Salt Lake County Facilities Management
2001 South State Street S3100
Salt Lake City, UT 84190

SALT LAKE COUNTY
PARKS AND RECREATION – EQUESTRIAN CENTER RESTROOM
PROJECT MANUAL

Construction Documents

NOVEMBER 2018

Architectural Nexus Project # 18142
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SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Project information.
   2. Work covered by Contract Documents.
   3. Work restrictions.
   5. Miscellaneous provisions.
   6. Hazardous Material Abatement

1.2 PROJECT INFORMATION

A. Project Identification:
   1. Salt Lake County Parks and Recreation Equestrian Center Restroom

B. Owner: Salt Lake County
   1. Owner’s Representative: Andrea Sorensen

C. Architect: Architectural Nexus.

1.3 CONSTRUCTION TIME FRAME: Refer to Instructions to Bidders.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of the following:

   Construct new restroom facilities in Southeast corner of the existing Outdoor Equestrian Arena. Construct the restroom and shower facility at the corner of the arena under the existing arena cover. Limit site work as shown in the drawings and as required to connect to utilities. The building shall be constructed on CMU, Concrete, Wood Ceiling Framing and finishes as shown. Minor selective demolition of the concrete foundation wall will be required.

B. The work shall be done in such a manner to meet the following criteria:
   1. Owner’s use of site must be maintained at times – Owner to access site, and restrooms for use of public by April 30th, 2019.

C. Type of Contract.
   1. Project will be constructed under a single prime contract.
1.5 ACCESS TO SITE

A. General: Contractor shall have limited use of Project site for construction operations during construction period as coordinated with owner. Contractor's use of Project site is limited by Owner's right to perform work or to retain other contractors on portions of Project.

B. Use of Site: Limit use of Project site to work in areas and parking lot staging area agreed to by Owner's representative. Do not disturb portions of Project site beyond areas in which the Work is indicated.
   1. Driveways, Walkways and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
      a. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

C. Condition of Existing facility: Maintain portions of existing facility throughout construction period. Repair damage caused by construction operations.

1.6 COORDINATION WITH OCCUPANTS

A. Possible Partial Owner Occupancy: Owner could occupy portion of site during entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's day-to-day operations.
   1. Maintain access to existing walkways and other adjacent occupied or used facilities. Do not close or obstruct walkways, or other occupied or used facilities without written permission from Owner and approval of authorities having jurisdiction.
   2. Notify Owner not less than 48 hours in advance of activities that will affect Owner's operations.

1.7 WORK RESTRICTIONS

A. Work Restrictions, General: Comply with restrictions on construction operations.
   1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.

B. On-Site Work Hours: Limit work in the existing building to normal business working hours of 6:00 a.m. to 7:00 p.m., Monday through Saturday, unless otherwise indicated.

C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:
   1. Notify Owner not less than two days in advance of proposed utility interruptions.

D. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.
   1. Notify Architect & Owner not less than two days in advance of proposed disruptive operations.
1.8 SPECIFICATION AND DRAWING CONVENTIONS

A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:

1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
2. Abbreviations: Materials and products are identified by abbreviations.
3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000
SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

1.2 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

1.3 ACTION SUBMITTALS

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

1. Substitution Request Form: Use CSI Form 13.1A.
2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
   a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
   b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
   c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
   d. Samples, where applicable or requested.
   e. Certificates and qualification data, where applicable or requested.
   f. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
   g. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time do not submit. Cost information, including a proposal of change, if any, in the Contract Sum.
   h. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
   i. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 7 days of receipt of request.

1.4 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.

1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied:

   a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
   b. Requested substitution will not adversely affect Contractor's construction schedule.
   c. Requested substitution has received necessary approvals of authorities having jurisdiction.
   d. Requested substitution is compatible with other portions of the Work.
   e. Requested substitution has been coordinated with other portions of the Work.
   f. Requested substitution provides specified warranty.

B. Substitutions for Convenience: Not allowed.

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500
SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:

1. Coordination drawings.
2. Requests for Information (RFIs).
3. Project meetings.

1.2 DEFINITIONS

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

1.3 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.

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. Delivery and processing of submittals.
4. Progress meetings.
5. Preinstallation conferences.
6. Project closeout activities.

1.4 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, where installation is not completely shown 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 dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

1.5 REQUESTS FOR INFORMATION (RFIs)

A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.

1. Architect will return RFIs submitted to Architect by other entities controlled by Contractor with no response.
2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

1. Project name.
2. Project number.
3. Date.
4. Name of Contractor.
5. Name of Architect.
6. RFI number, numbered sequentially.
7. RFI subject.
8. Specification Section number and title and related paragraphs, as appropriate.
9. Drawing number and detail references, as appropriate.
10. Field dimensions and conditions, as appropriate.
11. Contractor's suggested resolution. If Contractor's solution(s) impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
12. Contractor's signature.
13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.


D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow 7 working days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.

1. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt of additional information.
2. 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."

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.
4. RFI number including RFIs that were dropped and not submitted.
5. RFI description.
6. Date the RFI was submitted.
7. Date Architect's response was received.

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

1. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
2. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

1.6 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within 7 days of the meeting.

B. Preinstallation Conferences: Conduct a preinstallation conference at Project site before construction activity that requires 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 and Owner of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration.
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.

C. Progress Meetings: Weekly intervals.

1. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
2. 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.

3. 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 013100
SECTION 013233 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Preconstruction photographs.
2. Periodic construction photographs.

B. Related Requirements:

1. Section 017700 "Closeout Procedures" for submitting photographic documentation as Project Record Documents at Project closeout.

1.2 INFORMATIONAL SUBMITTALS

A. Key Plan: Submit key plan of building area with notation of vantage points marked for location and direction of each photograph. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.

B. Digital Photographs: Submit unaltered, original, full-size image files within seven days of taking photographs.

1. Digital Camera: Minimum sensor resolution of 8 megapixels.
2. Identification: Provide the following information with each image description in file metadata tag:
   a. Name of Project.
   b. Name and contact information for photographer.
   c. Date photograph was taken.
   d. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.

PART 2 - PRODUCTS

2.1 PHOTOGRAPHIC MEDIA

A. Digital Images: Provide images in JPG format, with minimum size of 8 megapixels.

PART 3 - EXECUTION

3.1 CONSTRUCTION PHOTOGRAPHS

A. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.
B. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.

1. Date and Time: Include date and time in file name for each image.
2. Field Office Images: Maintain one set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to Architect.

C. Preconstruction Photographs: Before commencement of demolition take photographs of Project area, including existing items to remain during construction, from different vantage points.

D. Periodic Construction Photographs: Take weekly, with timing each month adjusted to coincide with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.

END OF SECTION 013233
SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

B. Related Requirements:
   1. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
   2. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action.

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.

1.3 ACTION SUBMITTALS

A. Submittal Schedule: Submit a schedule 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.

1.4 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

   1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
   2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

      a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

B. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time...
will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.

2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.

3. Resubmittal Review: Allow 15 days for review of each resubmittal.

C. Paper Submittals: Place a permanent label or title block on each submittal item for identification.

1. Indicate name of firm or entity that prepared each submittal on label or title block.
2. Provide a space approximately 6 by 8 inches on label or beside title block to record Contractor's review and approval markings and action taken by Architect.
3. Include the following information for processing and recording action taken:
   a. Project name.
   b. Date.
   c. Name of Architect.
   d. Name of Construction Manager.
   e. Name of Contractor.
   f. Name of subcontractor.
   g. Name of supplier.
   h. Name of manufacturer.
   i. Submittal number or other unique identifier, including revision identifier.

   1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).

   j. Number and title of appropriate Specification Section.
   k. Drawing number and detail references, as appropriate.
   l. Location(s) where product is to be installed, as appropriate.
   m. Other necessary identification.

D. Electronic Submittals: Identify and incorporate information in each electronic submittal file 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.

   a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).

3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.

E. Options: Identify options requiring selection by Architect.
F. Deviations: Identify deviations from the Contract Documents on submittals.

G. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
   1. Note date and content of previous submittal.
   2. Note date and content of revision in label or title block and clearly indicate extent of revision.
   3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.

H. 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.

I. 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.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements:
   1. Submit electronic submittals via email as PDF electronic files.
   2. Action Submittals: Submit three paper copies of each submittal unless otherwise indicated. Architect will return two copies.
   3. Informational Submittals: Submit three paper copies of each submittal unless otherwise indicated. Architect will not return copies.
   4. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
      a. Provide a digital signature with digital certificate on electronically-submitted certificates and certifications where indicated.
      b. Provide a notarized statement on original paper copy certificates and certifications where indicated.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
   1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
   2. Mark each copy of each submittal to show which products and options are applicable.
   3. Include the following information, as applicable:
      a. Manufacturer's catalog cuts.
      b. Manufacturer's product specifications.
      c. Standard color charts.
      d. Statement of compliance with specified referenced standards.
      e. Testing by recognized testing agency.
f. Application of testing agency labels and seals.
g. Notation of coordination requirements.
h. Availability and delivery time information.

4. Submit Product Data concurrent with Samples.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
   a. Identification of products.
   b. Schedules.
   c. Compliance with specified standards.
   d. Notation of coordination requirements.
   e. Notation of dimensions established by field measurement.
   f. Relationship and attachment to adjoining construction clearly indicated.
   g. Seal and signature of professional engineer if specified.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.

3. Submit Shop Drawings in the following format:
   a. PDF electronic file.
   b. Three opaque copies of each submittal. Architect will retain two copies; remainder will be returned.

D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.

2. Identification: Attach label on unexposed side of Samples that includes the following:
   a. Generic description of Sample.
   b. Product name and name of manufacturer.
   c. Sample source.
   d. Number and title of applicable Specification Section.

3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.

4. 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 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.

5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of
color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

a. **Number of Samples:** Submit three sets of Samples. Architect will retain two Sample sets; remainder will be returned.

   1) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

E. **Product Schedule:** As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

1. Submit product schedule in the following format:

   a. PDF electronic file.
   b. Three paper copies of product schedule or list unless otherwise indicated. Architect will return two copies.

F. **Installer Certificates:** Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

G. **Product Certificates:** Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.

H. **Material Certificates:** Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

I. **Product Test Reports:** Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

J. **Design Data:** Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

**PART 3 - EXECUTION**

3.1 **CONTRACTOR'S REVIEW**

A. **Action 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.

SUBMITTAL PROCEDURES 013300 - 5
B. Project Closeout and Maintenance Material Submittals: See requirements in Section 017700 "Closeout Procedures."

C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT'S ACTION

A. General: Architect will not review submittals that do not bear Contractor's approval stamp and will return them without action.

B. Action Submittals: Architect will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.

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

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

E. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

END OF SECTION 013300
SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Substantial Completion procedures.
2. Final completion procedures.
3. Warranties.
4. Repair of the Work.

