed or bypassed state due to a time zone or a manual command.
3. Outputs in system shall have two icon representations, one for the secure (locked) state and one for the open (unlocked) state.
4. Icons displaying status of the I/O points shall be constantly updated to show their current real-time condition without prompting by the operator.
5. The operator shall be able to scroll the list of I/Os and press the appropriate toolbar button, or right click, to command the system to perform the desired function.
6. Graphic maps or drawings containing inputs, outputs, and override groups shall include the following:

    a. Database to import and store full-color maps or drawings and allow for input, output, and override group icons to be placed on maps.
    b. Maps to provide real-time display animation and allow for control of points assigned to them.
    c. System to allow inputs, outputs, and override groups to be placed on different maps.
    d. Software to allow changing the order or priority in which maps will be displayed.

7. Override Groups Containing I/Os:

    a. System shall incorporate override groups that provide the operator with the status and control over user-defined "sets" of I/Os with a single icon.
    b. Icon shall change automatically to show the live summary status of points in that group.
    c. Override group icon shall provide a method to manually control or set to time zone points in the group.
    d. Override group icon shall allow the expanding of the group to show icons representing the live status for each point in the group, individual control over each point, and the ability to compress the individual icons back into one summary icon.

8. Schedule Overrides of I/Os and Override Groups:

    a. To accommodate temporary schedule changes that do not fall within the holiday parameters, the operator shall have the ability to override schedules individually for each input, output, or override group.
    b. Each schedule shall be composed of a minimum of two dates with separate times for each date.
    c. The first time and date shall be assigned the override state that the point shall advance to, when the time and date become current.

d. The second time and date shall be assigned the state that the point shall return to, when the time and date become current.

9. Copy command in database shall allow for like data to be copied and then edited for specific requirements, to reduce redundant data entry.

L. Operator Access Control:

1. Control operator access to system controls through three password-protected operator levels. System operators and managers with appropriate password clearances shall be able to change operator levels for operators.
2. Three successive attempts by an operator to execute functions beyond their defined level during a 24-hour period shall initiate a software tamper alarm.
3. A minimum of 32 passwords shall be available with the system software. System shall display the operator's name or initials in the console's first field. System shall print the operator's name or initials, action, date, and time on the system printer at login and logoff.
4. The password shall not be displayed or printed.
5. Each password shall be definable and assignable for the following:

a. Commands usable.
b. Access to system software.
c. Access to application software.
d. Individual zones that are to be accessed.
e. Access to database.

M. Operator Commands:

1. Command Input: Plain-language words and acronyms shall allow operators to use the system without extensive training or data-processing backgrounds. System prompts shall be a word, a phrase, or an acronym.
2. Command inputs shall be acknowledged and processing shall start in not less than [**1**] <**Insert number**> second(s).
3. Tasks that are executed by operator's commands shall include the following:

a. Acknowledge Alarms: Used to acknowledge that the operator has observed the alarm message.
b. Place Zone in Access: Used to remotely disable intrusion alarm circuits emanating from a specific zone. System shall be structured so that console operator cannot disable tamper circuits.
c. Place Zone in Secure: Used to remotely activate intrusion alarm circuits emanating from a specific zone.
d. System Test: Allows the operator to initiate a system-wide operational test.
e. Zone Test: Allows the operator to initiate an operational test for a specific zone.
f. Print reports.
g. Change Operator: Used for changing operators.
h. Security Lighting Controls: Allows the operator to remotely turn on/off security lights.
i. Display Graphics: Used to display any graphic displays implemented in the system. Graphic displays shall be completed within 20 seconds from time of operator command.
j. Run system tests.
k. Generate and format reports.
l. Request help with the system operation.

1) Include in main menus.

2) Provide unique, descriptive, context-sensitive help for selections and functions with the press of one function key.
3) Provide navigation to specific topic from within the first help window.
4) Help shall be accessible outside the applications program.

m. Entry-Control Commands:

1) Lock (secure) or unlock (open) each controlled entry and exit up to four times a day through time-zone programming.
2) Arm or disarm each monitored input up to four times a day through time-zone programming.
3) Enable or disable readers or keypads up to twice a day through time-zone programming.
4) Enable or disable cards or codes up to four times per day per entry point through access-level programming.

4. Command Input Errors: Show operator input assistance when a command cannot be executed because of operator input errors. Assistance screen shall use plain-language words and phrases to explain why the command cannot be executed. Error responses that require an operator to look up a code in a manual or other document are not acceptable. Conditions causing operator assistance messages include the following:

a. Command entered is incorrect or incomplete.
b. Operator is restricted from using that command.
c. Command addresses a point that is disabled or out of service.
d. Command addresses a point that does not exist.
e. Command is outside the system's capacity.

N. Alarms:

1. System Setup:

a. Assign manual and automatic responses to incoming point status change or alarms.
b. Automatically respond to input with a link to other inputs, outputs, operator-response plans, unique sound with use of WAV files, and maps or images that graphically represent the point location.
c. 60-character message field for each alarm.
d. Operator-response-action messages shall allow message length of at least 65,000 characters, with database storage capacity of up to 32,000 messages. Setup shall assign messages to access point.
e. Secondary messages shall be assignable by the operator for printing to provide further information and shall be editable by the operator.
f. Allow 25 secondary messages with a field of 4 lines of 60 characters each.
g. Store the most recent 1000 alarms for recall by the operator using the report generator.

2. Software Tamper:

a. Annunciate a tamper alarm when unauthorized changes to system database files are attempted. Three consecutive unsuccessful attempts to log onto system shall generate a software tamper alarm.
b. Annunciate a software tamper alarm when an operator or other individual makes three consecutive unsuccessful attempts to invoke functions beyond their authorization level.

c. Allow only acknowledgment of software tamper alarms.

3. Read access to system transcript files shall be reserved for operators with the highest password authorization level available in system.
4. Animated Response Graphics: Highlight alarms with flashing icons on graphic maps; display and constantly update the current status of alarm inputs and outputs in real time through animated icons.
5. Multimedia Alarm Annunciation: WAV files to be associated with alarm events for audio annunciation or instructions.
6. Alarm Handling: Each input may be configured so that an alarm cannot be cleared unless it has returned to normal, with options of requiring the operator to enter a comment about disposition of alarm. Allow operator to silence alarm sound when alarm is acknowledged.
7. CCTV Alarm Interface: Allow commands to be sent to CCTV systems during alarms (or input change of state) through serial ports.
8. Camera Control: Provides operator ability to select and control cameras from graphic maps.

O. Alarm Monitoring: Monitor sensors, Controllers, and DTS circuits and notify operators of an alarm condition. Display higher-priority alarms first and, within alarm priorities, display the oldest unacknowledged alarm first. Operator acknowledgment of one alarm shall not be considered acknowledgment of other alarms nor shall it inhibit reporting of subsequent alarms.

1. Displayed alarm data shall include type of alarm, location of alarm, and secondary alarm messages.
2. Printed alarm data shall include type of alarm, location of alarm, date and time (to nearest second) of occurrence, and operator responses.
3. Maps shall automatically display the alarm condition for each input assigned to that map, if that option is selected for that input location.
4. Alarms initiate a status of "pending" and require the following two handling steps by operators:

   a. First Operator Step: “Acknowledged." This action shall silence sounds associated with the alarm. The alarm remains in the system "Acknowledged" but "Un-Resolved."
   b. Second Operator Step: Operators enter the resolution or operator comment, giving the disposition of the alarm event. The alarm shall then clear.

5. Each workstation shall display the total pending alarms and total unresolved alarms.
6. Each alarm point shall be programmable to disallow the resolution of alarms until the alarm point has returned to its normal state.
7. Alarms shall transmit to Central Station in real time, except for allowing connection time for dial-up locations.
8. Alarms shall be displayed and managed from a minimum of four different windows.

   a. Input Status Window: Overlay status icon with a large red blinking icon. Selecting the icon will acknowledge the alarm.
   b. History Log Transaction Window: Display name, time, and date in red text. Selecting red text will acknowledge the alarm.
   c. Alarm Log Transaction Window: Display name, time, and date in red. Selecting red text will acknowledge the alarm.
   d. Graphic Map Display: Display a steady colored icon representing each alarm input location. Change icon to flashing red when the alarm occurs. Change icon from flashing red to steady red when the alarm is acknowledged.

9. Once an alarm is acknowledged, the operator shall be prompted to enter comments about the nature of the alarm and actions taken. Operator's comments may be manually entered or selected from a programmed predefined list, or a combination of both.
10. For locations where there are regular alarm occurrences, provide programmed comments. Selecting that comment shall clear the alarm.
11. The time and name of the operator who acknowledged and resolved the alarm shall be recorded in the database.
12. Identical alarms from same alarm point shall be acknowledged at same time the operator acknowledges the first alarm. Identical alarms shall be resolved when the first alarm is resolved.
13. Alarm functions shall have priority over downloading, retrieving, and updating database from workstations and Controllers.
14. When a reader-controlled output (relay) is opened, the corresponding alarm point shall be automatically bypassed.

P. Monitor Display: Display text and graphic maps that include zone status integrated into the display. Colors are used for the various components and current data. Colors shall be uniform throughout the system.

1. Color Code:

   a. FLASHING RED: Alerts operator that a zone has gone into an alarm or that primary power has failed.
   b. STEADY RED: Alerts operator that a zone is in alarm and alarm has been acknowledged.
   c. YELLOW: Advises operator that a zone is in access.
   d. GREEN: Indicates that a zone is secure and that power is on.

2. Graphics:

   a. Support 32,000 graphic display maps and allow import of maps from a minimum of 16 standard formats from another drawing or graphics program.
   b. Allow I/O to be placed on graphic maps by the drag-and-drop method.
   c. Operators shall be able to view the inputs, outputs, and the point's name by moving the mouse cursor over the point on graphic map.
   d. Inputs or outputs may be placed on multiple graphic maps. The operator shall be able to toggle to view graphic map associated with inputs or outputs.
   e. Each graphic map shall have a display-order sequence number associated with it to provide a predetermined order when toggled to different views.
   f. Camera icons shall have the ability to be placed on graphic maps that, when selected by an operator, will open a video window, display the camera associated with that icon, and provide pan-tilt-zoom control.
   g. Input, output, or camera placed on a map shall allow the ability to arm or bypass an input, open or secure an output, or control the pan-tilt-zoom function of the selected camera.

Q. System test software enables operators to initiate a test of the entire system or of a particular portion of the system.

1. Test Report: The results of each test shall be stored for future display or printout. The report shall document the operational status of system components.

R. Report Generator Software: Include commands to generate reports for displaying, printing, and storing on disk and tape. Reports shall be stored by type, date, and time. Report printing shall be the lowest priority activity. Report generation mode shall be operator selectable but set up

initially as periodic, automatic, or on request. Include time and date printed and the name of operator generating the report. Report formats may be configured by operators.