1.2 ACTION SUBMITTALS

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

1.3 SUBSTANTIAL COMPLETION PROCEDURES

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

B. Submittals Prior to Substantial Completion: Complete the following a minimum of 7 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, final completion construction photographic documentation, and similar final record information.
3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
4. Submit submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Architect. Label with manufacturer's name and model number where applicable.

C. Procedures Prior to Substantial Completion: Complete the following a minimum of 7 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Instruct Owner's personnel in maintenance of products.
2. Complete final cleaning requirements, including touchup sealant installation.
3. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 7 days prior to the date the work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor’s list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for final completion.

1.4 FINAL COMPLETION PROCEDURES

A. Preliminary Procedures: Before requesting final inspection for determining final completion, complete the following:

1. Submit a final Application for Payment.
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 shall state that each item has been completed or otherwise resolved for acceptance.
3. Submit Commissioning Checklists
4. Instruct Owner's personnel in maintenance of products and systems

B. Inspection: Submit a written request for final inspection to determine acceptance. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.5 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

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. Submit list of incomplete items in the following format:
   a. PDF electronic file. Architect will return annotated copy electronically.

1.6 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, 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 the Project Manual.

1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.

3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

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

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 REPAIR OF THE WORK

A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.

B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinish damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

END OF SECTION 017700
SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:

1. Record Drawings.
2. Record Specifications.
3. Record Product Data.

1.2 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:

1. Number of Copies: Submit one set of marked-up record prints.
2. Number of Copies: Submit copies of record Drawings as follows:
   a. Final Submittal:
      1) Submit record digital data files and three sets of record digital data file plots.
      2) Plot each drawing file, whether or not changes and additional information were recorded.
   b. Record Specifications: Submit three paper copies and one annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.

PART 2 - PRODUCTS

2.1 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. Record data as soon as possible after obtaining it.
   c. Record and check the markup before enclosing concealed installations.

2. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
3. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
4. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. 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 the original Contract Drawings.
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.

C. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. 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.

2.2 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 and paper copy.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

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

END OF SECTION 017839
SECTION 024119 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Demolition and removal of selected portions of existing building foundation wall.
      2. Demolition and removal of selected site elements.

1.2 MATERIALS OWNERSHIP
   A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.3 PREINSTALLATION MEETINGS
   A. Predemolition Conference: Conduct conference at Project site.

1.4 INFORMATIONAL SUBMITTALS
   B. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for dust control. Indicate proposed locations and construction of barriers.
   C. Schedule of selective demolition activities with starting and ending dates for each activity.
   D. Pre-demolition photographs or video.

1.5 CLOSEOUT SUBMITTALS
   A. Inventory of items that have been removed and salvaged.

1.6 FIELD CONDITIONS
   A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner’s operations will not be disrupted.
   B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
   1. Hazardous materials will be removed by Owner before start of the Work.
   2. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

E. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
   1. Maintain fire-protection facilities in service during selective demolition operations.

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

1.7 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
2. Arrange to shut off utilities with utility companies.
3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.

3.3 PROTECTION

A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

3.4 SELECTIVE DEMOLITION

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
3. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
4. Maintain fire watch during and for at least 4 hours after flame-cutting operations.
5. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
6. Dispose of demolished items and materials promptly

B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

C. Removed and Salvaged Items:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area on-site designated by Owner.
5. Protect items from damage during transport and storage.
D. Removed and Reinstalled Items:

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

3.5 CLEANING

A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

B. Burning: Do not burn demolished materials.

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

END OF SECTION 024119
SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Design Mixtures: For each concrete mixture.
C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement.

1.3 INFORMATIONAL SUBMITTALS
A. Material certificates.
B. Material test reports.
C. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer, detailing fabrication, assembly, and support of formwork.
D. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

1.4 QUALITY ASSURANCE
A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA’s "Certification of Ready Mixed Concrete Production Facilities."
B. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
1.5 PRECONSTRUCTION TESTING
   A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.

1.6 FIELD CONDITIONS
   A. Cold-Weather Placement: Comply with ACI 306.1.

       1. 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.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL
   A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

       1. ACI 301.
       2. ACI 117.

2.2 FORM-FACING MATERIALS
   A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

   B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

2.3 STEEL REINFORCEMENT
   A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

   B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

   C. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from as-drawn steel wire into flat sheets.

   D. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice."
2.4 CONCRETE MATERIALS

A. Cementitious Materials:
   2. Fly Ash: ASTM C 618, Class F.

B. Normal-Weight Aggregates: ASTM C 33/C 33M, graded.
   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Air-Entraining Admixture: ASTM C 260/C 260M.

D. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
   1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   2. Retarding Admixture: ASTM C 494/C 494M, Type B.
   3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
   5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
   6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

E. Water: ASTM C 94/C 94M and potable.

2.5 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. BASF Corporation; Admixture Systems.
      b. Sika Corporation.
      c. SpecChem, LLC.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.
E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. BASF Corporation; Admixture Systems.
   b. Kaufman Products, Inc.
   c. SpecChem, LLC.

2.6 RELATED MATERIALS

2.7 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, according to ACI 301.
   B. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
   C. Admixtures: Use admixtures according to manufacturer's written instructions.
      1. Use water-reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
      2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
      3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a w/c ratio below 0.50.

2.8 CONCRETE MIXTURES FOR BUILDING ELEMENTS
   A. Normal-Weight Concrete: See General Structural Notes.

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

2.10 CONCRETE MIXING
   A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and furnish batch ticket information.
1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Chamfer exterior corners and edges of permanently exposed concrete.

3.2 EMBEDDED ITEM INSTALLATION

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. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.3 VAPOR-RETARDER INSTALLATION

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches and seal with manufacturer's recommended tape.

3.4 STEEL REINFORCEMENT INSTALLATION

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

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

3.5 JOINTS

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

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.

2. Sawed Joints: Form contraction 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 contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

3.6 CONCRETE PLACEMENT

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

B. 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. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

3.7 FINISHING FLOORS AND SLABS

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

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.

1. Apply scratch finish to surfaces indicated and to receive concrete floor toppings

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces indicated to receive trowel finish.
D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces indicated exposed to view.
2. Finish and measure surface, so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.-long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/4 inch.

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated. While concrete is still plastic, slightly scarify surface with a fine broom.

1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.8 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer’s written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.

D. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.9 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

3.10 FIELD QUALITY CONTROL

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

END OF SECTION 033000
SECTION 042200 - CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Concrete masonry units.
   2. Steel reinforcing bars.

B. Masonry Layout:
   1. Most walls are laid out to course. At existing construction (door ways, etc.) cut blocks will be required. Mason to layout out coursing so that no cut block is less than 6” in face width.

1.2 DEFINITIONS

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

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

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For reinforcing steel. Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315.

C. Samples: For each type and color of the following:
   1. Pigmented Exposed CMUs – Honed face “Gamboge” as manufactured by AMCOR or accepted Equal -
   2. Pigmented and colored-aggregate mortar.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type and size of product. For masonry units, include data on material properties.

B. 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 according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91/C 91M for air content.
2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

1.5 FIELD CONDITIONS

A. 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/ACI 530.1/ASCE 6.


PART 2 - PRODUCTS

2.1 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6, 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.

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

1. Where fire-resistance-rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.2 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, movement joints, headers, bonding, and other special conditions.

B. Integral Water Repellent: Provide units made with integral water repellent for exposed units.

C. CMUs: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength as indicated in the General Structural Notes.

2. Density Classification: Light weight or Medium weight.
2.3 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150/C 150M, 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.

B. Hydrated Lime: ASTM C 207, Type S.

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

D. Masonry Cement: ASTM C 91/C 91M.

E. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979/C 979M. Use only pigments with a record of satisfactory performance in masonry mortar.

F. 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.

G. Aggregate for Mortar: ASTM C 144.
   1. White-Mortar Aggregates: Natural white sand or crushed white stone.
   2. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.


I. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

J. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.

K. Water: Potable.

2.4 REINFORCEMENT

A. Uncoated-Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
2.5 TIES AND ANCHORS

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

3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. 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.

C. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.060-inch thick steel sheet, galvanized after fabrication.
2. Tie Section: Triangular-shaped wire tie made from 0.187-inch diameter, hot-dip galvanized-steel wire.

D. Partition Top Anchors: 0.105-inch thick metal plate with a 3/8-inch diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.

E. Rigid Anchors: Fabricate from steel bars 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins unless otherwise indicated.

1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M.

2.6 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with Section 076200 "Sheet Metal Flashing and Trim" and as follows:

1. Fabricate metal drip edges from stainless steel. Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
2. Fabricate metal sealant stops from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 1/4 inch to form a stop for retaining sealant backer rod.

B. Solder and Sealants for Sheet Metal Flashings: As specified in Section 076200 "Sheet Metal Flashing and Trim."

C. 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.

2.7 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from urethane.

B. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D 226/D 226M, Type I (No. 15 asphalt felt).

2.8 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 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.

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 C 270, Property 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.

D. Pigmented Mortar: Use colored cement product

1. Application: Use pigmented mortar for exposed mortar joints with the following units:

   a. Decorative CMUs.
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. Application: Use colored-aggregate mortar for exposed mortar joints with the following units:
   a. Decorative CMUs.

F. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.
3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. 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.

3.2 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 or minus 1/4 inch.
2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch 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 in 10 feet, or 1/2-inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, and reveals, do not vary from level by more than 1/8 inch in 10 feet maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet 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 maximum.

5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet maximum.

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.
2. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
3. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

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

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

E. 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.

F. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.4 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs 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.
B. Lay solid CMUs 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. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

D. At locations indicated to receive wall tile, provide smooth mortar joints.

E. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.5 FLASHING

A. General: Install embedded flashing at ledges and other obstructions to downward flow of water in wall 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 lintels, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.

3. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall, and adhere flexible flashing to top of metal drip edge.

4. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall, and adhere flexible flashing to top of metal flashing termination.

3.6 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.

2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and that of other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.
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/ACI 530.1/ASCE 6 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.

3.7 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

B. Inspections: Special inspections according to Level B in TMS 402/ACI 530/ASCE 5.

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.

E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.

G. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for compressive strength.

H. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

I. Prism Test: For each type of construction provided, according to ASTM C 1314 at 28 days.

3.8 REPAIRING, POINTING, AND CLEANING

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

B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
1. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
2. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

3.9 MASONRY WASTE DISPOSAL

A. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
   1. Do not dispose of masonry waste as fill within 18 inches of finished grade.

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 042200
SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Miscellaneous steel framing and supports.
2. Miscellaneous steel trim.
3. Checker or Diamond Plate Steel Sheets.

B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Paint products.
2. Grout.

B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F, ambient; 180 deg F (100 deg C), material surfaces.
2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.

D. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.

E. Checker or Diamond Plate: ASTM A786, 1/4 inch thick, galvanized Z60.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless-steel fasteners for fastening aluminum.
2. Provide stainless-steel fasteners for fastening stainless steel.

B. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

C. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.

D. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting." Section 099123 Interior Painting.

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

E. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

G. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

H. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entained, concrete with a minimum 28-day compressive strength of 3000 psi.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Use connections that maintain structural value of joined pieces.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.

C. Weld corners and seams continuously to comply 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. At exposed connections, finish exposed welds and surfaces smooth and blended.

D. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Locate joints where least conspicuous.

E. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

F. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors not less than 8 inches from ends and corners of units and 24 inches o.c.
2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

C. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill or punch baseplates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness unless otherwise indicated.

2.7 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

C. Galvanize exterior miscellaneous steel trim.

D. Prime exterior miscellaneous steel trim with zinc-rich primer.

2.8 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

2.9 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.10 FINISHES, GENERAL

A. Finish metal fabrications after assembly.
2.11 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with primers specified in Section 099113 "Exterior Painting" primers specified in Section 099123 "Interior Painting" unless zinc-rich primer is indicated.

C. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."


D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction.
E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 055000
SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Framing with dimension lumber.
   2. Framing with engineered wood products.
   3. Plywood backing panels.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product.

1.3 INFORMATIONAL SUBMITTALS

A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.

B. Evaluation Reports: For the following, from ICC-ES:
   1. Wood-preservative-treated wood.
   2. Engineered wood products.
   4. Post-installed anchors.
   5. Metal framing anchors.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, 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. Dress lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.
C. Engineered Wood Products: Acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.

1. Allowable design stresses, as published by manufacturer, shall meet or exceed those indicated. Manufacturer’s published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2.
   1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. 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 above the ground in crawlspaces or unexcavated areas.
   5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 DIMENSION LUMBER FRAMING

A. Non-Load-Bearing Interior Partitions: As noted.
   1. Application: All interior partitions.
   2. Species:
      a. Southern pine or mixed southern pine; SPIB.
      b. Northern species; NLGA.
      c. Eastern softwoods; NeLMA.
      d. Western woods; WCLIB or WWPA.

B. Framing Other Than Non-Load-Bearing Partitions: As noted.
1. Application: Framing other than interior partitions.

2. Species:
   a. Hem-fir (north); NLGA.
   b. Southern pine; SPIB.
   c. Douglas fir-larch; WCLIB or WWPA.
   d. Southern pine or mixed southern pine; SPIB.
   e. Spruce-pine-fir; NLGA.
   f. Douglas fir-south; WWPA.
   g. Hem-fir; WCLIB or WWPA.
   h. Douglas fir-larch (north); NLGA.
   i. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.

C. Exposed Framing: Hand-select material for uniformity of appearance and freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot-holes, shake, splits, torn grain, and wane.

   1. Species and Grade: As indicated above for load-bearing construction of same type.

D. Rim Boards: Product designed to be used as a load-bearing member and to brace wood I-joists at bearing ends, complying with research or evaluation report for I-joists.

   1. Manufacturer: Provide products by same manufacturer as I-joists.
   2. Material: All-veneer product glued-laminated wood or product made from any combination solid lumber, wood strands, and veneers.

2.4 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

   1. Blocking.
   2. Nailers.
   3. Roof top equipment bases and support curbs.
   5. Furring.

B. Dimension Lumber Items: Construction or No. 2 grade lumber of any species.

C. Concealed Boards: 19 percent maximum moisture content and any of the following species and grades:

   1. Mixed southern pine or southern pine; No. 2 grade; SPIB.
   2. Western woods; Construction or No. 2 Common grade; WCLIB or WWPA.
2.5 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: Plywood, DOC PS 1, Exposure 1, C-D Plugged, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

2.6 FASTENERS

A. General: Fasteners shall be of size and type indicated and shall comply with requirements specified in this article for material and manufacture.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners.

B. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

C. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or ICC-ES AC308 as appropriate for the substrate.

2.7 METAL FRAMING ANCHORS

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

1. KC Metals Products, Inc.
2. Simpson Strong-Tie Co., Inc.
3. USP Structural Connectors.

B. Allowable design loads, as published by manufacturer, shall meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency. Framing anchors shall be punched for fasteners adequate to withstand same loads as framing anchors.


1. Use for interior locations unless otherwise indicated.

D. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A 653/A 653M; structural steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 coating designation; and not less than 0.036 inch thick.

1. Use for wood-preservative-treated lumber and where indicated.
2.8 MISCELLANEOUS MATERIALS

A. Sill-Sealer Gaskets: Glass-fiber-resilient insulation, fabricated in strip form, for use as a sill sealer; 1-inch nominal thickness, compressible to 1/32 inch; selected from manufacturer's standard widths to suit width of sill members indicated.

B. Sill-Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to suit width of sill members indicated.

C. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt 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.

D. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D3498 that is approved for use indicated by adhesive manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

B. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

C. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.

D. Do not splice structural members between supports unless otherwise indicated.

E. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

F. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

G. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

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.
3.2 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.

B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061000
SECTION 061516 - WOOD ROOF DECKING

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes solid-sawn or glued-laminated wood roof decking

1.2 ACTION SUBMITTALS
   A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS
   A. Research/Evaluation Reports: For glued-laminated wood roof decking indicated to be of diaphragm design and construction, from ICC-ES.

PART 2 - PRODUCTS

2.1 WOOD ROOF DECKING, GENERAL
   A. General: Comply with DOC PS 20 and with applicable grading rules of inspection agencies certified by ALSC’s Board of Review.

2.2 SOLID-SAWN WOOD ROOF DECKING
   A. Standard for Solid-Sawn Wood Roof Decking: Comply with AITC 112.
   C. Roof Decking Species: Douglas fir-larch.
   D. Roof Decking Nominal Size: 2 by 6 or 2 by 8.
   E. Roof Decking Grade: Select(ed) Decking or Select Dex.
   F. Grade Stamps: Factory mark each item with grade stamp of grading agency. Apply grade stamp to surfaces that are not exposed to view.
   G. Moisture Content: Provide wood roof decking with 15 percent maximum moisture content at time of dressing.
H. Face Surface: Smooth.

2.3 GLUED-LAMINATED WOOD ROOF DECKING

A. Face Species: Douglas fir-larch.
B. Roof Decking Nominal Size: 2 by 6 or 2 by 8.
C. Face Grade: Custom or Supreme: Clear face is required. Occasional pieces may contain a small knot or minor characteristic that does not detract from the overall appearance.
D. Face Grade: Decorative: Sound knots and natural characteristics are allowed, including chipped edge knots, short end splits, seasoning checks, and some pin holes. Face knot holes, stains, end slits, skips, roller splits, and planer burns are not allowed.
E. Face Grade: Service: Face knot holes, stains, end splits, skips, roller splits, planer burns, and other nonstrength-reducing characteristics are allowed. Strength-reducing characteristics are not allowed.
F. Moisture Content: Provide wood roof decking with 15 percent maximum moisture content at time of dressing.
G. Face Surface Smooth.
H. Laminating Adhesive: Wet-use type complying with ASTM D 2559.

2.4 ACCESSORY MATERIALS

A. Fastener Material: Hot-dip galvanized steel.
B. Sealants: Latex, complying with applicable requirements in Section 079200 “Joint Sealants” and recommended by sealant manufacturer and manufacturer of substrates for intended application.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install solid-sawn wood roof decking to comply with AITC 112.
   1. Locate end joints for two-span continuous lay-up or controlled random lay-up.
B. Install laminated wood roof decking to comply with manufacturer’s written instructions.
   1. Locate end joints for two-span continuous lay-up or controlled random lay-up.
   2. Nail each course of glued-laminated wood roof decking at each support with one nail slant nailed above the tongue and one nail straight nailed through the face.
a. Use 12d nails for 2-by-6 and 2-by-8 roof decking.
b. Use 30d nails for 3-by-6 and 3-by-8 roof decking.
c. Use 60d nails for 4-by-6 and 4-by-8 roof decking. Predrill roof decking to prevent splitting.
d. Use 30d tongue nails in bottom tongue and 3/8-inch face spikes for 5-by-6 and 5-by-8 roof decking. Predrill roof decking at spikes to prevent splitting.

3. Slant nail each course of glued-laminated wood roof decking to the tongue of the adjacent course at 30 inches o.c. and within 12 inches of the end of each unit. Stagger nailing 15 inches in adjacent courses.

a. Use 6d nails for 2-by-6 and 2-by-8 roof decking.
b. Use 8d nails for 3-by-6 and 3-by-8 roof decking.
c. Use 10d nails for 4-by-6 and 4-by-8 roof decking.
d. Use 16d nails for 5-by-6 and 5-by-8 roof decking.

C. Anchor wood roof decking, where supported on walls, with bolts as indicated.

D. Apply joint sealant to seal roof decking at exterior walls at the following locations:

1. Between roof decking and supports located at exterior walls.
2. Between roof decking and exterior walls that butt against underside of roof decking.
3. Between tongues and grooves of roof decking over exterior walls and supports at exterior walls.

3.2 PROTECTION

A. Provide water-resistive barrier over roof decking as the Work progresses to protect roof decking until roofing is applied.
SECTION 061753 - SHOP-FABRICATED WOOD TRUSSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Wood roof 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.

C. Delegated-Design Submittal: For metal-plate-connected wood trusses indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Evaluation Reports: For the following, from ICC-ES:
   1. Metal-plate connectors.
   2. Metal truss accessories.

1.4 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 that complies with quality-control procedures in TPI 1 and that involves third-party inspection by an independent testing and inspecting agency acceptable to Architect and authorities having jurisdiction.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Handle and store trusses to comply with recommendations in TPI 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. Structural Performance: Provide metal-plate-connected wood trusses capable of withstanding design loads within limits and under conditions indicated. Comply with requirements in TPI 1 unless more stringent requirements are specified below.

2.2 DIMENSION LUMBER

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. 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 METAL CONNECTOR PLATES

A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

1. Alpine Engineered Products, Inc.; an ITW company.
2. Cherokee Metal Products, Inc.; Masengill Machinery Company.
3. CompuTrus, Inc.
4. Eagle Metal Products.
6. MITEk Industries, Inc.; a subsidiary of Berkshire Hathaway Inc.
7. Robbins Engineering, Inc.
8. Truswal Systems Corporation; an ITW company.

B. General: Fabricate connector plates to comply with TPI 1.
2.4 FASTENERS

A. General: 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, made from pressure-preservative treated wood, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Nails, Brads, and Staples: ASTM F 1667.

2.5 METAL FRAMING ANCHORS AND ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Cleveland Steel Specialty Co.
2. KC Metals Products, Inc.
3. Phoenix Metal Products, Inc.
4. Simpson Strong-Tie Co., Inc.
5. USP Structural Connectors.

C. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those of basis-of-design products. Manufacturer’s published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.


2.6 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 meet requirements.

END OF SECTION 061753
SECTION 072100 - THERMAL 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:
      1. Polyisocyanurate faced foam-plastic board.

1.3 INFORMATIONAL SUBMITTALS
   A. Product Test Reports: For each product, for tests performed by a qualified testing agency.
   B. Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.4 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

2.1 POLYISOCYANURATE FOAM-PLASTIC BOARD
   A. Polyisocyanurate Board, Foil Faced ASTM C 1289, foil faced, Type I, Class 1 or 2.
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
   
   a. Carlisle Coatings & Waterproofing Inc.
   b. Dow Chemical Company (The).
   c. Firestone Building Products.


### 2.2 INSULATION FASTENERS

**A.** Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
   
   a. AGM Industries, Inc.
   b. Gemco.

2. **Angle:** Formed from 0.030-inch (0.762-mm) thick, perforated, galvanized carbon-steel sheet with each leg 2 inches (50 mm) square.

3. **Spindle:** Copper-coated, low-carbon steel; fully annealed; 0.105 inch (2.67 mm) in diameter; length to suit depth of insulation.

**B.** Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch (0.41-mm) thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches (38 mm) square or in diameter.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
   
   a. AGM Industries, Inc.
   b. Gemco.

### 2.3 ACCESSORIES

**A.** Insulation for Miscellaneous Voids:

1. **Glass-Fiber Insulation:** ASTM C 764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E 84.

**B.** 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.

**C.** Asphalt Coating for Cellular-Glass Block Insulation: Cutback asphalt or asphalt emulsion of type recommended by manufacturer of cellular-glass block insulation.
PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications.

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. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. 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.

3.3 PROTECTION

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

END OF SECTION 072100
SECTION 074113.16 - STANDING-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes standing-seam metal roof panels.

1.2 PREINSTALLATION MEETINGS
   A. Preinstallation Conference: Conduct conference at Project site

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Shop Drawings: Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
   C. Samples: For each type of metal panel indicated.

1.4 INFORMATIONAL SUBMITTALS
   A. Product test reports.
   B. Warranties: Sample of special warranties.

1.5 CLOSEOUT SUBMITTALS
   A. Maintenance data.

1.6 QUALITY ASSURANCE
   A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
   B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.
1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Finish Warranty Period: 20 years from date of Substantial Completion.

C. Special Weather tightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.
   1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Energy Performance: Provide roof panels that are listed on the EPA/DOE's ENERGY STAR "Roof Product List" for low slope roof products.

B. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:
   1. Wind Loads: As indicated on Drawings.
   2. Other Design Loads: As indicated on Drawings
   3. Deflection Limits: For wind loads, no greater than 1/180 of the span.

C. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E 1680 at the following test-pressure difference:
   1. Test-Pressure Difference: 1.57 lbf/sq. ft. (75 Pa)

D. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 1646 at the following test-pressure difference:
   1. Test-Pressure Difference: 2.86 lbf/sq. ft. (137 Pa).

E. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E 2140.

F. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
1. Uplift Rating: UL 90.

G. FM Global Listing: Provide metal roof panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are listed in FM Global's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.

1. Fire/Windstorm Classification: Class 1A-90
2. Hail Resistance: SH.

H. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces

2.2 STANDING-SEAM METAL ROOF PANELS

A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.

1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1514.
2. Aluminum Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1637.

A. Mechanically-seamed, Concealed Fastener, Metal Roof Panels: Structural metal roof panel consisting of formed metal sheet with vertical ribs at panel edges, installed by lapping and mechanically interlocking edges of adjacent panels, and attaching panels to supports using concealed clips and fasteners in a weathertight installation.

a. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, structural quality, Grade 340, Coating Class AZM150, prepainted by the coil-coating process per ASTM A755/A755M

b. Nominal Thickness: 24 ga.
d. Color: As selected by Architect from Manufacturer’s full range of colors.

2. Clips: One-piece fixed to accommodate thermal movement.

a. Material: 0.028-inch nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.

3. Panel Coverage: 12 inches
4. Panel Height: 2.0 inch
2.3 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils (0.76 mm) thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.

2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D 1970.

B. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

2.4 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C 645; cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 (Z275 hot-dip galvanized) coating designation or ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch (25-mm-) thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Gutters and Downspouts: Formed from same material as roof panels according to SMACNA's "Architectural Sheet Metal Manual." Finish to match metal roof panels and roof fascia and rake trim.

E. Roof Curbs: Fabricated from same material as roof panels, 0.048-inch (1.2-mm) nominal thickness; with bottom of skirt profiled to match roof panel profiles and with welded top box and integral full-length cricket. Fabricate curb subframing of 0.060-inch-(1.52-mm-) nominal thickness, angle-, C-, or Z-shaped steel sheet. Fabricate curb and
subframing to withstand indicated loads of size and height indicated. Finish roof curbs to match metal roof panels.

F. Panel Fasteners: Self-tapping screws designed to withstand design loads.

G. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing; 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.

2. Joint Sealant: ASTM C 920; as recommended in writing by metal panel manufacturer.


2.5 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

2.6 FINISHES

A. Panels and Accessories:

1. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.

2. Concealed Finish: White or light-colored acrylic or polyester backer finish.
PART 3 - EXECUTION

3.1 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.2 UNDERLAYMENT INSTALLATION

A. Felt Underlayment: Apply at locations indicated below, in shingle fashion to shed water, and with lapped joints of not less than 2 inches (50 mm).
   1. Apply over the entire roof surface.

B. Slip Sheet: Apply slip sheet over underlayment before installing metal roof panels.

C. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 076200 "Sheet Metal Flashing and Trim."

3.3 METAL PANEL INSTALLATION

A. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
   1. Install clips to supports with self-tapping fasteners.
   2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
   3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
   4. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
   5. Watertight Installation:
      a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
      b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
      c. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with sealant and fastened together by interlocking clamping plates.

B. Accessory Installation: Install accessories with positive anchorage to building and weather tight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
C. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

3.4 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. END OF SECTION 074113.16
SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Manufactured fascia, trim, reglets and counterflashing.

1.2 SUBMITTALS

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

B. Shop Drawings: Show installation layouts of sheet metal flashing and trim, including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work.
   1. Include details for forming, joining, supporting, and securing sheet metal flashing and trim, including pattern of seams, termination points, fixed points, expansion joints, expansion-joint covers, edge conditions, special conditions, and connections to adjoining work.

C. Samples: For each exposed product and for each finish specified.

D. Maintenance data.

E. Warranty: Sample of special warranty.

1.3 QUALITY ASSURANCE

A. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.

B. Preinstallation Conference: Conduct conference at Project site.

1.4 WARRANTY

A. Special Warranty on Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within 20 years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 SHEET METALS

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.

B. Metallic-Coated Steel Sheet: Restricted flatness steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755.

1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653, G90 coating designation; structural quality.
2. Exposed Coil-Coated Finish:
   a. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
   b. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat.
3. Color: To match roofing

2.2 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F.

B. Slip Sheet: Building paper, 3-lb/100 sq. ft. minimum, rosin sized.

2.3 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and recommended by manufacturer of primary sheet metal unless otherwise indicated.

B. Fasteners: 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.

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.

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) Steel Sheet: Hot-dip galvanized steel according to ASTM A 153 or ASTM F 2329 or Series 300 stainless steel.

C. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

D. Elastomeric Sealant: ASTM C 920, elastomeric polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

2.4 REGLETS

A. Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctions.

1. Material: Galvanized steel, 0.022 inch thick.

2.5 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA’s "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.

1. Obtain field measurements for accurate fit before shop fabrication.
2. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
3. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.

B. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant.

C. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.

D. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
E. Back side seams: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.

PART 3 - EXECUTION

3.1 UNDERLAYMENT INSTALLATION

A. Polyethylene Sheet: Install polyethylene sheet with adhesive for anchorage. Apply in shingle fashion to shed water, with lapped and taped joints of not less than 2 inches.

B. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.

3.2 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement so that completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.

1. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
3. Space cleats not more than 12 inches apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
4. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
5. Install sealant tape where indicated.
6. Torch cutting of sheet metal flashing and trim is not permitted.

B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by SMACNA.

1. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene sheet.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would...
not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.

D. Seal joints as shown and as required for watertight construction.

3.3 ROOF FLASHING INSTALLATION

A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and SMACNA's “Architectural Sheet Metal Manual.” Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

B. Copings: Anchor to resist uplift and outward forces according to recommendations in SMACNA's “Architectural Sheet Metal Manual” and as indicated.

1. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 24-inch centers.
2. Anchor interior leg of coping with washers and screw fasteners through slotted holes at 24-inch centers.

C. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints a minimum of 4 inches and bed with sealant.

D. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.4 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

END OF SECTION 076200
SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:
   1. Silicone joint sealants.
   2. Siliconized latex joint sealants.

1.2 PERFORMANCE REQUIREMENTS

A. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

B. Provide joint sealants as indicated on drawing and between two dissimilar surfaces. Confirm color matching requirements with Architect.

1.3 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples: 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.

C. Joint-Sealant Schedule: Include the following information:
   1. Joint-sealant application, joint location, and designation.
   2. Joint-sealant manufacturer and product name.

D. Product test reports.

E. Field-adhesion test reports.

F. Warranties.

1.4 WARRANTY

A. Special Installer's Warranty: Manufacturer's standard form in which 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.

PART 2 - PRODUCTS

2.1 MATERIALS, 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 sealant manufacturer, based on testing and field experience.

B. VOC Content of Interior Sealants: Provide sealants and sealant primers for use inside the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Part 59, Subpart D (EPA Method 24):

1. Architectural Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

C. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

D. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

E. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.

2.2 SILICONE JOINT SEALANTS

A. Neutral-Curing Silicone Joint Sealant: ASTM C 920.
B. Mildew-Resistant, Acid-Curing Silicone Joint Sealant: ASTM C 920.

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

   a. BASF Building Systems.
   b. Dow Corning Corporation.
   c. GE Advanced Materials - Silicons.
   d. May National Associates, Inc.
   e. Pecora Corporation.
   f. Polymeric Systems, Inc.
   g. Schnee-Morehead, Inc.
   h. Sika Corporation; Construction Products Division.
   i. Tremco Incorporated.
2. Type: Single component (S).
3. Grade: Pourable (P) or nonsag (NS).
4. Class: 100/50.
5. Uses Related to Exposure: Nontraffic (NT).

2.3 SILICONE-LATEX JOINT SEALANTS

A. Siliconized Latex Joint Sealant: Siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. BASF Building Systems.
   b. Bostik, Inc.
   c. May National Associates, Inc.
   d. Pecora Corporation.
   e. Schnee-Morehead, Inc.
   f. Tremco Incorporated.