1. Automatic Printing: Setup shall specify, modify, or inhibit the report to be generated; the time the initial report is to be generated; the time interval between reports; the end of period; and the default printer.
2. Printing on Requests: An operator may request a printout of any report.
3. Alarm Reports: Reporting shall be automatic as initially set up. Include alarms recorded by system over the selected time and information about the type of alarm (such as door alarm, intrusion alarm, tamper alarm, etc.) the type of sensor, the location, the time, and the action taken.
4. Access and Secure Reports: Document zones placed in access, the time placed in access, and the time placed in secure mode.
5. Custom Reports: Reports tailored to exact requirements of who, what, when, and where. As an option, custom report formats may be stored for future printing.
6. Automatic History Reports: Named, saved, and scheduled for automatic generation.
7. Cardholder Reports: Include data, or selected parts of the data, as well as the ability to be sorted by name, card number, imprinted number, or by any of the user-defined fields.
8. Cardholder by Reader Reports: Based on who has access to a specific reader or group of readers by selecting the readers from a list.
9. Cardholder by Access-Level Reports: Display everyone that has been assigned to the specified access level.
10. Who Is In (Muster) Report:

    a. Emergency Muster Report: One click operation on toolbar launches report.
    b. Cardholder Report. Contain a count of persons that are "In" at a selected Location and a count with detailed listing of name, date, and time of last use, sorted by the last reader used or by the group assignment.

11. Panel Labels Reports: Printout of control-panel field documentation including the actual location of equipment, programming parameters, and wiring identification. Maintain system installation data within system database so that they are available on-site at all times.
12. Activity and Alarm On-Line Printing: Activity printers for use at workstations; prints all events or alarms only.
13. History Reports: Custom reports that allows the operator to select any date, time, event type, device, output, input, operator, Location, name, or cardholder to be included or excluded from the report.

    a. Initially store history on the hard disk of the host PC.
    b. Permit viewing of the history on workstations or print history to any system printer.
    c. The report shall be definable by a range of dates and times with the ability to have a daily start and stop time over a given date range.
    d. Each report shall depict the date, time, event type, event description, device, or I/O name, cardholder group assignment, and cardholder name or code number.
    e. Each line of a printed report shall be numbered to ensure that the integrity of the report has not been compromised.
    f. Total number of lines of the report shall be given at the end of the report. If the report is run for a single event such as "Alarms," the total shall reflect how many alarms occurred during that period.

14. Reports shall have the following four options:

    a. View on screen.
    b. Print to system printer. Include automatic print spooling and "Print To" options if more than one printer is connected to system.

c. "Save to File" with full path statement.
d. System shall have the ability to produce a report indicating status of system inputs and outputs or of inputs and outputs that are abnormal, out of time zone, manually overridden, not reporting, or in alarm.

15. Custom Code List Subroutine: Allow the access codes of system to be sorted and printed according to the following criteria:

a. Active, inactive, or future activate or deactivate.
b. Code number, name, or imprinted card number.
c. Group, Location, access levels.
d. Start and stop code range.
e. Codes that have not been used since a selectable number of days.
f. In, out, or either status.
g. Codes with trace designation.

16. The reports of system database shall allow options so that every data field may be printed.
17. The reports of system database shall be constructed so that the actual position of the printed data shall closely match the position of the data on the data-entry windows.

S. Anti-Passback:

1. System shall have global and local anti-passback features, selectable by Location. System shall support hard and soft anti-passback.
2. Hard Anti-Passback: Once a credential holder is granted access through a reader with one type of designation (IN or OUT), the credential holder may not pass through that type of reader designation until the credential holder passes though a reader of opposite designation.
3. Soft Anti-Passback: Should a violation of the proper IN or OUT sequence occur, access shall be granted, but a unique alarm shall be transmitted to the control station, reporting the credential holder and the door involved in the violation. A separate report may be run on this event.
4. Timed Anti-Passback: A Controller capability that prevents an access code from being used twice at the same device (door) within a user-defined amount of time.
5. Provide four separate zones per Location that can operate without requiring interaction with the host PC (done at Controller). Each reader shall be assignable to one or all four anti-passback zones. In addition, each anti-passback reader can be further designated as "Hard," "Soft," or "Timed" in each of the four anti-passback zones. The four anti-passback zones shall operate independently.
6. The anti-passback schemes shall be definable for each individual door.
7. The Master Access Level shall override anti-passback.
8. System shall have the ability to forgive (or reset) an individual credential holder or the entire credential holder population anti-passback status to a neutral status.

T. Visitor Assignment:

1. Provide for and allow an operator to be restricted to only working with visitors. The visitor badging subsystem shall assign credentials and enroll visitors. Allow only access levels that have been designated as approved for visitors.
2. Provide an automated log of visitor name, time and doors accessed, and whom visitor contacted.
3. Allow a visitor designation to be assigned to a credential holder.
4. Security access system shall be able to restrict the access levels that may be assigned to credentials that are issued to visitors.

5. Allow operator to recall visitors' credential holder file, once a visitor is enrolled in the system.
6. The operator may designate any reader as one that deactivates the credential after use at that reader. The history log shall show the return of the credential.
7. System shall have the ability to use the visitor designation in searches and reports. Reports shall be able to print all or any visitor activity.

U. Time and Attendance:

1. Time and attendance reporting shall be provided to match IN and OUT reads and display cumulative time in for each day and cumulative time in for length of the report.
2. Shall be provided to match IN and OUT reads and display cumulative time in for each day and cumulative time in for length of the report.
3. System software setup shall allow designation of selected access-control readers as time and attendance hardware to gather the clock-in and clock-out times of the users at these readers.

    a. Reports shall show in and out times for each day, total in time for each day, and a total in time for period specified by the user.
    b. Allow the operator to view and print the reports, or save the report to a file.
    c. Alphabetically sort reports on the person's last name, by Location or location group. Include all credential holders or optionally select individual credential holders for the report.

V. Training Software: Enables operators to practice system operation including alarm acknowledgment, alarm assessment, response force deployment, and response force communications. System shall continue normal operation during training exercises and shall terminate exercises when an alarm signal is received at the console.

W. Entry-Control Enrollment Software: Database management functions that allow operators to add, delete, and modify access data as needed.

1. The enrollment station shall not have alarm response or acknowledgment functions.
2. Provide multiple, password-protected access levels. Database management and modification functions shall require a higher operator access level than personnel enrollment functions.
3. The program shall provide means to disable the enrollment station when it is unattended to prevent unauthorized use.
4. The program shall provide a method to enter personnel identifying information into the entry-control database files through enrollment stations. In the case of personnel identity verification subsystems, this shall include biometric data. Allow entry of personnel identifying information into the system database using menu selections and data fields. The data field names shall be customized during setup to suit user and site needs. Personnel identity verification subsystems selected for use with the system shall fully support the enrollment function and shall be compatible with the entry-control database files.
5. Cardholder Data: Provide 99 user-defined fields. System shall have the ability to run searches and reports using any combination of these fields. Each user-defined field shall be configurable, using any combination of the following features:

    a. MASK: Determines a specific format that data must comply with.
    b. REQUIRED: Operator is required to enter data into field before saving.
    c. UNIQUE: Data entered must be unique.
    d. DEACTIVATE DATE: Data entered will be evaluated as an additional deactivate date for all cards assigned to this cardholder.
    e. NAME ID: Data entered will be considered a unique ID for the cardholder.

6. Personnel Search Engine: A report generator with capabilities such as search by last name, first name, group, or any predetermined user-defined data field; by codes not used in definable number of days; by skills; or by seven other methods.
7. Multiple Deactivate Dates for Cards: User-defined fields to be configured as additional stop dates to deactivate any cards assigned to the cardholder.
8. Batch card printing.
9. Default card data can be programmed to speed data entry for sites where most card data are similar.
10. Enhanced ACSII File Import Utility: Allows the importing of cardholder data and images.
11. Card Expire Function: Allows readers to be configured to deactivate cards when a card is used at selected devices.

## 2.4 SYSTEM DATABASE

A. Database and database management software shall define and modify each point in database using operator commands. Definition shall include parameters and constraints associated with each system device.

B. Database Operations:

1. System data management shall be in a hierarchical menu tree format, with navigation through expandable menu branches and manipulated with use of menus and icons in a main menu and system toolbar.
2. Navigational Aids:

    a. Toolbar icons for add, delete, copy, print, capture image, activate, deactivate, and muster report.
    b. Point and click feature to facilitate data manipulation.
    c. Next and previous command buttons visible when editing database fields to facilitate navigation from one record to the next.
    d. Copy command and copy tool in the toolbar to copy data from one record to create a new similar record.

3. All data entry shall be automatically checked for duplicate and illegal data and shall verify that data are in a valid format.
4. Provide a memo or note field for each item that is stored in database, allowing the storing of information about any defining characteristics of the item. Memo field is used for noting the purpose the item was entered for, reasons for changes that were made, and the like.

C. File Management:

1. Provide database backup and restoration system, allowing selection of storage media, including 3.5-inch floppy disk, Zip and Jaz drives, and designated network resources.
2. Provide manual and automatic mode of backup operations. The number of automatic sequential backups before the oldest backup becomes overwritten; FIFO mode shall be operator selectable.
3. Backup program shall provide manual operation from any PC on the LAN and shall operate while system remains operational.

D. Operator Passwords:

1. Software shall support up to 32,000 individual system operators, each with a unique password.

2. Operator Password: Minimum eight alphanumeric characters.
3. Allow passwords to be case sensitive.
4. Passwords shall not be displayed when entered.
5. Provide each password with a unique and customizable password profile, and allow several operators to share a password profile. Include the following features in the password profile:

    a. Allow for at least 32,000 operator password profiles.
    b. Predetermine the highest-level password profile for access to all functions and areas of program.
    c. Allow or disallow operator access to any program operation, including the functions of View, Add, Edit, and Delete.
    d. Restrict which doors an operator can assign access to.

6. Operators shall use a user name and password to log on to system.

    a. This user name and password is used to access database areas and programs as determined by the associated profile.

7. Make provision to allow the operator to log off without fully exiting program. User may be logged off but program will remain running while displaying the login window for the next operator.

E. Access Card/Code Operation and Management: Access authorization shall be by card, by a manually entered code (PIN), or by a combination of both (card plus PIN).

1. Access authorization shall verify the facility code first, the card or card-and-PIN validation second, and the access level (time of day, day of week, date), anti-passback status, and number of uses last.
2. Use data-entry windows to view, edit, and issue access levels. Access authorization entry management system shall maintain and coordinate all access levels to prevent duplication or the incorrect creation of levels.
3. Allow assignment of multiple cards/codes to a cardholder.
4. Allow assignment of up to four access levels for each Location to a cardholder. Each access level may contain any combination of doors.
5. Each door may be assigned four time zones.
6. Access codes may be up to 11 digits in length.
7. Software shall allow the grouping of locations so cardholder data can be shared by all locations in the group.
8. Visitor Access: Issue a visitor badge, without assigning that person a card or code, for data tracking or photo ID purposes.
9. Cardholder Tracing: Allow for selection of cardholder for tracing. Make a special audible and visual annunciation at control station when a selected card or code is used at a designated code reader. Annunciation shall include an automatic display of the cardholder image.
10. Allow each cardholder to be given either an unlimited number of uses or a number from 1 to 9998 that regulates the number of times the card can be used before it is automatically deactivated.
11. Provide for cards and codes to be activated and deactivated manually or automatically by date. Provide for multiple deactivate dates to be preprogrammed.

F. Security Access Integration:

1. Photo ID badging and photo verification shall use same database as the security access and may query data from cardholder, group, and other personal information to build a custom ID badge.