2.4 JOINT SEALANT COLOR

A. Color: As selected by Architect from manufacturer’s full range.

2.5 JOINT SEALANT BACKING

A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, 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 where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.6 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.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.
   1. 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.

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.

3.2 INSTALLATION

A. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

B. Install sealant backings of kind 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.

C. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

D. 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.

E. 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.

3.3 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed and cured sealant joints as follows:
   a. Perform 10 tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.
   b. Perform 1 test for each 1000 feet of joint length thereafter or 1 test per each floor per elevation.


3.4 JOINT-SEALANT SCHEDULE


1. Joint Locations:
   a. Joints between different materials listed above.
   b. Perimeter joints between materials listed above and frames of interior doors and windows.
   c. Control and expansion joints in ceilings and other overhead surfaces.
   d. Other similar joints as indicated.
   e. Other joints between dissimilar materials.


1. Joint Locations:
   a. Control and expansion joints on exposed interior surfaces of exterior walls.
   b. Perimeter joints of exterior openings where indicated (doors).
   c. Vertical joints on exposed surfaces of interior unit masonry concrete walls and partitions.
d. Perimeter joints between interior wall surfaces and frames of interior doors and windows.

e. Other similar joints as indicated.


C. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal non-traffic surfaces.

1. Joint Sealant Location:

   a. Joints between plumbing fixtures and adjoining walls, floors, and counters.

   b. Other similar joints as indicated.


END OF SECTION 079200
SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes hollow-metal work.

1.2 DEFINITIONS
A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Shop Drawings: Include elevations, door edge details, frame profiles, metal thicknesses, preparations for hardware, and other details.
C. Schedule: Prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings.

1.4 INFORMATIONAL SUBMITTALS
A. Product test reports.

PART 2 - PRODUCTS

2.1 INTERIOR DOORS AND FRAMES
A. Heavy-Duty Doors and Frames: SDI A250.8, Level 2.
   1. Physical Performance: Level B according to SDI A250.4.
   2. Doors:
      a. Type: As indicated in the Door and Frame Schedule.
      b. Thickness: 1-3/4 inches (44.5 mm).
      c. Face: Uncoated, cold-rolled steel sheet, minimum thickness of 0.042 inch (1.0 mm).
      d. Edge Construction: Model 1, Full Flush, closed top edge.
      e. Core: Manufacturer’s standard.
   3. Frames:
a. Materials: Uncoated, steel sheet, minimum thickness of 0.053 inch (1.3 mm).
b. Construction: Full profile welded.


2.2 EXTERIOR HOLLOW-METAL DOORS AND FRAMES

A. Heavy-Duty Doors and Frames: SDI A250.8, Level 2.
   1. Physical Performance: Level B according to SDI A250.4.
   2. Doors:
      a. Type: As indicated in the Door and Frame Schedule.
      b. Thickness: 1-3/4 inches (44.5 mm).
      c. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch (1.0 mm), with minimum G-90 coating.
      d. Edge Construction: Model 1, Full Flush, solid top.
      e. Core: Manufacturer's highest R-value insulation material.
   3. Thermal-Rated (All Exterior) Doors: Provide doors fabricated with thermal-resistance value (R-value) of not less than 2.1 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.
   4. Frames:
      a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm), with minimum A40 (ZF120) coating.
      b. Construction: Full profile welded.
   5. Exposed Finish: Prime

2.3 FRAME ANCHORS

A. Jamb Anchors:
   1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch (1.0 mm) thick, with corrugated or perforated straps not less than 2 inches (51 mm) wide by 10 inches (254 mm) long; or wire anchors not less than 0.177 inch (4.5 mm) thick.
   2. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch- (9.5-mm-) diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch (1.0 mm), and as follows:
   1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
2.4 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.

D. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.

   1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

F. Power-Actuated Fasteners in Concrete: From corrosion-resistant materials.

G. Grout: ASTM C 476, except with a maximum slump of 4 inches (102 mm), as measured according to ASTM C 143/C 143M.

H. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat.

2.5 FABRICATION

A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer’s plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Hollow-Metal Doors:

   1. Exterior Doors: Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.

C. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

   1. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

   2. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
3. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.

4. Jamb Anchors: Provide number and spacing of anchors as follows:

   a. Masonry Type: Locate anchors not more than 16 inches (406 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c., to match coursing, and as follows:

      1) Two anchors per jamb up to 60 inches (1524 mm) high.
      2) Three anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.

   b. Postinstalled Expansion Type: Locate anchors not more than 6 inches (152 mm) from top and bottom of frame. Space anchors not more than 26 inches (660 mm) o.c.

D. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.

   1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
   2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

E. Stops and Moldings: Provide stops and moldings around louvers where indicated. Form corners of stops and moldings with mitered hairline joints.

2.6 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.


2.7 ACCESSORIES

A. Grout Guards: Formed from same material as frames, not less than 0.016 inch (0.4 mm) thick.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Hollow-Metal Frames: Install hollow-metal frames for doors of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.
1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
   a. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
   b. Install frames with removable stops located on secure side of opening.
   c. Remove temporary braces necessary for installation only after frames have been properly set and secured.
   d. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
   e. Field apply bituminous coating to backs of frames that will be filled with grout containing antifreezing agents.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
   a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.

4. Concrete Walls: Solidly fill space between frames and concrete with mineral-fiber insulation.

5. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

6. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
   a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
   c. Twist: Plus or minus 1/16 inch (1.6 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 (1.6 mm), measured at jambs at floor.

B. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Steel Doors:
   a. Between Door and Frame Jambs and Head: 1/8 inch (3.2 mm) plus or minus 1/32 inch (0.8 mm).
   b. Between Edges of Pairs of Doors: 1/8 inch (3.2 mm) to 1/4 inch (6.3 mm) plus or minus 1/32 inch (0.8 mm).
   c. At Bottom of Door: 3/4 inch (19.1 mm) plus or minus 1/32 inch (0.8 mm).
   d. Between Door Face and Stop: 1/16 inch (1.6 mm) to 1/8 inch (3.2 mm) plus or minus 1/32 inch (0.8 mm).
3.2 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow-metal work immediately after installation.

C. 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.

D. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

E. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081113
SECTION 087100 - DOOR HARDWARE

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. Commercial door hardware for the following:
   a. Swinging doors.
   b. Other doors to the extent indicated.

2. Cylinders for doors specified in other Sections.

3. Electrified door hardware.

B. Related Sections include the following:

1. Division 08 Section "Hollow Metal Doors and Frames"

C. Products furnished, but not installed, under this Section include the following. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.

1. Thresholds, weather stripping, and cylinders for locks specified in other Sections.

1.3 PRICING AND PAYMENT PROCEDURES

1.4 REFERENCED STANDARDS

A. Provide hardware in accordance with the following standards in addition to those specified in Division 01 Section “References”.


2. Builders Hardware Manufacturer’s Association (BHMA)
b. ANSI/BHMA A156.3: Exit Devices, 2008 edition  
c. ANSI/BHMA A156.4: Door Controls - Closers, 2008 edition  
d. ANSI/BHMA A156.18: Materials and Finishes, 2006 edition

3. Door and Hardware Institute (DHI)  
e. Sequence and Format for the Hardware Schedule, 2001 edition

1.5 SUBMITTALS

A. Product Data: Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Details of electrified door hardware, indicating the following:  
1. Wiring Diagrams: Power, signal, and control wiring. Include the following:  
a. System schematic.  
b. Elevation of each door.  
2. Detail interface between electrified door hardware and fire alarm, access control, security, building control system.  
3. Operation Narrative: Describe the operation of doors controlled by electrified door hardware.

C. Samples for Verification: For exposed door hardware of each type, in specified finish, full size. Tag with full description for coordination with the door hardware sets. Submit Samples before, or concurrent with, submission of the final door hardware sets, if requested.  
1. Samples will be returned to Contractor. Units that are acceptable and remain undamaged through submittal, review, and field comparison process may, after final check of operation, be incorporated into the Work, within limitations of keying requirements.

D. Qualification Data: For Installer

E. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for locks, latches, and closers as requested.

F. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware and keying schedule.

G. Warranty: Special warranty specified in this Section.
H. Door Hardware Sets: Prepared by or under the supervision of Architectural Hardware Consultant, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final door hardware sets with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.

2. Content: Include the following information:
   a. Identification number, location, hand, fire rating, and material of each door and frame.
   b. Type, style, function, size, quantity, and finish of each door hardware item.
   c. Complete designations of every item required for each door or opening including name and manufacturer.
   d. Fastenings and other pertinent information.
   e. Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
   f. Explanation of abbreviations, symbols, and codes contained in schedule.
   g. Mounting locations for door hardware.
   h. Door and frame sizes and materials.
   i. List of related door devices specified in other Sections for each door and frame.
   j. Description of each electrified door hardware function, including location, sequence of operation, and interface with other building control systems.

3. Submittal Sequence: Submit the final door hardware sets at earliest possible date, particularly where approval of the door hardware sets must precede fabrication of other work that is critical in Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the door hardware sets.

I. Keying Schedule: Prepared by or under the supervision of Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Coordinate with existing keying at adjacent facilities and owner's representative.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by lock manufacturer.

1. Installer's responsibilities include supplying and installing door hardware and providing a qualified Architectural Hardware Consultant available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.

2. Installer shall have warehousing facilities in Project's vicinity.


4. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
B. Architectural Hardware Consultant Qualifications: A person who is currently certified by DHI as an Architectural Hardware Consultant and 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.

C. Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.
   1. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

D. Keying Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." In addition to Owner, Construction Manager, Contractor, and Architect, conference participants shall also include Installer’s Architectural Hardware Consultant and Owner’s Security Consultant. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:
   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. Address for delivery of keys.

E. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.7 DELIVERY, STORAGE, AND HANDLING
A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

B. Tag each item or package separately with identification related to the final door hardware sets, and include basic installation instructions, templates, and necessary fasteners with each item or package.

C. Deliver keys to Owner’s Representative.

1.8 COORDINATION
A. Coordinate layout and installation of recessed hardware with floor construction. Cast anchoring inserts into concrete. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Templates: Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. 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. Coordinate with aluminum entrance door supplier for door hardware installation.

D. Electrical System Roughing-in: Coordinate layout and installation of electrified door hardware with connections to power supplies, fire alarm system and detection devices, access control system, security system, and building control system.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Structural failures including excessive deflection, cracking, or breakage.
   b. Faulty operation of operators and door hardware.
   c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: Three (3) years from date of Substantial Completion, except as follows:

   a. Continuous Hinges: Lifetime of Building
   b. Grade 1 Cylindrical Locks: Ten (10) years from date of Substantial Completion.
   c. Exit Devices: Three (3) years from date of Substantial Completion.
   d. Manual Closers: Thirty (30) years from date of Substantial Completion.
   e. Automatic Operators: Two (2) years from date of Substantial Completion.
   f. Electrified Hardware Items: One (1) year from date of Substantial Completion.

1.10 EXTRA MATERIALS

A. Furnish full-size units of door hardware described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Door Hardware:

   1. 2 each Falcon T581L Dane x 626 Locksets
   2. 2 each LCN 4040XP EDA x 689 Closers

1.11 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.
2.1 SCHEDULED HARDWARE

A. Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of finish hardware are indicated in the "Hardware Schedule" at the end of this Section. Products are identified by using hardware designation numbers of the following:

1. Manufacturer's Product Designations: The product designation and name of one manufacturer are listed for each hardware type required for the purpose of establishing minimum requirements. Provide either the product designated or, where more than one manufacturer is specified under the Article "Manufacturers" in Part 2 for each hardware type, the comparable product of one of the other manufacturers that complies with requirements.

2.2 MATERIALS AND FABRICATION

A. General

1. Manufacturer's Name Plate: Do not use manufacturers' products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire-rated labels and as otherwise acceptable to Architect.

   a. Manufacturer's identification will be permitted on rim of lock cylinders only.

2. Base Metals: Produce hardware units of basic metal and forming method indicated using manufacturer's standard metal alloy, composition, temper, and hardness, but in no case of lesser (commercially recognized) quality than specified for applicable hardware units for finish designations indicated.

3. Provide hardware manufactured to conform to published templates generally prepared for machine screw installation. Do not provide hardware that has been prepared for self-tapping sheet metal screws, except as specifically indicated.

B. Fasteners

1. Furnish screws for installation with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Furnish stainless steel (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finish of this other work as closely as possible including "prepared for paint" surfaces to receive painted finish.

2. Provide concealed fasteners for hardware units that are exposed when door is closed except to the extent no standard units of type specified are available with concealed fasteners. Use through bolts only as indicated in this section unless their use is the only means of reinforcing the work adequately to fasten the hardware securely. Where thru-bolts are used as a means of reinforcing the work, provide sleeves for each thru-bolt or use sex screw fasteners.
2.3 HINGES

A. Basis of Design
   1. Ives: 5BB1

B. Acceptable Alternate:
   1. Hager: BB1279
   2. Stanley: FBB179
   3. McKinney: TB2714
   4. Bommer: BB5000

C. Requirements:
   1. Quantity: Provide the following, unless otherwise indicated:
      a. Two Hinges: For doors with heights up to 60 inches.
      b. Three Hinges: For doors with heights 61 to 90 inches.
   2. Template Requirements: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.
   3. Hinge Weight: As indicated in hardware sets.
   4. Hinge Base Metal: Unless otherwise indicated, provide the following:
      b. Interior Hinges: Steel with steel pin.
      c. Hinges for Fire-Rated Assemblies: Steel with steel pin.
   5. Hinge Options: Where indicated in door hardware sets or on Drawings:
      a. Safety Stud: Designed for stud in one leaf to engage hole in opposing leaf.
      b. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for out-swinging doors.
      c. Corners: Square.
   6. Fasteners: Comply with the following:
      b. Wood Screws: For wood doors and frames.
      c. Threaded-to-the-Head Wood Screws: For fire-rated wood doors.

2.4 CONTINUOUS HINGES

A. Basis of Design:
   1. Ives: 112HD 224HD

B. Acceptable Alternate:
1. Stanley: 661HD 662HD
2. Hager: 780-112HD 780-224HD
5. Pemko: FMSLFHD FMHD

C. Requirements:
   1. Geared Continuous Hinges: Shall utilize a single gear section for the door leaf and a separate gear section for the frame side of the door. Provide full mortise or surface applied hinge as scheduled in each set. Geared hinges are to be UL 10C tested and approved for 90 minutes.

2.5 OPERATING DOOR TRIM

A. Door Bolts
   1. Basis of Design: FB358/FB45
      a. Ives: 8 DP1/DP2
   2. Acceptable Alternate:
      a. Rockwood: 557/555 570
      b. Hager: 283D/282D 280X
      c. Trimco: 3915/3917 3910/3911
   3. Requirements:
      a. Provide bolt model recommended by manufacturer for door material type.
      b. Provide 1 inch throw stainless steel bolt with 12 inch length unless otherwise scheduled in the sets.
      c. Provide a dust proof strike for bottom bolt at all locations where there is not a threshold.

B. Push Plates, Pull Plates, and Pulls
   1. Basis of Design:
      a. Ives: 8200 8305
   2. Acceptable Alternate:
      a. Rockwood: 70C 111x70
      b. Hager: 30S 31J
      c. Trimco: 1001 1018
   3. Requirements:
b. Pull Plate: Provide 4 inch by 16 inch by .050 inch push plate constructed of stainless steel, bevel all four edges. Provide 10 inch center to center (CTC) pull constructed of stainless steel with a diameter of 1 inch.

C. Decorative Door Pulls

1. Basis of Design: 9264F/9266
   a. Ives: F

2. Acceptable Alternate:
   a. Rockwood: RM3311
   b. Burns: VP4251

3. Requirements:
   a. Provide door pulls 1-1/4 inch diameter with flat tips. Pull shall be constructed of brass, bronze, or stainless steel.
   b. Provide pull length and shape as indicated in the sets.

2.6 ELECTRIC STRIKES

A. Acceptable Products:
   1. Von Duprin: 6300 Series
   2. HES: 9000 Series

B. Requirements:
   1. Provide electric strikes that are continuous duty rated without the use of external rectifiers.
   2. Provide electric strikes with function (fail safe, fail secure) and power requirements as scheduled.

2.7 LOCKS AND LATCHES

A. General:
   1. Lock Chassis: Shall be made from steel, with locking spindles of stainless steel.
   2. Latch Bolt: Shall be constructed of stainless steel with 3/4 inch throw on mortise locks and 1/2 inch throw otherwise. Latch to be deadlocking on keyed functions.
   3. Lever Trim: Shall be pressure cast brass, bronze, zinc, or steel with wrought rose design. Levers are to be solid with no voids or plastic inserts.
   4. Strike Plates: Provide ANSI 4-7/8 inch strike plates. At pairs of doors, provide strike with 7/8 inch flat lip. At single doors, provide round-lipped strike with lip
length as required to minimally clear jamb and trim. Provide dust box at each strike location.

B. Grade 1 Bored Locks

1. Acceptable Products:
   a. Basis of Design:
      1) Falcon: T Series
   b. Acceptable Alternate:
      1) Schlage: ND Series
      2) Sargent: 10 Line
      3) Best: 93K Series

2. Requirements:
   a. ANSI Grade: BHMA/ANSI A156.2, Series 4000, Grade 1.
   b. Door Prep: Provide lockset to install using a standard ANSI 161 door prep.
   c. Anti-Rotation Plate: Provide lockset with a mechanically interlocked anti-
      rotation plate. Anti-Rotation teeth or “bite tabs” are not acceptable. Locks
      without any rotation prevention devices are not acceptable.
   d. Lever Return Springs: Provide each lever with two compression type return
      springs that are easily accessible without dismantling the lock chassis.
      Locks utilizing tension or torsion lever return springs are unacceptable.
      Locks with internal springs that require dismantling the lock chassis are
      unacceptable.
   e. Lever Spindles: Provide lock with either milled or 1-piece deep drawn
      spindles. 2-piece interlocking stamped spindles are not acceptable.
   f. Multi-Functionality: Provide modular lockset with capability to convert to a
      new lock function by changing key cams.
   g. Vandal Resistant Lever: Where scheduled, provide lockset with lever that
      freely rotates even when locked to resist vandalism and abuse.

C. Deadbolts

1. Requirements:
   a. Provide deadbolts by same manufacturer as the provided locksets.
   b. Provide chassis type, function, and grade as scheduled.

2.8 ACCESS CONTROLLED LOCKS

A. Keypad Only Access Controlled Locks

1. Acceptable Products:
   a. Basis of Design:
      1) Alarm Lock: Trilogy
   b. Acceptable Alternate:
      1) Schlage Electronics CO Series
2. Requirements:
   a. Provide battery-operated standalone keypad lock with non-handed chassis of type scheduled.
   b. Lock shall have an incorporated 12 button keypad.
   c. Lock shall have capacity for a minimum of 100 pin codes at least 4 digits in length.
   d. Provide lock with functions and keying as scheduled.
   e. Provide lock with emergency key override.

2.9 CYLINDERS AND CORES

A. Acceptable Products:
   1. ASSA: Match existing key system.

B. Requirements:
   1. Large Format Interchangeable Cylinders: Provide cylinders of quantity and type and with the appropriate cam/tailpiece to be compatible with the locking hardware provided. Provide cylinder housings ready to accept 6-pin, Large Format Interchangeable Cores (LFIC).
      a. Disposable Temporary Cores: Provide each cylinder housing and/or lock lever with disposable construction cores during the construction period.
      b. Keyed Temporary Cores: Provide each cylinder housing and/or lock lever with keyed construction core during the construction period. Cores will remain property of the contractor and will be returned upon installation of owner's permanent key system.
      c. Permanent Cores: Provide factory keyed cores that match existing ASSA keysystem.

   2. Conventional Cylinders: Provide cylinders of quantity and type and with the appropriate cam/tailpiece to be compatible with the locking hardware provided. Provide factory keyed 6-Pin conventional cylinders matching existing keysystem.
      a. Temporary Construction Keying: Provide each cylinder with “Split Key” type temporary keying during the construction period. At substantial completion, accompany the owner’s representative while voiding construction keying.

   3. Keys: Provide cylinder manufacturer’s standard keys. Keys shall be shipped separate from cores directly to owner’s representative. For estimating purposes, provide keys in the following quantities:
      a. Construction Control Keys: 2 each
      b. Construction Change Keys: 12 each
      c. Permanent Control Keys: 2 each
      d. Split Key Voiding Keys: 2 each
      e. Permanent Master Keys: 2 each
      f. Permanent Change Keys: 4 per core
2.10 EXIT DEVICES

A. Acceptable Products:

1. Basis of Design:
   a. Von Duprin: 35A Series, no substitute where scheduled
   b. Falcon: 24/25 Series

2. Acceptable Alternate:
   a. Falcon: 25/24 Series
   b. Sargent: 88 Series
   c. Corbin Russwin: ED5000 Series

B. Requirements:

1. ANSI Grade: BHMA/ANSI A156.3, Grade 1.
2. Device Construction:
   a. Exit device(s) shall have a mechanism case constructed of extruded aluminum or wrought stainless steel, base plates constructed of cold rolled or cast steel, push pad of extruded aluminum with stainless steel covering or wrought stainless steel, and end caps with flush mounted, sloped design. At full-glass doors, provide exit devices with no exposed fasteners or rivets visible through glass. Where required by stile width, provide narrow-stile type device.
   b. Latchbolt: Provide Pullman-type deadlocking latch bolts constructed of stainless steel. Where specified provide high security Pullman-type latchbolt that collapses to be square faced under high pull forces. Latch return springs shall be compression type. Tension and Torsion latch return springs are not acceptable.
   c. Dogging Mechanism: where dogging or latch-retraction options are not specifically scheduled for non-fire rated doors, provide device with a hex-key activated hook-type dogging mechanism constructed of steel.
   d. Plastic or nylon used for the push pad, or parts in the dogging mechanism or latchbolt mechanism are unacceptable.
   e. Sound Dampening: Device shall be provided with factory-installed sound dampening materials.
   f. Provide device type, function, and trim style as indicated in hardware schedules.