2. Automatic or manual image recall and manual access based on photo verification shall also be a means of access verification and entry.
3. System shall allow sorting of cardholders together by group or other characteristic for a fast and efficient method of reporting on, and enabling or disabling, cards or codes.

G. Key control and tracking shall be an integrated function of cardholder data.

1. Provide the ability to store information about which conventional metal keys are issued and to whom, along with key construction information.
2. Reports shall be designed to list everyone that has possession of a specified key.

H. Facility Codes: System shall accommodate up to 2048 facility codes per Location, with the option of allowing facility codes to work at all doors or only particular doors.

I. Operator Comments:

1. With the press of one appropriate button on toolbar, the user shall be permitted to make operator comments into history at anytime.
2. Automatic prompting of operator comment shall occur before the resolution of each alarm.
3. Operator comments shall be recorded by time, date, and operator number.
4. Comments shall be sorted and viewed through reports and history.
5. The operator may enter comments in two ways; either or both may be used:

    a. Manually entered through keyboard data entry (typed), up to 65,000 characters per each alarm.
    b. Predefined and stored in database for retrieval on request.

6. System shall have a minimum of 999 predefined operator comments with up to 30 characters per comment.

J. Group:

1. Group names may be used to sort cardholders into groups that allow the operator to determine the tenant, vendor, contractor, department, division, or any other designation of a group to which the person belongs.
2. System software shall have the capacity to assign 1 of 32,000 group names to an access authorization.
3. Make provision in software to deactivate and reactivate all access authorizations assigned to a particular group.
4. Allow sorting of history reports and code list printouts by group name.

K. Time Zones:

1. Each zone consists of a start and stop time for 7 days of the week and three holiday schedules. A time zone is assigned to inputs, outputs, or access levels to determine when an input shall automatically arm or disarm, when an output automatically opens or secures, or when access authorization assigned to an access level will be denied or granted.
2. Up to four time zones may be assigned to inputs and outputs to allow up to four arm or disarm periods per day or four lock or unlock periods per day; up to three holiday override schedules may be assigned to a time zone.
3. Data-entry window shall display a dynamically linked bar graph showing active and inactive times for each day and holiday, as start and stop times are entered or edited.
4. System shall have the capacity for 2048 time zones for each Location.

L. Holidays:

1. Three different holiday schedules may be assigned to a time zone. Holiday schedule consists of date in format MM/DD/YYYY and a description. When the holiday date matches the current date of the time zone, the holiday schedule replaces the time zone schedule for that 24-hour period.
2. System shall have the capacity for 32,000 holidays.
3. Three separate holiday schedules may be applied to a time zone.
4. Holidays have an option to be designated as occurring on the designated date each year. These holidays remain in system and will not be purged.
5. Holidays not designated to occur each year shall be automatically purged from database after the date expires.

M. Access Levels:

1. System shall allow for the creation up to 32,000 access levels.
2. One level shall be predefined as the Master Access Level. The Master Access Level shall work at all doors at all times and override any anti-passback.
3. System shall allow for access to be restricted to any area by reader and by time. Access levels shall determine when and where an Identifier is authorized.
4. System shall be able to create multiple door and time zone combinations under same access level so that an Identifier may be valid during different time periods at different readers even if the readers are on the same Controller.

N. User-Defined Fields:

1. System shall provide a minimum of 99 user-defined fields, each with up to 50 characters, for specific information about each credential holder.
2. System shall accommodate a title for each field; field length shall be 20 characters.
3. A "Required" option may be applied to each user-defined field that, when selected, forces the operator to enter data in the user-defined field before the credential can be saved.
4. A "Unique" option may be applied to each user-defined field that, when selected, will not allow duplicate data from different credential holders to be entered.
5. Data format option may be assigned to each user-defined field that will require the data to be entered with certain character types in specific spots in the field entry window.
6. A user-defined field, if selected, will define the field as a deactivate date. The selection shall automatically cause the data to be formatted with the windows MM/DD/YYYY date format. The credential of the holder will be deactivated on that date.
7. A search function shall allow any one user-defined field or combination of user-defined fields to be searched to find the appropriate cardholder. The search function shall include search for a character string.
8. System shall have the ability to print cardholders based on and organized by the user-defined fields.

O. Code Tracing:

1. System shall perform code tracing selectable by cardholder and by reader.
2. Any code may be designated as a "traced code" with no limit to how many codes can be traced.
3. Any reader may be designated as a "trace reader" with no limit to which or how many readers can be used for code tracing.
4. When a traced code is used at a trace reader, the access-granted message that usually appears on the monitor window of the Central Station shall be highlighted with a different color than regular messages. A short singular beep shall occur at the same time the highlighted message is displayed on the window.

5. The traced cardholder image (if image exists) shall appear on workstations when used at a trace reader.

## 2.5 SURGE AND TAMPER PROTECTION

A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor-entry connection to components.

B. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station control-unit alarm display shall identify tamper alarms and indicate locations.

## 2.6 STANDARD WORKSTATION HARDWARE

A. Workstation shall consist of a standard unmodified PC, with accessories and peripherals that configure the workstation for a specific duty.

B. Workstation Computer: Standard unmodified PC of modular design. The CPU word size shall be 64 bytes or larger; the CPU operating speed shall be at least 2.4 GHz.

1. Memory: 64 GB of usable installed memory, expandable to a minimum of 256 GB without additional chassis or power supplies.
2. Power Supply: Minimum capacity of 250 W.
3. Real-Time Clock:

    a. Accuracy: Plus or minus 1 minute per month.
    b. Time Keeping Format: 24-hour time format including seconds, minutes, hours, date, day, and month; resettable by software.
    c. Provide automatic time correction once every 24 hours by synchronizing clock with the Central Station.

4. Serial Ports: Provide two RS-232-F serial ports for general use, with additional ports as required. Data transmission rates shall be selectable under program control.
5. Parallel Port: An enhanced parallel port.
6. LAN Adapter Card: 10/1000 Mbps PCI bus, internal network interface card.
7. Sound Card: For playback and recording of digital WAV sound files that are associated with audible warning and alarm functions.
8. Color Monitor: Not less than 17 inches, with a minimum resolution of 1280 by 1024 pixels, noninterlaced, and a maximum dot pitch of 0.28 mm. The video card shall support at least 256 colors at a resolution of[1280 by 1024 at a minimum refresh rate of 70 Hz.
9. Keyboard: With a minimum of 64 characters, standard ASCII character set based on ANSI X3.154.
10. Mouse: Standard, compatible with the installed software.
11. Disk storage shall include the following, each with appropriate controller:

    a. Minimum 2 TB hard disk, maximum average access time of 10 ms.

12. Printer:

    a. Laser printer with minimum resolution of 600 dpi.
    b. RAM: 64 GB, minimum.

c. Printing Speed: Minimum 24 pages per minute.
d. Paper Handling: Automatic sheet feeder.

13. Interface: Bidirectional parallel, and universal serial bus.
14. LAN Adapter Card: 10/1000 Mbps internal network interface card.

C. Redundant Workstation: One identical redundant workstation, connected in a hot standby, peer configuration. This workstation shall automatically maintain its own copies of system software, application software, and data files. System transactions and other activities that alter system data files shall be updated to system files of redundant workstation in near real time. If its associated workstation fails, redundant workstation shall assume control immediately and automatically.

## 2.7 FIXED MAP DISPLAY

A. A fixed map display shall show layout of the protected facilities. Zones corresponding to those monitored by system shall be highlighted on the display. Status of each zone shall be displayed using LEDs as required within each designated zone. An LED test switch shall be provided on the map display.

## 2.8 CONTROLLERS

A. Controllers: Intelligent peripheral control unit, complying with UL 294, that stores time, date, valid codes, access levels, and similar data downloaded from the Central Station or workstation for controlling its operation.

B. Subject to compliance with requirements in this Article, manufacturers may use multipurpose Controllers.

C. Battery Backup: Sealed, lead acid; sized to provide run time during a power outage of 90 minutes, complying with UL 924.

D. Alarm Annunciation Controller:

1. The Controller shall automatically restore communication within 10 seconds after an interruption with the field device network.

a. Inputs: Monitor dry contacts for changes of state that reflect alarm conditions. Provides at least eight alarm inputs, which are suitable for wiring as normally open or normally closed contacts for alarm conditions.
b. Alarm-Line Supervision:

1) Supervise the alarm lines by monitoring each circuit for changes or disturbances in the signal by monitoring for abnormal open, grounded, or shorted conditions using dc change measurements. System shall initiate an alarm in response to an abnormal current, which is a dc change of 5 percent or more for longer than 500 ms.
2) Transmit alarm-line-supervision alarm to the Central Station during the next interrogation cycle after the abnormal current condition.

E. Entry-Control Controller:

1. Function: Provide local entry-control functions including one- and two-way communications with access-control devices such as card readers, keypads, biometric personal identity verification devices, door strikes, magnetic latches, gate and door operators, and exit push-buttons.

    a. Operate as a stand-alone portal Controller using the downloaded database during periods of communication loss between the Controller and the field-device network.
    b. Accept information generated by the entry-control devices; automatically process this information to determine valid identification of the individual present at the portal:

        1) On authentication of the credentials or information presented, check privileges of the identified individual, allowing only those actions granted as privileges.
        2) Privileges shall include, but not be limited to, time of day control, day of week control, group control, and visitor escort control.

    c. Maintain a date-, time-, and Location-stamped record of each transaction. A transaction is defined as any successful or unsuccessful attempt to gain access through a controlled portal by the presentation of credentials or other identifying information.

2. Inputs:

    a. Data from entry-control devices; use this input to change modes between access and secure.

3. Outputs:

    a. Indicate success or failure of attempts to use entry-control devices and make comparisons of presented information with stored identification information.
    b. Grant or deny entry by sending control signals to portal-control devices and mask intrusion alarm annunciation from sensors stimulated by authorized entries.
    c. Maintain a date-, time-, and Location-stamped record of each transaction and transmit transaction records to the Central Station.
    d. Door Prop Alarm: If a portal is held open for longer than 20 seconds, alarm sounds.

4. With power supplies sufficient to power at voltage and frequency required for field devices and portal-control devices.
5. Data Line Problems: For periods of loss of communications or when data transmission is degraded and generating continuous checksum errors, the Controller shall continue to control entry by accepting identifying information, making authentication decisions, checking privileges, and controlling portal-control devices.

    a. Store up to 1000 transactions during periods of communication loss between the Controller and access-control devices for subsequent upload to the Central Station on restoration of communication.

6. Controller Power: NFPA 70, Class II power supply transformer, with 12- or 24-V ac secondary, backup battery and charger.

    a. Backup Battery: Premium, valve-regulated, recombinant-sealed, lead-calcium battery; spill proof; with a full 1-year warranty and a pro rata 19-year warranty.

With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.

b. Backup Power Supply Capacity: 90 minutes of battery supply. Submit battery and charger calculations.

c. Power Monitoring: Provide manual dynamic battery load test, initiated and monitored at the control center; with automatic disconnection of the Controller when battery voltage drops below Controller limits. Report by using local Controller-mounted LEDs and by communicating status to Central Station. Indicate normal power on and battery charger on trickle charge. Indicate and report the following:

1) Trouble Alarm: Normal power off load assumed by battery.
2) Trouble Alarm: Low battery.
3) Alarm: Power off.

## 2.9 KEYPADS

A. Designed for use with unique combinations of alphanumeric and other symbols as an Identifier. Keys of keypads shall contain an integral alphanumeric/special symbol keyboard with symbols arranged in ascending ASCII-code ordinal sequence. Communications protocol shall be compatible with Controller.

1. Keypad display or enclosure shall limit viewing angles of the keypad as follows:

a. Maximum Horizontal Viewing Angle: 5 degrees or less off in either direction of a vertical plane perpendicular to the plane of the face of the keypad display.
b. Maximum Vertical Viewing Angle: 15 degrees or less off in either direction of a horizontal plane perpendicular to the plane of the face of the keypad display.

2. Duress Codes: Provide duress situation indication by entering a special code.

## 2.10 CARD READERS

A. Power: Card reader shall be powered from its associated Controller, including its standby power source.

B. Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the Controller. Response time shall be 800 ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.

C. Enclosure: Suitable for surface, semiflush, or pedestal mounting. Mounting types shall additionally be suitable for installation in the following locations:

1. Indoors, controlled environment.
2. Indoors, uncontrolled environment.
3. Outdoors, with built-in heaters or other cold-weather equipment to extend the operating temperature range as needed for operation at the site.

D. Display: LED or other type of visual indicator display shall provide visual and audible status indications and user prompts. Indicate power on/off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.

E. Stripe Swipe Readers: Bidirectional, reading cards swiped in both directions, powered by the Controller.

1. Readers for outdoors shall be in a polymeric plastic enclosure, with all electronics potted in plastic. Rated for operation in ambient conditions of minus 40 to plus 160 deg in a humidity range of 10 to 90 percent.

F. Bar-Code Reader: Set up for Code 128.

G. Insert Readers: Requiring the card to be inserted from the bottom, powered by the Controller.

H. Touch Plate and Proximity Readers:

1. Active detection proximity card readers shall provide power to compatible credential cards through magnetic induction, and shall receive and decode a unique identification code number transmitted from the credential card.
2. Passive detection proximity card readers shall use a swept-frequency, RF field generator to read the resonant frequencies of tuned circuits laminated into compatible credential cards. The resonant frequencies read shall constitute a unique identification code number.
3. The card reader shall read proximity cards in a range from contact with to at least 6 inches from the reader.

I. Keypad and Swipe Reader Combination: Designed to require an entry on the keypad before presenting the credential card.

1. Keypad: Allow the entry of four alphanumeric characters that are associated with a specific credential. Keys of keypads shall contain an integral alphanumeric/special symbol keyboard with symbols arranged in ascending ASCII-code ordinal sequence. Keypad display or enclosure shall limit viewing angles of the keypad as follows:

a. Maximum Horizontal Viewing Angle: 5 degrees or less off in either direction of a vertical plane perpendicular to the plane of the face of the keypad display.
b. Maximum Vertical Viewing Angle: 15 degrees or less off in either direction of a horizontal plane perpendicular to the plane of the face of the keypad display.

2. Swipe Reader: Set up for 26-bit data cards. Comply with SIA AC-01.

## 2.11 ENROLLMENT CENTER

1. Autostar Technology Pte Ltd.
2. Applied Wireless Identifications Group, Inc.
3. DMP.
4. IDenticard Systems, Inc.
5. ISONAS.
6. Ultra Electronics Limited.

B. Equipment for enrolling personnel into, and removing personnel from, system database, using **a** dedicated workstation PC.

1. Include equipment to enroll selected biometric credentials.

C. Enrollment equipment shall support encoding of credential cards including cryptographic and other internal security checks as required for system.

1. Allow only authorized entry-control enrollment personnel to access the enrollment equipment using passwords.
2. Include enrollment subsystem configuration controls and electronic diagnostic aids for subsystem setup and troubleshooting with the Central Station.
3. Enrollment station records printer shall meet requirements of the report printer.

D. System Capacity: Number of badges shall be limited only by hard disk space. Badge templates and images shall be in color, supporting the maximum color capability of Microsoft Windows operating system.

E. Badge Configuration:

1. Software for badge template creation shall include a template consisting of background and predetermined locations of photographs, text objects and data fields for text, and bar-code and biometric information. Include automatic sizing of data fields placed on a badge to compensate for names, which may otherwise be too large to fit in the area designated.
2. Allow different badge templates to be used for each department, tenant, or visitor.
3. As a setup option, templates shall be automatically selected for the badge, based on the group the credential holder is assigned to. Allow the operator to override the automatic template selection and use a template chosen by the operator for creating a badge.
4. Setup shall determine which graphics and credential holder information will be displayed and where on the card it will be placed. All data in the security access system such as name, code, group, access level, and any of the 99 user-defined fields shall be selectable, with the ability to place them anywhere on the card.
5. System shall include an importing, filing, and recall system of stored images and shapes that can be placed on the badge.
6. Allow multiple images on same badge, including, but not be limited to, bar codes, digital photos, and signatures.
7. Support transparent backgrounds so that image is only surrounded by the intended background, but not its immediate background.

F. Photo Imaging: Integral to security access.

1. Import images from bitmap file formats, digital cameras, TWAIN cameras, or scanners. Allow image cropping and editing, WYSIWYG badge building application, and badge print preview and printing capabilities.
2. System shall support multiple images stored for each credential holder, including signatures, portrait views, and profile views.

G. Text Objects: Badge configuration shall provide for creation of custom text as an object, allowing font selection, typing, scaling, and formatting of the text object. Formatting options shall include changing font, font size, text flow, and text alignment; bending or curving the text object into a circle or semicircle; applying 3-D effects; and applying predefined effects such as tilt, extrusion, or beveling. Text shall be placed and optionally automatically centered within any region of the badge layout.

H. Badges and Credential Cards:

1. Badges are credential cards that do not contain data to be read by card readers.
2. Credential cards shall store uniquely coded data used by card readers as an Identifier.

    a. Magnetic-Stripe Cards: Comply with ISO 7810, ISO 7811-1, ISO 7811-2, ISO 7811-3, and ISO 7811-6. Use single-layer magnetic tape material that is

coated with a plastic slick protective coat and affixed to the back of the credential card near the top.

b. Wire Effect Cards: Ferromagnetic wires laminated into the credential card using binary digits specified for Wiegand readers to generate a unique credential card identification code.

c. Proximity Cards: Use proximity detection without physical contact with the proximity reader for proper operation.

3. Allow entry-control card to be modified by lamination or direct print process during the enrollment process for use as a picture and identification badge without reduction of readability. The design shall allow for the addition of at least one slot or hole to accommodate the attachment of a clip for affixing the credential card to the type of badge holder used at the site.

a. Card Size and Dimensional Stability: Standard size, 2-1/8 by 3-3/8 inches; dimensionally stable so that an undamaged card with deformations resulting from normal use is readable by the card reader.

b. Card Material: Abrasion resistant, nonflammable, and nontoxic; and impervious to solar radiation and effects of ultraviolet light.

c. Card Construction: Core and laminate or monolithic construction. Lettering, logos, and other markings shall be hot stamped into the credential material or direct printed.

1) With phosphorous ink as a security enhancement.
2) Furnish equipment for on-site assembly and lamination of credential cards.

d. Card Durability and Maintainability: Designed and constructed to yield a useful lifetime of at least 5 years or 5000 insertions or swipes, whichever results in a longer period of time. Allow credential cards to be cleaned by wiping with a sponge or cloth wetted with soap and water.

I. Card-Making Equipment: Consisting of a workstation, video camera, video-imaging equipment, and a printer.

1. Camera: NTSC color standard, RGB video output, 470 lines minimum horizontal resolution, and automatic white balance with full rated output under illumination of 0.5 fc.
2. Video Imaging: Live-image capture software and hardware and a digital signature capture pad.
3. Standard workstation, modified as follows:

a. Redundant workstation is not required.
b. Printer is not required.
c. UPS is not required.
d. Sound card is not required.

4. Printer: Dye-sublimation resin thermal transfer, 300 dpi resolution, 16.7 million colors, accepting cards ranging in size from 2.1 by 3 inches to 2.6 by 3.7 inches and having card thickness ranging from 0.020 to 0.060 inch. Printer shall have options for encoding magnetic stripe using tracks 1, 2, and 3. Throughput shall be not less than 60 seconds per card.

## 2.12 PUSH-BUTTON SWITCHES

A. Available Manufacturers:

1. Securitron Magnalock Corporation; an ASSA ABLOY Group Company.

B. Push-Button Switches: Momentary-contact back-lighted push buttons, with stainless-steel switch enclosures.

1. Electrical Ratings:

a. Minimum continuous current rating of 10 A at 120 V ac or 5 A at 240-V ac.
b. Contacts that will make 720 VA at 60 A and that will break at 720 VA at 10 A.

2. Enclosures: Flush or surface mounting. Push buttons shall be suitable for flush mounting in the switch enclosures.
3. Enclosures shall additionally be suitable for installation in the following locations:

a. Indoors, controlled environment.
b. Indoors, uncontrolled environment.
c. Outdoors.

4. Power: Push-button switches shall be powered from their associated Controller, using dc control.

## 2.13 DOOR AND GATE HARDWARE INTERFACE

A. Exit Device with Alarm: Operation of the exit device shall generate an alarm and annunciate a local alarm. Exit device and alarm contacts are specified in Division 08 Section "Door Hardware."

B. Exit Alarm: Operation of a monitored door shall generate an alarm. Exit devices and alarm contacts are specified in Division 08 Section "Door Hardware."

C. Electric Door Strikes: Use end-of-line resistors to provide power line supervision. Signal switches shall transmit data to Controller to indicate when the bolt is not engaged and the strike mechanism is unlocked, and shall report a forced entry. Power and signal shall be from the Controller. Electric strikes are specified in Division 08 "Door Hardware."

D. Electromagnetic Locks: End-of-line resistors shall provide power line supervision. Lock status sensing signal shall positively indicate door is secure. Power and signal shall be from the Controller. Electromagnetic locks are specified in Division 08 Section "Door Hardware."

E. Vehicle Gate Operator: Interface electrical operation of gate with controls of this Section. Vehicle gate operators shall be connected, monitored, and controlled, by the security access Controllers. Vehicle gate and accessories are specified in Division 32 Section "Chain Link Fences and Gates."

## 2.14 RS-232 ASCII INTERFACE SPECIFICATIONS

A. ASCII interface shall allow RS-232 connections to be made between the control station operating as the host PC and any equipment that will accept RS-232 ASCII command strings, such as CCTV switchers, intercoms, and paging systems.

1. Each alarm input in system shall allow for individual programming to output up to four unique ASCII character strings through two different COM ports on the host PC.

2. Each input shall have the ability to be defined to transmit a unique ASCII string for alarm and one for restore through one COM port, and a unique ASCII string for a nonalarm abnormal condition and one for a normal condition through the same or different COM port.
3. The predefined ASCII character strings shall have the ability to be up to 420 characters long with full use of all the ASCII control characters, such as return or line feed. The character strings shall be defined in database of system and then assigned to the appropriate inputs.
4. The COM ports of the host PC used to interface with external equipment shall be defined in the setup portion of the software. The COM port's baud rate, word length, stop bits, and parity shall be definable in the software to match that of the external equipment.

B. Pager System Interface: Alarms shall be able to activate a pager system with customized message for each input alarm.

1. RS-232 output shall be capable of connection to a pager interface that can be used to call a paging system or service and send a signal to a portable pager. System shall allow an individual alphanumeric message per alarm input to be sent to the paging system. This interface shall support both numeric and alphanumeric pagers.