3. Provide shim kits, filler plates, and other accessories as required for each opening.
4. Unless otherwise indicated in the sets, provide device with roller-type strike.
5. Where scheduled, provide removable mullions by same manufacturer as provided exit devices. Provide mullion stabilizers, key removable option, strike preps, and fire rating as indicated in sets.
6. Concealed vertical exit devices shall be a cable-actuated concealed vertical latch system available in two-point and less bottom latch (LBL) configurations. Vertical rods are not acceptable.
   a. Cable shall include color-coded stainless steel with polytetrafluoroethylene (Teflon®) liner and stainless steel core wire. Latches and center slides are
color coded to aid in installation. Conduit and core wire ends snap into latch and center slides without the use of tools. Latchbolts and blocking cams shall be manufactured from sintered metal low carbon copper-infiltrated steel, with a molybdenum disulfide coating for low friction and consistent performance.

b. Top latchbolt shall have a minimum 0.382 inch and greater than 90 degree engagement with strike to prevent door and frame separation under high static load. Bottom latchbolt, when used, shall have a minimum of 0.44 inch engagement with strike.

c. Product cycle life shall exceed 1,000,000 cycles.

d. Latch release does not require separate trigger mechanism.

e. Top and bottom latch must operate independently of each other. Top latch will fully engage top strike even when bottom latch is compromised.

f. Cable and latching system shall have the ability to:
   1) Be assembled as a complete assembly and function prior to being installed in the door.
   2) Install into the door as a one-piece single assembly
   3) Be installed independently of device installation and function on door even prior to device and trim installation.
   4) Connect to the exit device at a single attachment point.
   5) Adjust bottom latch height from a single point, after the system is installed and connected to exit device, while the door is hanging
   6) Alter latch position up and down within two-inches without additional adjustment.
   7) Ability to remove the system while door is hanging.
   8) Configure latchbolt mounting: double or single tab mount for steel doors, and wood doors, face mount for aluminum doors, eliminating requirement of tabs.
   9) Provide adjustable exit device to latch center line adjustment. Ensures double tab mounting option for top latch, regardless of exit device centerline.

2.11 MECHANICAL DOOR CLOSERS

A. General:

1. Valves: Closers shall have separate valves for latch speed, main speed, and back check. Valves shall be staked to prevent accidental removal. Provide the appropriate closer body, handing, and brackets to mount closer inside the building on the least-public side of the door.

   a. Where closers are to be mounted parallel arm, provide with heavy duty, fully forged arms.
   b. Where closers are to be mounted regular arm and the opening can otherwise be opened to 180 degrees, provide closer with the appropriate special templating to allow 180 degree door swing. Where a special template is not available for 180 degree swing, provide closer arm with integrated stop.
2. Integrated Stop Closer Arms: Where a closer with integrated stop is required, provide the appropriate closer and arm as follows:
   a. Parallel arm with spring-cushioned stop arm: Provide where door is otherwise able to open to 95 degrees and requires a parallel arm mount closer.
   b. Parallel arm with dead stop arm: Provide where door is obstructed from opening to 95 degrees and requires a parallel arm mount closer.
   c. Regular arm with push side surface-mounted overhead stop: Provide where door closer should mount on pull side of door.
3. Hold Open Arms: Provide closer arms with mechanical hold-opens as scheduled.
4. Provide closers with any special templates, brackets, plates, or other accessories required for interface with header, door, wall, and other hardware. Provide closers with screw packs containing thru-bolts, machine screws, and wood screws.
5. Closers shall be provided with all-weather fluid and shall not require readjustment from 120 degrees F to -30 degrees F. Fluid shall be non-flaming and shall not fuel door or floor covering fires. Upon request, provide data indicating thermal properties of fluid.
6. Closers shall close and latch door when adjusted to meet accessibility requirements for door opening force: 8.5 lbs at exterior doors, 5 lbs at interior doors, and 15 lbs at labeled fire doors.

B. Heavy Duty Door Closers:
1. Basis of Design:
   a. Base Bid:
      1) LCN: 4040XP
      2) LCN 4040XP no substitute where scheduled.
   b. Acceptable Alternate:
      1) Sargent: 351
      2) Falcon: SC70
2. Requirements:
   a. ANSI Grade: BHMA/ANSI A156.4, Grade 1.
   b. Closer Construction: Closer shall have aluminum alloy body with 1-1/2 inch steel piston, double heat treated pinion, 5/8 inch bearing journals, and full complement needle or caged ball bearings. Closer shall be adjustable from sizes 1 through 6.
   c. Provide closers with spring size adjustment dial for ease of adjusting.

2.12 AUTOMATIC OPERATORS

A. Acceptable Products:
1. Basis of Design:
2. Acceptable Alternate:
   a. Norton: 5900 Series
   b. Stanley: Magic Force

B. Requirements:
   1. Provide low energy automatic operator units that are electro-mechanical design complying with ANSI A156.19.
      a. Opening: Powered by DC motor working through reduction gears.
      b. Closing: Spring force.
      d. Operation: Motor is off when door is in closing mode. Door can be manually operated with power on or off without damage to operator. Provide variable adjustments, including opening and closing speed adjustment.
   2. Provide units with manual off/auto/hold-open switch, push and go function to activate power operator, vestibule interface delay, electric lock delay, hold-open delay adjustable from 2 to 30 seconds, and logic terminal to interface with accessories, mats, and sensors.
   3. Provide drop plates, brackets, or adapters for arms as required to suit details.
   4. Provide motion sensors and/or actuator switches for operation as specified. Provide weather-resistant actuators at exterior applications.
   5. Provide complete assemblies of controls, switches, power supplies, relays, and parts/material recommended and approved by manufacturer of automatic operator for each individual leaf.

2.13 ARCHITECTURAL DOOR TRIM

A. Protection Plates and Edge Guards
   1. Basis of Design:
      a. Ives: 8400 Series
   2. Acceptable Alternate:
      a. Rockwood: K1050
      b. Hager: 194S
      c. Trimco: K Series
   3. Requirements:
      a. Provide .050 inch thick stainless steel protection plates with height as scheduled. Plate shall have four beveled edges and countersunk screws. Provide plate with width as follows:
         1) Pairs of Doors: Provide plate to be 1 inch less door width.
2) Single Doors: Provide plate to be 2 inches less door width on push side, pull side mounted plates to be 1 inch less door width.
3) Where Specified with Edge Guards: Provide plate to be 2 inches less door width.

B. Door Stops and Holders

1. Basis of Design:
   a. Ives: WS407 FS439

2. Acceptable Alternate:
   a. Rockwood: 405/406 441H
   b. Hager: 236W 242F
   c. Trimco: 1270 W1211

3. Requirements:
   a. Provide stops and holders as indicated in the hardware sets.
   b. Where wall bumpers are scheduled, provide concave rubber bumper where the adjacent lever trim incorporates a push-button. Otherwise, provide convex rubber bumpers.

2.14 OVERHEAD STOPS AND HOLDERS

A. Acceptable Products:

1. Basis of Design:
   a. Glynn Johnson: 100 Series 90 Series

2. Acceptable Alternate
   a. Rixson-Firemark: 6 Series 9 Series
   b. ABH: 1000 Series 9000 Series
   c. Sargent: 100 Series 90 Series

B. Requirements:

1. Provide overhead stops and holders as scheduled, sized per manufacturer’s recommendations based on door width.
2. Provide concealed overhead stops with adjustable jamb bracket.
3. Where possible without conflicting with other hardware, mount surface overhead stops on least public side of door.
4. Provide stops with any special templates, brackets, plates, or other accessories required for interface with header, door, wall, and other hardware.

2.15 SADDLE AND PANIC THRESHOLDS

A. Acceptable Products:
1. Zero International: 655A
2. National Guard: 425HD
3. Pemko: 1715A

B. Requirements:
1. Saddle thresholds: Provide with length equal to the width of the opening.
2. Panic thresholds: Provide with length equal to the overall frame width. Provide with mitered and welded ends.
3. Provide stainless steel machine screws and lead anchors for each threshold.

2.16 WEATHERSTRIP AND GASKET

A. General:
1. Provide weather strip and gasketing as scheduled.
2. Size weather strip and gasket to provide a continuous seal around opening and at meeting stiles.

B. Perimeter Seals
1. Acceptable Products:
   a. Zero: 328A 111AA
   b. National Guard: 700SA 2525B
   c. Pemko: 2891AS PK33D

C. Astragals, Meeting Stiles, and Mullion Seals
1. Acceptable Products:
   a. Zero: 43S 8780N
   b. National Guard: 139A 5100
   c. Pemko: 357C 5100SB

2. Requirements
   a. Where overlapping astragals are scheduled on exterior doors, provide with thru-bolts.
   b. Where overlapping astragals are scheduled on out-swinging doors, provide for mounting on the pull-side of the active leaf. Otherwise, provide for mounting on the push-side of the inactive leaf.

D. Door Bottoms
1. Acceptable Products:
   a. Zero: 8198AA
2.17 MISCELLANEOUS HARDWARE

A. Silencers

1. Acceptable Products:

   a. Ives: SR64 SR65 SR66
   b. Rockwood: 608 609 608CA
   c. Hager: 307D 308D --
   d. Trimco: 1229A 1229B --

2. Requirements:

   a. Where indicated on single openings, provide 3 each rubber silencers on lock jamb.
   b. Where indicated on paired openings, provide 2 each rubber silencers on header.

2.18 ELECTRONIC ACCESSORIES

A. Keyswitches and Push Buttons

1. Basis of Design:

   a. Schlage Electronics: 653 Series

2. Acceptable Alternate:

   a. Securitron: MK Series

3. Requirements:

   a. Keyswitches: Provide single gang keyswitch with momentary/maintained switches as indicated in the sets. Provide with LED indicator lights as scheduled.

2.19 HIGH SECURITY EMERGENCY KEY BOX

A. Acceptable Products:

1. Knox, Inc. 3200 Series x RMK

B. Requirements:

1. Provide recess-mounted emergency key box as approved by the local fire jurisdiction. Key box to be master-keyed as dictated by local fire jurisdiction.
2.20 FINISHES

A. Match items to the manufacturer's standard color and texture finish for the latch and locksets (or push-pull units if no latch or locksets).