C. Alarm System Interface:

1. RS-232 output shall be capable of transmitting alarms from other monitoring and alarm systems to central-station automation software.
2. Alternatively, alarms that are received by this access control system are to be transferred to alarm automation system as if they were sent through a digital alarm receiver.

a. System shall be able to transmit an individual message from any alarm input to a burglar alarm automation monitoring system.
b. System shall be able to append to each message a predefined set of character strings as a prefix and suffix.

## 2.15 VIDEO AND CAMERA CONTROL

A. Control station or designated workstation displays live video from a CCTV source.

1. Control Buttons: On the display window, with separate control buttons to represent Left, Right, Up, Down, Zoom In, Zoom Out, Scan, and a minimum of two custom command auxiliary controls.
2. Provide at least seven icons to represent different types of cameras, with ability to import custom icons. Provide option for display of icons on graphic maps to represent their physical location.
3. Provide the alarm-handling window with a command button that will display the camera associated with the alarm point.

B. Display mouse-selectable icons representing each camera source, to select source to be displayed. For CCTV sources that are connected to a video switcher, control station shall automatically send control commands through a COM port to display the requested camera when the camera icon is selected.

C. Allow cameras with preset positioning to be defined by displaying a different icon for each of the presets. Provide control with Next and Previous buttons to allow operator to cycle quickly through the preset positions.

2.16 CABLES

A. Available Manufacturers:

1. Anixter, Inc.
2. Belden Inc.; Electronics Division.
3. Berk-Tek; a Nexans Company.
4. BIW Cable Systems; a Draka USA Company.
5. Champlain Cable Corporation.
6. Chromatic Technologies; a Draka USA Company.
7. Coleman Cable.
8. General Cable Technologies Corporation.
9. KRONE Incorporated.
10. Mohawk/CDT; a division of Cable Design Technologies.
11. West Penn Wire/CDT; a division of Cable Design Technologies.

B. Comply with Division 28 Section "Conductors and Cables for Electronic Safety and Security."

C. PVC-Jacketed, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; PVC jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.

1. NFPA 70, Type CM.
2. Flame Resistance: UL 1581 Vertical Tray.

D. Plenum-Type, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; plastic jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.

1. NFPA 70, Type CMP.
2. Flame Resistance: NFPA 262 Flame Test.

E. RS-485 communications require 2 twisted pairs, with a distance limitation of 4000 feet.

F. PVC-Jacketed, RS-485 Cable: Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, PVC insulation, unshielded, PVC jacket, and NFPA 70, Type CMG.

G. Plenum-Type, RS-485 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and fluorinated-ethylene-propylene jacket.

1. NFPA 70, Type CMP.
2. Flame Resistance: NFPA 262 Flame Test.

H. Multiconductor, PVC Readers and Wiegand Keypads Cables: No. 22 AWG, paired and twisted multiple conductors, stranded (7x30) tinned copper conductors, semirigid PVC insulation, overall aluminum foil-polyester tape shield with 100 percent shield coverage, plus tinned copper braid shield with 65 percent shield coverage, and PVC jacket.

1. NFPA 70, Type CMG.
2. Flame Resistance: UL 1581 Vertical Tray.
3. For TIA/EIA-RS-232 applications.

I. Paired PVC Readers and Keypads Cable: Paired, 3 pairs, twisted, No. 20 AWG, stranded (7x28) tinned copper conductors, polyethylene (polyolefin) insulation, individual aluminum foil-polyester tape shielded pairs each with No. 22 AWG, stranded (19x34) tinned copper drain wire, 100 percent shield coverage, and PVC jacket.

1. NFPA 70, Type CM.
2. Flame Resistance: UL 1581 Vertical Tray.

J. Plenum-Type, Multiconductor, Readers and Keypads Cable: 6 conductors, No. 20 AWG, stranded (7x28) tinned copper conductors, fluorinated-ethylene-propylene insulation, overall aluminum foil-polyester tape shield with 100 percent shield coverage plus tinned copper braid shield with 85 percent shield coverage, and fluorinated-ethylene-propylene jacket.

1. NFPA 70, Type CMP.
2. Flame Resistance: NFPA 262 Flame Test.

K. Plenum-Type, Paired Lock Cable: 1 pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.

1. NFPA 70, Type CMP.
2. Flame Resistance: NFPA 262 Flame Test.

L. Plenum-Type, Paired Lock Cable: 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and plastic jacket.

1. NFPA 70, Type CMP.
2. Flame Resistance: NFPA 262 Flame Test.

M. Plenum-Type, Paired Input Cable: 1 pair, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, aluminum foil-polyester tape shield (foil side out), with No. 22 AWG drain wire, 100 percent shield coverage, and plastic jacket.

1. NFPA 70, Type CMP.
2. Flame Resistance: NFPA 262 Flame Test.

N. Plenum-Type, Paired AC Transformer Cable: 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and plastic jacket.

1. NFPA 70, Type CMP.
2. Flame Resistance: NFPA 262 Flame Test.

## 2.17 TRANSFORMERS

A. NFPA 70, Class II control transformers, NRTL listed. Transformers for security access-control system shall not be shared with any other system.

## 2.18 CABLE AND ASSET MANAGEMENT

A. Available Manufacturers:

1. IMAP Textron; Division of Greenlee Textron.
2. Total Wire Software Company, Inc.

B. Computer-based cable and asset management system, with fully integrated database and graphic capabilities, complying with requirements in TIA/EIA-606.

1. Document physical characteristics by recording the network, asset, user, TIA/EAI details, device configurations, and exact connections between equipment and cabling.

a. Manage the physical layer of security system.
b. List device configurations.
c. List and display circuit connections.
d. Record firestopping data.
e. Record grounding and bonding connections and test data.

2. Information shall be presented in database view, schematic plans, or technical drawings.

a. Microsoft Visio Technical Drawing shall be used as drawing and schematic plans software. Drawing symbols, system layout, and design shall comply with SIA AG-01.

3. System shall interface with the following testing and recording devices:

a. Direct upload tests from circuit testing instrument into the PC.
b. Direct download circuit labeling into labeling printer.

C. Software shall be designed for Microsoft Windows of same version as security access system's Central Station and workstations and shall be installed on the designated PC, using a hard drive dedicated only to this management function. Hard-drive capacity shall be not less than 50 GB.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to PCs, Controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Comply with recommendations in SIA CP-01.

B. Comply with EIA/TIA-606, "Administration Standard for the Telecommunications Infrastructure of Commercial Buildings."

C. Obtain detailed Project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval.

1. Record setup data for control station and workstations.
2. For each Location, record setup of Controller features and access requirements.
3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
4. Set up groups, facility codes, linking, and list inputs and outputs for each Controller.
5. Assign action message names and compose messages.
6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
7. Prepare and install alarm graphic maps.
8. Develop user-defined fields.
9. Develop screen layout formats.
10. Propose setups for guard tours and key control.
11. Discuss badge layout options; design badges.
12. Complete system diagnostics and operation verification.
13. Prepare a specific plan for system testing, startup, and demonstration.
14. Develop acceptance test concept and, on approval, develop specifics of the test.
15. Develop cable and asset management system details; input data from construction documents. Include system schematics and Visio Technical Drawings.

D. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

## 3.3 CABLING

A. Comply with NECA 1, "Good Workmanship in Electrical Contracting."

B. Install cables and wiring according to requirements in Division 28 Section "Conductors and Cables for Electronic Safety and Security."

C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

D. Install LAN cables using techniques, practices, and methods that are consistent with Category 6 rating of components and that ensure Category 6 performance of completed and linked signal paths, end to end.

E. Install cables without damaging conductors, shield, or jacket.

F. Boxes and enclosures containing security system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered to be accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

G. Install end-of-line resistors at the field device location and not at the Controller or panel location.

## 3.4 CABLE APPLICATION

A. Comply with EIA/TIA-569, "Commercial Building Standard for Telecommunications Pathways and Spaces."

B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.

C. RS-232 Cabling: Install at a maximum distance of 50 feet.

D. RS-485 Cabling: Install at a maximum distance of 4000 feet.

E. Card Readers and Keypads:

1. Install number of conductor pairs recommended by manufacturer for the functions specified.
2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from Controller to the reader is 250 feet, and install No. 20 AWG wire if maximum distance is 500 feet.
3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the Controller.
4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

F. Install minimum No. 16 AWG cable from Controller to electrically powered locks. Do not exceed 250 feet.

G. Install minimum No. 18 AWG ac power wire from transformer to Controller, with a maximum distance of 25 feet.

## 3.5 GROUNDING

A. Comply with Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Comply with IEEE 1100, "Power and Grounding Sensitive Electronic Equipment."

C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Bond shields and drain conductors to ground at only one point in each circuit.

E. Signal Ground:

1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
2. Bus: Mount on wall of main equipment room with standoff insulators.
3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

## 3.6 INSTALLATION

A. Push Buttons: Where multiple push buttons are housed within a single switch enclosure, they shall be stacked vertically with each push-button switch labeled with 1/4-inch high text and symbols as required. Push-button switches shall be connected to the Controller associated with the portal to which they are applied, and shall operate the appropriate electric strike, electric bolt, or other facility release device.

B. Install card, fob, and biometric readers.

## 3.7 IDENTIFICATION

A. In addition to requirements in this Article, comply with applicable requirements in Division 26 Section "Identification for Electrical Systems" and with TIA/EIA-606.

B. Using cable and asset management software specified in Part 2, develop Cable Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with same designation. Use logical and systematic designations for facility's architectural arrangement.

C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

D. At completion, cable and asset management software shall reflect as-built conditions.

## 3.8 SYSTEM SOFTWARE

A. Develop, install, and test software and databases for the complete and proper operation of systems involved. Assign software license to Owner.

## 3.9 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. Testing Agency: Engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports:

C. Perform the following field tests and inspections and prepare test reports:

1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Class 2, bidirectional, Category 5 tester. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA-568-1, "Commercial Building Telecommunications Cabling Standards - Part 1 General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA-568-B.
2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

D. Remove and replace malfunctioning devices and circuits and retest as specified above.

## 3.10 STARTUP SERVICE

A. Engage a factory-authorized service representative to supervise and assist with startup service. Complete installation and startup checks according to approved procedures that were developed in " Preparation" Article and with manufacturer's written instructions.

1. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

## 3.11 PROTECTION

A. Maintain strict security during the installation of equipment and software. Rooms housing the control station, and workstations that have been powered up shall be locked and secured, with an activated burglar alarm and access-control system reporting to a Central Station complying with UL 1610, "Central-Station Burglar-Alarm Units," during periods when a qualified operator in the employ of Contractor is not present.

## 3.12 DEMONSTRATION

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

B. Develop separate training modules for the following:

1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
3. Security personnel.
4. Hardware maintenance personnel.
5. Corporate management.

END OF SECTION 28 13 00

# SECTION 28 23 00
# VIDEO SURVEILLANCE

## 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. The work in this section shall be provided under separate contract and is included for general guidance purposes only.

B. This Section includes video surveillance system consisting of cameras, data transmission wiring, and a control station with its associated equipment.

C. Video surveillance system shall be integrated with monitoring and control system specified in Division 28 Section "Access Control" that specifies systems integration.

### 1.3 DEFINITIONS

A. AGC: Automatic gain control.

B. B/W: Black and white.

C. CCD: Charge-coupled device.

D. MPEG: Moving picture experts group.

E. NTSC: National Television System Committee.

F. UPS: Uninterruptible power supply.

### 1.4 SUBMITTALS

A. Product Data: For each type of product indicated, including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.

1. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
2. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
3. UPS: Sizing calculations.
4. Wiring Diagrams: Power, signal, and control wiring, and grounding.

C. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, videotape recorders, digital video recorders, video switches, and control-station components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data" include the following:

1. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

F. Warranty: Special warranty 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 NECA 1.

C. Comply with NFPA 70.

D. Electronic data exchange between video surveillance system with an access control system shall comply with SIA TVAC.

## 1.6 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: Rated for continuous operation in ambient temperatures of 60 to 85 deg F and a relative humidity of 20 to 80 percent, non-condensing.
2. Interior, Controlled Environment: System components, except central-station control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, non-condensing. NEMA 250, Type 1 enclosures.
3. Interior, Uncontrolled Environment: System components installed in non- temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 0 to 122 deg F dry bulb and 20 to 90 percent relative humidity, non-condensing. NEMA 250, Type 3R enclosures.
4. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph and snow cover up to 24 inches thick. NEMA 250, Type 4 enclosures.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Three 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.

2.2 SYSTEM REQUIREMENTS

A. Video signal format shall comply with the NTSC standard composite video, interlaced. Composite video signal termination shall be 75 ohms.

B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.

C. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display shall identify tamper alarms and indicate locations.

2.3 STANDARD CAMERAS

A. Manufacturers:

1. ADEMCO Video; Pittway Corporation.
2. AXCESS Inc.
3. Crest Electronics, Inc.
4. General Electric.
5. Hitachi Visual Technologies.
6. JVC Professional Products.
7. Panasonic Security Systems Group.
8. Pelco.
9. Philips Communication, Security & Imaging; Philips Electronics N.V.
10. Safety Vision.
11. Samsung Opto-Electronics America, Inc.
12. SANYO Fisher Company; SANYO North America Corporation.
13. Sony.
14. Sensormatic Electronics Corporation.
15. Silent Witness Enterprises Ltd.

16. Toshiba Security Products.
17. Vicon Industries, Inc.

B. Automatic Color Dome Camera: Assembled and tested as a manufactured unit, containing a dome assembly, color camera, motorized pan and tilt, zoom lens, and receiver/driver.

1. Comply with UL 639. Size shall be CCD ¼".
2. Pickup Device: CCD interline transfer, 380,000 768(H) by 494(V) pixels.
3. Horizontal Resolution: 480 lines.
4. Signal-to-Noise Ratio: Not less than 50 dB, with the camera AGC off.
5. With AGC, manually selectable on or off.
6. Sensitivity: Camera shall provide usable images in low-light conditions, delivering an image at a scene illumination of 1.0 lux at F1.4 in color mode, 0.03 lux at F1.4 in black/white mode with the camera AGC off.
7. Manually selectable modes for backlight compensation or normal lighting.
8. Pan-and-Tilt Units: Motorized units arranged to provide remote-controlled aiming of cameras with smooth and silent operation and equipped with matching mounting brackets.

    a. Panning Rotation: 0 to 355 degrees, with adjustable stops.
    b. Tilt Movement: 90 degrees, plus or minus 5 degrees, with adjustable stops.
    c. Speed: 12 degrees per second in both horizontal and vertical planes.
    d. Wiring: Factory prewired for camera and zoom lens functions and pan-and-tilt power and control.
    e. Built-in encoders or potentiometers for position feedback, and thermostat-controlled heater.
    f. Pan-and-tilt unit shall be available with preset positioning capability to recall the position of a specific scene.
9. Preset positioning: 8 user-definable scenes, each allowing 16-character titles. Controls shall include the following:

    a. In "sequence mode," camera shall continuously sequence through preset positions, with dwell time and sequencing under operator control.
    b. Motion detection shall be available at each camera position.
    c. Up to four preset positions may be selected to be activated by an alarm. Each of the alarm positions may be programmed to output a response signal.

10. Scanning Synchronization: Determined by external synch over the coaxial cable. Camera shall revert to internally generated synchronization on loss of external synch signal.
11. White Balance: Auto-tracing white balance, with manually settable fixed balance option.
12. Motion Detector: Built-in digital.
13. Dome shall support multiplexed control communications using coaxial cable recommended by manufacturer.
14. Power supply: 24 VAC.

## 2.4 REINFORCED DOME CAMERAS

A. Available Manufacturers:

1. Extreme CCTV, Inc.

B. Camera: Designed for high-abuse locations, with a weathertight surface mounting, impact-resistance polycarbonate dome, and heavy-gage, 6061 T6 aluminum body.

1. Suitable for exterior environment, rated for continuous operation in ambient temperatures of minus 40 to plus 122 deg F (minus 40 to plus 50 deg C) dry bulb and up to 85 percent relative humidity.
2. Pickup Device: CCD interline transfer, 290,000, (510(H) by 492(V)) pixels.
3. Horizontal Resolution: 350 lines.
4. Signal-to-Noise Ratio: Not less than 46 dB.
5. With AGC and automatic backlight compensation.
6. Sensitivity: Camera shall provide usable images in low-light conditions, delivering an image at a scene illumination of 6 lux at f/2.0.
7. Scanning Synchronization: Determined by external synch over the coaxial cable. Camera shall revert to internally generated synchronization on loss of external synch signal.
8. White Balance: Auto-tracing white balance.

## 2.5 LENSES

A. Manufacturers:

1. ADEMCO Video; Pittway Corporation.
2. AXCESS Inc.
3. Crest Electronics, Inc.
4. General Electric.
5. Hitachi Visual Technologies.
6. JVC Professional Products.
7. Panasonic Security Systems Group.
8. Pelco.
9. Philips Communication, Security & Imaging; Philips Electronics N.V.
10. Safety Vision.
11. Samsung Opto-Electronics America, Inc.
12. SANYO Fisher Company; SANYO North America Corporation.
13. Sony.
14. Sensormatic Electronics Corporation.
15. Silent Witness Enterprises Ltd.
16. Toshiba Security Products.
17. Vicon Industries, Inc.

B. Description: Optical-quality coated optics, designed specifically for video surveillance applications, and matched to specified camera. Provide color-corrected lenses with color cameras.

1. Auto-Iris Lens: Electrically controlled iris with circuit set to maintain a constant video level in varying lighting conditions.
2. Fixed Lenses: With calibrated focus ring.
3. Zoom Lenses: Motorized, remote-controlled units, rated as "quiet operating." Features include the following:

    a. Electrical Leads: Filtered to minimize video signal interference.
    b. Motor Speed: Variable.
    c. Lens shall be available with preset positioning capability to recall the position of specific scenes.

## 2.6 POWER SUPPLIES

A. Power Supplies: Low-voltage power supplies matched for voltage and current requirements of cameras and accessories, type as recommended by camera, infrared illuminator and lens manufacturer.

1. Enclosure: NEMA 250, Type 1.

## 2.7 INFRARED ILLUMINATORS

A. Available Manufacturers:

1. Merit Li-Lin Ent. Co., Ltd.
2. Rainbow CCTV; International Space Optics, S.A.
3. Ultrak, Inc.
4. Visiontech.
5. Watec America Corporation.

B. Description: Lighting fixtures that emit light only in the infrared spectrum, suitable for use with cameras indicated, for nighttime surveillance, without emitting visible light.

1. Field-Selectable Beam Patterns: Narrow, medium, and wide.
2. Rated Lamp Life: More than 8000 hours
3. Power Supply: 120-V ac.

C. Area Coverage: Illumination to 150 feet in a narrow beam pattern.

D. Exterior housings shall be suitable for same environmental conditions as associated camera.

## 2.8 CAMERA-SUPPORTING EQUIPMENT

A. Manufacturers:

1. ADEMCO Video; Pittway Corporation.
2. AXCESS Inc.
3. Crest Electronics, Inc.
4. General Electric.
5. Hitachi Visual Technologies.
6. JVC Professional Products.
7. Panasonic Security Systems Group.
8. Pelco.
9. Philips Communication, Security & Imaging; Philips Electronics N.V.
10. Safety Vision.
11. Samsung Opto-Electronics America, Inc.
12. SANYO Fisher Company; SANYO North America Corporation.
13. Sony.
14. Sensormatic Electronics Corporation.
15. Silent Witness Enterprises Ltd.
16. Toshiba Security Products.
17. Vicon Industries, Inc.

B. Minimum Load Rating: Rated for load in excess of the total weight supported times a minimum safety factor of two.

C. Mounting Brackets for Fixed Cameras: Type matched to items supported and mounting conditions. Include manual pan-and-tilt adjustment.

D. Protective Housings for Fixed and Movable Cameras: Steel or 6061 T6 aluminum enclosures with internal camera mounting and connecting provisions that are matched to camera/lens combination and mounting and installing arrangement of camera to be housed.

1. Tamper switch on access cover sounds an alarm signal when unit is opened or partially disassembled. Central-control unit shall identify tamper alarms and indicate location in alarm display. Tamper switches and central-control unit are specified in Division 28 Section "Intrusion Detection."
2. Camera Viewing Window: Lexan window, aligned with camera lens.
3. Duplex Receptacle: Internally mounted.
4. Alignment Provisions: Camera mounting shall provide for field aiming of camera and permit removal and reinstallation of camera lens without disturbing camera alignment.
5. Built-in thermostat-activated heater and blower units. Units shall be automatically controlled so the environmental limits of the camera equipment are not exceeded.
6. With sun shield that does not interfere with normal airflow around the housing.
7. Mounting bracket and hardware for wall or ceiling mounting of the housing. Bracket shall be of same material as the housing; mounting hardware shall be stainless steel.
8. Finish: Housing and mounting bracket shall be factory finished using manufacturer's standard finishing process suitable for the environment.
9. Enclosure Rating: NEMA 250, Type 3R.

## 2.9 MONITORS

A. Available Manufacturers:

1. ADEMCO Video; Pittway Corporation.
2. AXCESS Inc.
3. Crest Electronics, Inc.
4. General Electric.
5. Hitachi Visual Technologies.
6. JVC Professional Products.
7. Panasonic Security Systems Group.
8. Pelco.
9. Philips Communication, Security & Imaging; Philips Electronics N.V.
10. Safety Vision.
11. Samsung Opto-Electronics America, Inc.
12. SANYO Fisher Company; SANYO North America Corporation.
13. Sony.
14. Sensormatic Electronics Corporation.
15. Silent Witness Enterprises Ltd.
16. Toshiba Security Products.
17. Vicon Industries, Inc.

B. Monochrome:

1. Metal cabinet units designed for continuous operation.
2. Screen Size (Diagonal Dimension): 13”.
3. Horizontal Resolution: 600 lines, minimum, at center.
4. Minimum Front Panel Devices and Controls: Power switch, power-on indicator, and brightness, horizontal hold, vertical hold, and contrast controls.
5. Mounting: Adjustable tilting and training.

6. Mounting: Single, 14-inch, vertical, EIA 19-inch (483-mm) electronic equipment rack or cabinet complying with EIA 310.
7. Electrical: 120-V ac, 60 Hz.

C. Color:

1. Video: 1-V peak to peak composite video, sync negative with loop through.
2. Screen Size (Diagonal Dimension): 19”.
3. Resolution: 640 X 480 (NTSC)
4. Minimum Front Panel Devices and Controls: Power switch, power-on indicator, and brightness, contrast, color, and tint controls.
5. Degaussing: Automatic.
6. Mounting: Desk or wall bracket.
7. Electrical: 120-V ac, 60 Hz.

## 2.10 DIGITAL VIDEO RECORDERS

A. Manufacturers:

1. ADEMCO Video; Pittway Corporation.
2. AXCESS Inc.
3. Crest Electronics, Inc.
4. General Electric.
5. Hitachi Visual Technologies.
6. JVC Professional Products.
7. Panasonic Security Systems Group.
8. Pelco.
9. Philips Communication, Security & Imaging; Philips Electronics N.V.
10. Safety Vision.
11. Samsung Opto-Electronics America, Inc.
12. SANYO Fisher Company; SANYO North America Corporation.
13. Sony.
14. Sensormatic Electronics Corporation.
15. Silent Witness Enterprises Ltd.
16. Toshiba Security Products.
17. Vicon Industries, Inc.

B. Digital, time-lapse type, full frame and motion recorder, with removable hard drive.

1. Recording Rate: 120 image per second at 720 (H) X 240 (V) and 320 (H) X 240 (V) sampling.
2. Resolution: 720 by 480, minimum sampling and 3-D scan conversion for stabilized pictures in a single frame with five compression mode.
3. Programming shall be from trackball and push buttons on face of the recorder, settings shall be displayed on any video monitor connected to the recorder. Programming shall include the following:

    a. Motion analysis graph.
    b. Password protection.
    c. Alarm and timer controls.
    d. Continuous recording option.
    e. Time-lapse operating modes.
    f. Search video by time, event, or motion.

4. Programming: Smart Media card for software updating, image archiving, and image transfer to a PC.
5. Storage: 250 GB removable IDE hard drive. Software shall permit hot-swapping drives.
6. Time and Date Generator: Records time (hr:min:sec) and date legend of each frame.
7. Audio Recording: 70 to 7000 Hz. Input: phono and microphone; output: photo.
8. Mounting: Standard 19-inch rack complying with EIA 310, or freestanding desktop.
9. 10/100 Base T connection for “record” review and “camera” view and control on a PC equipped with Microsoft Window XP professional operating system software and Microsoft Explorer internet browser software.
10. Architecture shall allow multiple units to be cascaded in increments of 16 cameras. Include cascading function for the number of cameras on the project.

C. Switcher: For displaying images from sixteen (16) cameras on a single monitor. Programmable switcher multiplexer shall be separate unit or shall be combined with DVR.

1. Camera functions and control shall be accessible for all cameras through the use of control units or matrix control system.
2. Shall simultaneously permit direct camera selection for recording playback of any of 16 video sources, multi-screen viewing and multi-plexed camera encoding (triplex).
3. Programmable switcher with dwell time and camera order programming. Unit shall automatically switch multiple camera images to enable sequential spot monitoring and simultaneous field recording. Unit shall provide separate spot, multi-screen, multi-screen/RGB and cascaded video monitor outputs. Unit shall offer full screen, 4, 7, 9, 10, 13 and 16 multi-screen monitoring modes.
4. Unit shall furnish sixteen (16) looping vide outputs, four (4) channels of audio, one (1) external storage connection on external copy connection and two (2) independent video outputs assignable to multi-screen or spot functions.
5. Shall be designed to rack mount, 120 VAC per module.

D. Camera Controls: Arranged for multiple-camera control, with switches to select camera to be controlled.

1. Camera Control: 3D joystick type, single hand control of pan, tilt and zoom function of PTZ camera.
2. Recorder Control: Jog dial and shuttling to find disk recorder book marks and input others settings, separate buttons for playback, recording and search function.
3. Switcher Control: Control for fully array of image switching/sequencing and display position camera title on/off.
4. User setting button.
5. Program upload function.

## 2.11 VIDEO MOTION SENSORS (INTERIOR)

A. Available Manufacturers:

1. A & S Security Products, Inc.
2. AXCESS Inc.
3. ICU Security, Inc.
4. Sensormatic Electronics Corporation.
5. Visiontech.

B. Device Performance: Detect changes in video signal within a user-defined protected zone. Video inputs shall be composite video as defined in SMPTE 170. Provide an alarm output for each video input.

1. Detect movement within protected zone of intruders wearing clothing with a reflectivity that differs from that of background scene by a factor of two. Reject all other changes in video signal.
2. Modular design that allows for expansion or modification of number of inputs.
3. Controls:

    a. Size of detection zones.
    b. Sensitivity of detection of each protected zone.

4. Mounting: Standard 19-inch rack complying with EIA 310.

## 2.12 CONTROL STATIONS

A. Power Continuity for Control Station: Batteries in power supplies of central-station control units and individual system components shall maintain continuous system operation during outages of both normal and backup ac system supply.

1. Batteries: Rechargeable, valve-regulated, recombinant, sealed, lead-acid type with nominal 10-year life expectancy. Capacity adequate to operate portion of system served, including audible trouble signal devices for up to 4 hours and audible and visual alarm devices under alarm conditions for an additional 10 minutes.
2. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Charger shall recharge fully discharged battery within 24 hours.

B. Annunciation: Indicate a change in system condition and switching of system or component to backup power.

## 2.13 SIGNAL TRANSMISSION COMPONENTS

A. Cable: Coaxial cable elements have 75-ohms nominal impedance. Cables shall comply with Division 27 Section “Master Antenna Television System” and shall be composite cable which includes BNC type, 75 ohms, and 2-conductor, 18 awg for power. Category 6 shall comply with Division 27 Section “Communications Horizontal Cabling”.

B. Video Surveillance Coaxial Cable Connectors: BNC type, 75 ohms. Of three-piece construction, consisting of a crimp-type center tit, sleeve, and main body.

# PART 3 - EXECUTION

## 3.1 WIRING

A. Wiring Method: Install cables in raceways and as otherwise indicated. Conceal raceways and wiring except in unfinished spaces.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

C. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. 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.

D. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

## 3.2 VIDEO SURVEILLANCE SYSTEM INSTALLATION

A. Install cameras and infrared illuminators level and plumb.

B. Install cameras with 84-inch minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.

C. Set pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms and adjust.

D. Install power supplies and other auxiliary components at control stations, unless otherwise indicated.

E. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system component enclosures, and mounted in self-protected, inconspicuous positions.

F. Avoid ground loops by making ground connections at only the control station.

1. For 12- and 24-V dc cameras, connect the coaxial cable shields only at the monitor end.

G. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Identification of Electrical Systems."

## 3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation and supervise pretesting, testing, and adjusting of video surveillance equipment.

B. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.

C. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video surveillance equipment for acceptance and operational testing as follows:

1. Prepare equipment list described in Part 1 "Submittals" Article.
2. Verify operation of auto-iris lenses.
3. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
4. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.

5. Set and name all preset positions; consult Owner's personnel.
6. Set sensitivity of motion detection.
7. Connect and verify responses to alarms.
8. Verify operation of control-station equipment.

D. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.

E. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

F. Remove and replace malfunctioning items and retest as specified above.

G. Record test results for each piece of equipment.

H. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

## 3.4 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions and to optimize performance of the installed equipment. Tasks shall include, but are not limited to, the following:

1. Check cable connections.
2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
3. Adjust all preset positions; consult Owner's personnel.
4. Recommend changes to cameras, lenses, and associated equipment to improve Owner' utilization of video surveillance system.
5. Provide a written report of adjustments and recommendations.

## 3.5 CLEANING

A. Clean installed items using methods and materials recommended in writing by manufacturer.

B. Clean video surveillance system components, including camera-housing windows, lenses, and monitor screens.

## 3.6 DEMONSTRATION

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

1. Train Owner's maintenance personnel on procedures and schedules for troubleshooting, servicing, and maintaining equipment.
2. Demonstrate methods of determining optimum alignment and adjustment of components and settings for system controls.

3. Review equipment list and data in maintenance manuals. Refer to Division 01 Section "Operation and Maintenance Data"
4. Conduct a minimum of four hours' training as specified in instructions to Owner's employees in Division 01 Section "Demonstration and Training"

END OF SECTION 28 23 00

# SECTION 28 31 11
# DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Heat detectors.
5. Notification appliances.
6. Addressable interface device.
7. Digital alarm communicator transmitter.
8. System printer.

### 1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. NICET: National Institute for Certification in Engineering Technologies.

C. FACP: Fire Alarm Control Panel.

D. FANP: Fire Alarm Power Extender Panel.

E. FAAP: Fire Alarm Annunciator (LCD).

### 1.4 SYSTEM DESCRIPTION

A. Non-coded, UL-certified addressable system, with multiplexed signal transmission, dedicated to fire-alarm service only.

B. Comply with NFPA 72.

### 1.5 SUBMITTALS

A. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.

2. Shop Drawings shall be prepared by persons with the following qualifications:

    a. Licensed or certified by authorities having jurisdiction.

B. Product Data: For each type of product indicated.

C. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.

1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
2. Include voltage drop calculations for notification appliance circuits.
3. Include battery-size calculations.
4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
6. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
7. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

D. Qualification Data: For qualified Installer.

E. Field quality-control reports.

F. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
3. Record copy of site-specific software.
4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:

    a. Frequency of testing of installed components.
    b. Frequency of inspection of installed components.
    c. Requirements and recommendations related to results of maintenance.
    d. Manufacturer's user training manuals.

5. Manufacturer's required maintenance related to system warranty requirements.
6. Abbreviated operating instructions for mounting at fire-alarm control unit.

G. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: CD disk, complete with data files.
3. Device address list.

4. Printout of software application and graphic screens.

## 1.6 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.

C. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer.

D. 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.

## 1.7 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for two years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

## 1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
3. Smoke Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than 1 unit of each type.
4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but no fewer than 1 unit of each type.
5. Keys and Tools: One extra set for access to locked and tamper-proofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system.

1.9 WARRANTY

A. Written warranty, executed by manufacturer agency to repair or replace equipment, devices, and auxiliary components that fail in material or workmanship within specified warranty period.

1. Warranty Period: Two years from the date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. General Electric Company/EST.
2. NOTIFIER; a Honeywell company.
3. Siemens Building Technologies, Inc.; Fire Safety Division.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

1. Manual stations.
2. Verified automatic alarm operation of smoke detectors.
3. Automatic sprinkler system water flow.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm at fire-alarm control unit FACP.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Activate voice/alarm communication system.
7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
8. Activate emergency shutoffs for gas and fuel supplies.
9. Record events in the system memory.
10. Record events by the system printer.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit FACP.
4. Ground or a single break in fire-alarm control unit internal circuits.
5. Abnormal ac voltage at fire-alarm control unit FACP.
6. Break in standby battery circuitry.

7. Failure of battery charging.
8. Abnormal position of any switch at fire-alarm control unit FACP.
9. Removal of an alarm initiating device.

E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit FACP. Record the event on system printer.

## 2.3 FIRE-ALARM CONTROL UNIT

A. General Requirements for Fire-Alarm Control Unit:

1. Enclosure: Steel, baked enamel, painted cabinet with indicator viewing window, removable hinged outer door with cylinder lock and dead front construction with the outer door open. The inner dead front doors shall be hinged for ease of system operation by firefighters and access by technicians for testing and maintenance modes.
2. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.

    a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
    b. Include a real-time clock for time annotation of events on the event recorder and printer.

3. Addressable initiation devices that communicate device identity and status.

    a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.
    b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

4. Addressable control circuits for operation of mechanical equipment.
5. Digital communication capabilities supporting Style 4 (Class B) communications using DC digital and fiber optics technologies as required for the control panel to communicate with network nodes including remote fire alarm panels, interface with building automation system, graphic command center, remote annunciators and displays, both global displaying total network information.

    a. Capability shall exist within the system to extend the network at any node. The system shall support a maximum of two network extension circuits in series on any system branch, extending the inherent distance limitations for network communications.
    b. Communication protocol shall be of the CS/MACD (carrier sense, multiple access, collision detect) type, RJ-485 token ring configuration or "ARNET" communication protocol.

6. The system shall have built-in equipment allowing reporting of system events to pagers.
7. The system shall employ a RS-232 RS485, TCP/IP and other interface protocol to interface with building automation system.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 3 line(s) of 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

C. Circuits:

1. Initiating Device, Notification Appliance, and Signaling Line Circuits:

   a. Initiating Device Circuits NFPA 72, Class A.
   b. Notification Appliance Circuits: Class B.
   c. Signaling Line Circuits: Style 6.

2. Initiating Device, Notification Appliance, and Signaling Line Circuits:

   a. Initiating Device Circuits NFPA 72, Class B.
   b. Notification Appliance Circuits Class B.
   c. Signaling Line Circuits: Style 4.

3. Serial Interfaces: Two RS-232 ports for printers.

D. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
2. Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.
3. Record events by the system printer.
4. Sound general alarm if the alarm is verified.
5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

E. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in walls shall be connected to fire-alarm system.

F. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

G. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

H. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of fire-alarm control unit.

1. Indicated number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711 and be listed by an NRTL.

   a. Allow the application of and evacuation signal to indicated number of zones and, at same time, allow voice paging to the other zones selectively or in any combination.
   b. Programmable tone and message sequence selection.
   c. Standard digitally recorded messages for "Evacuation" and "All Clear."

d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of fire-alarm control unit.

2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

I. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

J. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

K. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed lead calcium.

L. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

## 2.4 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit FACP.
2. Station Reset: Key- or wrench-operated switch.
3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.

## 2.5 SYSTEM SMOKE DETECTORS

A. Multi-Sensor Type System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal, multi-sensor type containing photoelectrical sensor, tested according to UL 268A and thermal sensor, combination of rate of rise and fixed temperature.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit **FACP**.
3. Base Mounting: Detector shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.

B. Duct Smoke Detectors: Photoelectric type complying with UL 268A and specified above.

1. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
2. Each sensor shall have multiple levels of detection sensitivity.
3. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
4. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

C. Heat Detectors:
1. General Requirements for Heat Detectors: Comply with UL 521.
2. Heat Detector, Combination Type: Comply with UL 521. Actuated by either a fixed temperature of 135 deg. F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
3. Mounting: Twist-lock base interchangeable with smoke-detector bases.
4. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
5. Mounting: Twist-lock base interchangeable with smoke-detector bases.
6. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

## 2.6 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Individually addressed, connected to a signaling line circuit (zoned as indicated), equipped for mounting as indicated and with screw terminals for system connections.

B. Horns: Electronic type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of [**Insert Option Here**] dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol, minimum ten (10) selectable tone.

C. Voice/Tone Notification Appliances:

1. Appliances shall comply with UL 1480 and shall be listed and labeled by an NRTL.
2. High-Range Units: Rated 2 to 15 W Mech/Equipment Room.
3. Low-Range Units: Rated 1 to 2 W.
4. Mounting: Semi-recessed.
5. Matching Transformers: Tap range matched to acoustical environment of speaker location.

D. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch high letters on the lens.

1. Rated Light Output: 15/30/75/110 cd, selectable in the field.
2. Mounting: Wall mounted unless otherwise indicated.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.
6. Mounting Faceplate: Factory finished, white.

## 2.7 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
3. Rating: 24-V ac or dc.

B. Material and Finish: Match door hardware.

## 2.8 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

## 2.9 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

B. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Verification that both telephone lines are available.
2. Programming device.
3. LED display.
4. Manual test report function and manual transmission clear indication.
5. Communications failure with the central station or fire-alarm control unit.

C. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.
2. Address of the supervisory signal.
3. Address of the trouble-initiating device.
4. Loss of ac supply or loss of power.
5. Low battery.
6. Abnormal test signal.
7. Communication bus failure.

D. Secondary Power: Integral rechargeable battery and automatic charger.

E. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.10 RADIO ALARM TRANSMITTER

A. Transmitter shall comply with NFPA 1221 and shall be listed and labeled by an NRTL.

B. Comply with 47 CFR 90.

C. Description: Manufacturer's standard commercial product; factory assembled, wired, tested, and ready for installation and operation.

1. Packaging: A single, modular, NEMA 250, Type 1 metal enclosure with a tamper-resistant flush tumbler lock.
2. Signal Transmission Mode and Frequency: VHF or UHF 2-W power output, coordinated with operating characteristics of the established remote alarm receiving station designated by Owner.
3. Normal Power Input: 120-V ac.
4. Secondary Power: Integral-sealed, rechargeable, 12-V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.
5. Antenna: Omni-directional, coaxial half-wave, dipole type with driving point impedance matched to transmitter and antenna cable output impedance. Wind-load strength of antenna and mounting hardware and supports shall withstand 100 mph with a gust factor of 1.3 without failure.
6. Antenna Cable: Coaxial cable with impedance matched to the transmitter output impedance.
7. Antenna-Cable Connectors: Weatherproof.
8. Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to the transmitter, matching fire-alarm and other system outputs to message-generating inputs of the transmitter that produce required message transmissions.

D. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit or from its own internal sensors or controls and shall automatically transmit signal along with a unique code that identifies the transmitting station to the remote alarm receiving station. Transmitted messages shall correspond to standard designations for fire-reporting system to which the signal is being transmitted and shall include separately designated messages in response to the following events or conditions:

1. Transmitter Low-Battery Condition: Sent when battery voltage is below 85 percent of rated value.
2. System Test Message: Initiated manually by a test switch within the transmitter cabinet, or automatically at an optionally preselected time, once every 24 hours, with transmission time controlled by a programmed timing device integral to transmitter controls.
3. Transmitter Trouble Message: Actuated by failure, in excess of one-minute duration, of the transmitter normal power source, derangement of the wiring of the transmitter, or any alarm input interface circuit or device connected to it.
4. Local Fire-Alarm-System Trouble Message: Initiated by events or conditions that cause a trouble signal to be indicated on the building system.
5. Local Fire-Alarm-System Alarm Message: Actuated when the building system goes into an alarm state. Identifies device that initiated the alarm.
6. Local Fire-Alarm-System Supervisory-Alarm Message: Actuated when the building alarm system indicates a supervisory alarm.

2.11 SYSTEM PRINTER

A. Printer shall be listed and labeled by an NRTL as an integral part of fire-alarm system.

2.12 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, not less than No. 18 AWG or size as recommended by system manufacturer.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Low-Voltage Circuits: No. 18 AWG, minimum and recommended by system supplier.
2. Line-Voltage Circuits: No. 12 AWG, minimum and recommended by system supplier.

D. Multi-conductor Armored Cable: NFPA 70 Type MC, copper conductors, TFN/THHN conductor insulation, copper drain wire, armor with outer jacket with red identifier stripe, UL listed for fire alarm and cable tray installation, plenum rated and size/pair, recommended by system supplier.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 for installation of fire-alarm equipment.

B. Equipment Mounting: Install fire-alarm control unit on finished floor with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

C. Detector Spacing:

1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing and shown on Contract Documents.
2. Smooth ceiling spacing shall not exceed 30 feet.
3. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
4. HVAC: Locate detectors not closer than 5 feet from air-supply diffuser or return-air opening.
5. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.

D. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.

E. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

F. Indicating Devices: Install at 80” A.F.F. to center.

G. Manual Pull Station: Install at 48” A.F.F. to center.

H. Device Location-Indicating Lights: Locate in public space (in ceiling) near the device they monitor.

I. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches above the finished floor.

J. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that will resist 100-mph wind load with a gust factor of 1.3 without damage.

## 3.2 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Smoke dampers in air ducts of designated air-conditioning duct systems.
2. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
3. Supervisory connections at valve supervisory switches.

## 3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

C. Install device address at each device.

## 3.4 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

## 3.5 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

B. Perform tests and inspections.

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. Visual Inspection: Conduct visual inspection prior to testing.

a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

E. Fire-alarm system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

## 3.6 DEMONSTRATION

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

END OF SECTION 28 31 11

# SECTION 313116
# TERMITE CONTROL

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section Includes:
   1. Soil treatment.
   2. Wood treatment.
   3. Bait-station system.
   4. Metal mesh barrier system.

B. Related Requirements:
   1. Section 061000 "Rough Carpentry" for wood preservative treatment by pressure process.

### 1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components, and profiles for termite control products.
   2. Include the EPA-Registered Label for termiticide products.

### 1.03 QUALITY ASSURANCE

A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located and who is accredited by manufacturer.

### 1.04 FIELD CONDITIONS

A. Soil Treatment:
   1. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.
   2. Related Work: Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

## PART 2 PRODUCTS

### 2.01 SOURCE LIMITATIONS

A. Obtain termite control products from single source from single manufacturer.

### 2.02 SOIL TREATMENT

A. Termiticide: EPA-Registered termiticide acceptable to authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Bayer Environmental Science
      b. Ensystex, Inc
   2. Service Life of Treatment: Soil treatment termiticide that is effective for not less than five years against infestation of subterranean termites.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.

B. Proceed with application only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

A. General: Prepare work areas according to the requirements of authorities having jurisdiction and according to manufacturer's written instructions before beginning application and installation of termite control treatment(s). Remove extraneous sources of wood cellulose and other edible materials, such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.

B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.
   1. Fit filling hose connected to water source at the site with a backflow preventer, according to requirements of authorities having jurisdiction.

### 3.03 APPLYING SOIL TREATMENT

A. Application: Mix soil treatment termiticide solution to a uniform consistency. Distribute treatment uniformly. Apply treatment at the product's EPA-Registered Label volume and rate for maximum specified concentration of termiticide to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction.
   1. Slabs-on-Grade and Basement Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
   2. Foundations: Soil adjacent to and along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing.
   3. Penetrations: At expansion joints, control joints, and areas where slabs and below-grade walls will be penetrated.

B. Post warning signs in areas of application.

C. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

### 3.04 PROTECTION

A. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

B. Protect termiticide solution dispersed in treated soils and fills from being diluted by exposure to water spillage or weather until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

### 3.05 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of termite-control-treatment Installer. Include annual maintenance as required for proper performance according to the product's EPA-Registered Label and manufacturer's written instructions. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

B. Continuing Maintenance Proposal: Provide from termite-control-treatment Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.
   1. Include annual inspection for termite activity and effectiveness of termite treatment according to manufacturer's written instructions.

**END OF SECTION**