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.

C. The designations used in schedules and elsewhere to indicate hardware finishes are those listed in ANSI/BHMA A156.18, "Materials and Finishes," including coordination with the traditional U.S. finishes shown by certain manufacturers for their products.

D. The designations used in schedules and elsewhere to indicate hardware finishes are the industry-recognized standard commercial finishes, except as otherwise noted.

1. Brushed Chrome and/or Stainless Steel Appearance
   e. Weatherstrip and Gasket: Clear Anodized Aluminum finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

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

3.2 PREPARATION

A. Steel Doors and Frames: Comply with DHI A115 Series.

   1. Surface-Applied Door Hardware: Drill and tap doors and frames according to ANSI A250.6.

B. Wood Doors: Comply with DHI A115-W Series.

3.3 INSTALLATION
A. Pre-installation conference shall be conducted prior to installation of hardware at Project site. Meet with the, Owner, Contractor, installer, and manufacturer’s representatives. A separate pre-installation conference shall be conducted prior to the installation of electronic security hardware with the electrical contractor. Review catalogs, brochures, templates, installation instructions, and the approved hardware schedule. Survey installation procedures and workmanship, with special emphasis on unusual conditions, as to ensure correct technique of installation, and coordination with other work. Notify participants at least ten, 10 working days before conference.

B. Hardware installers must have a minimum of five (5) years’ experience in installation of hardware. Provide verification of installer’s qualification to Consultant for approval. All installers to attend review meetings with the hardware distributor.

C. Install hardware using only manufacturer supplied and approved fasteners in strict adherence with manufacturers published installation instructions.

D. Install head seal prior to installation of “PA”-parallel arm mounted door closers and push side mounted door stops/holders. Trim, cut and notch thresholds and saddles neatly to minimally fit the profile of the door frame. Install thresholds and saddles in a bed of caulking completely sealing the underside from water and air penetration.

E. Counter sink through bolt of door pull under push plate during installation.

F. Mounting Heights: Mount door hardware units at heights indicated, as follows, unless otherwise indicated or required to comply with governing regulations.

2. Custom Steel Doors and Frames: DHI’s “Recommended Locations for Builders’ Hardware for Custom Steel Doors and Frames.”

G. Install each door hardware item to comply with manufacturer’s written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

H. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 07 Section “Joint Sealants.”

3.4 FIELD QUALITY CONTROL

A. Architectural Hardware Consultant: Architect shall engage a qualified Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
B. Architectural Hardware Consultant shall inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.5 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Door Closers: Unless otherwise required by authorities having jurisdiction, adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door.

B. Occupancy Adjustment: Approximately six months after date of Substantial Completion, Installer’s Architectural Hardware Consultant shall examine and readjust, including adjusting operating forces, each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.6 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes. Refer to Division 01 Section “Demonstration and Training.”

3.8 DOOR HARDWARE SETS

A. The following schedule of hardware sets shall be considered a guide and the supplier is cautioned to refer to general conditions, special conditions, and the full requirements of this section. It shall be the hardware supplier’s responsibility to furnish all required hardware.

B. Where items of hardware are not definitely or correctly specified and are required for completion of the Work, a written statement of such omission, error, conflict, or other discrepancy shall be sent to the Architect, prior to date specified for receipt of bids, for clarification by addendum.
C. Adjustments to the Contract Sum will not be allowed for omissions or items of hardware not clarified prior to bid opening.

**HARDWARE GROUP NO. 01**  
**FOR USE ON MARK/DOOR #:**  
S101  S102  

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**DOOR HARDWARE**  
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END OF SECTION 087100
SECTION 088300 - MIRRORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following types of silvered flat glass mirrors:
   1. Annealed monolithic glass mirrors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Sustainable Design Submittals:
C. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachment details.
D. Samples: For each type of the following:
   1. Mirrors: 12 inches square, including edge treatment on two adjoining edges.

1.3 INFORMATIONAL SUBMITTALS

A. Preconstruction test report.
B. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For mirrors to include in maintenance manuals.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.
   1. Warranty Period: Five years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 SILVERED FLAT GLASS MIRRORS

A. Mirrors, General: ASTM C 150; manufactured using copper-free, low-lead mirror coating process.

B. Laminated Mirrors: ASTM C 1172, Type II.
   1. Glass for Outer Lite: Annealed float glass, Mirror ultraclear (low-iron)
   2. Nominal Thickness for Outer Lite: .25”.
   3. Glass for Inner Lite: Annealed float glass; ASTM C 1036, Type I (transparent flat glass), Quality-Q3; Class 1 (clear).
   4. Nominal Thickness: .25”
   5. Interlayer: 0.030-inch- thick, clear polyvinyl-butyral.

2.2 MIRROR HARDWARE

A. Stainless Steel J-Channels: Stainless Steel with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover edges of mirrors in a single piece.
   1. Bottom and Side Trim: J-channels formed with front leg and back leg not less than 3/8 and 7/8 inch in height, respectively, and a thickness of not less than 0.04 inch.
   2. Top Trim: J-channels formed with front leg and back leg not less than 5/8 and 1 inch in height, respectively, and a thickness of not less than 0.04 inch.

B. Mirror Shelf: Stainless Steel 4” depth x width of mirror, integral to frame at each location.

C. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.

2.3 FABRICATION

A. Fabricate cutouts for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts so they fit closely around penetrations in mirrors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, over which mirrors are to be mounted, with Installer present, for
compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 INSTALLATION

A. General: Install mirrors to comply with mirror manufacturer’s written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.

B. Clean exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Clean mirrors as recommended in writing by mirror manufacturer.

END OF SECTION 088300
SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Interior gypsum board.
   2. Fiber Reinforced gypsum board (at all locations below 8'-0" AFF)

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Samples: For each texture finish indicated on same backing indicated for Work.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 NON SAG EXTERIOR SOFFIT (INTERIOR APPLICATION) GYPSUM BOARD
A. Exterior Gypsum Soffit Board: ASTM C 1396/C 1396M, with manufacturer’s standard edges.
   1. Core: 5/8 inch (15.9 mm), Type X.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Gypsum.
      b. CertainTeed Corporation.
      c. Georgia-Pacific Building Products.
      e. USG Corporation – Basis of Design
4. Long Edges: Tapered and featured (rounded or beveled) for prefilling.

2.3 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.
   1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.
   2. Shapes:
      a. Cornerbead.
      b. Bullnose bead.
      c. LC-Bead: J-shaped; exposed long flange receives joint compound.
      d. L-Bead: L-shaped; exposed long flange receives joint compound.
      e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
      f. Expansion (control) joint.
      g. Curved-Edge Cornerbead: With notched or flexible flanges.

2.4 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.
B. Joint Tape:
   1. Interior Gypsum Board: Paper.
C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
   1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
   2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
      a. Use setting-type compound for installing paper-faced metal trim accessories.
   3. Fill Coat: For second coat, use setting-type, sandable topping compound.
   4. Finish Coat: For third coat, use setting-type, sandable topping compound.

2.5 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer’s written instructions.
B. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.

PART 3 - EXECUTION

3.1 APPLYING AND FINISHING PANELS

A. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

B. Comply with ASTM C 840.

C. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

D. For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

E. Prefill open joints, rounded or beveled edges, and damaged surface areas.

F. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

G. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:

   1. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.

      a. Primer and its application to surfaces are specified in Section "High Performance Coatings"

3.2 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

END OF SECTION 092900
SECTION 099113 - EXTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes surface preparation and the application of paint systems on exterior substrates.
      1. Steel and iron.
      2. Galvanized metal.
      3. Cement / Gypsum Board

1.2 DEFINITIONS
   A. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
   B. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product. Include preparation requirements and application instructions.
      1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
   B. Samples: For each type of paint system and each color and gloss of topcoat.

1.4 QUALITY ASSURANCE

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Manufacturers available to provide products include:
      1. PPG
      2. Sherwin Williams
      3. Benjamin Moore
   B. Products: Subject to compliance with requirements, provide one of the products listed in the Exterior Painting Schedule for the paint category indicated.
2.2 PAINT, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. Material Compatibility:
   1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

C. Colors: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   1. Gypsum / Cement Board: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Proceed with coating application only after unsatisfactory conditions have been corrected.
   1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.
3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Manual."

B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 CLEANING AND PROTECTION

A. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

B. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 EXTERIOR PAINTING SCHEDULE

A. Steel and Iron Substrates:
   1. Water-Based Light Industrial Coating System
      a. Prime Coat: Primer, alkyd, anti-corrosive for metal, MPI #79.
         1) Manufacturers include:
            i. Benjamin Moore Rust Scat Alkyd Metal Primer
            ii. PPG Paints Multiprime 4160
            iii. Sherwin Williams Kem Kromik Universal Primer
      b. Prime Coat: Shop primer specified in Section where substrate is specified.
      d. Topcoat: Light industrial coating, exterior, water based, semi-gloss MPI Gloss Level 5, MPI #163.
         1) Manufactures include:
            i. PPG Architectural Pitt-Tech Plus DTM Industrial Enamel.
            ii. Sherwin Williams All surface Enamel HP Semi-Gloss.

B. Galvanized-Metal Substrates:
   1. Latex System
      a. Prime Coat: Primer, galvanized, water based, MPI #101.
1) Sherwin Williams Dura-Plate 235 Multi-Purpose Epoxy


c. Topcoat: Latex, exterior, semi-gloss, MPI #108.

1) Sherwin Williams Macropoxy 646 Fast Cure Epoxy.

END OF SECTION 099113
SECTION 099600 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes surface preparation and the application of high-performance coating systems on the following substrates:
   1. Interior Substrates:
      a. Concrete masonry units (CMUs).
      b. Steel.
      c. Interior Applied Exterior Gypsum Soffit

1.2 DEFINITIONS
A. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
B. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product. Include preparation requirements and application instructions.
   1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.

B. Samples: For each type of coating system and in each color and gloss of topcoat indicated.

1.4 QUALITY ASSURANCE
A. Mockups: Apply mockups of each coating system indicated to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Architect will select one surface to represent surfaces and conditions for application of each coating system.
      a. Wall and Ceiling Surfaces: Provide samples of at least 36 sq. ft.
      b. Other Items: Architect will designate items or areas required.
   2. Final approval of color selections will be based on mockups.
a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Tnemec – Basis of Design
2. PPG Architectural Coatings.

2.2 HIGH-PERFORMANCE COATINGS, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
3. Products shall be of same manufacturer for each coat in a coating system.

C. Colors: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Fiber-Cement Board: 12 percent.
3. Masonry (Clay and CMUs): 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
D. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and coating systems indicated.

B. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.

3.3 APPLICATION

A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."

B. 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.

3.4 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE

A. Galvanized-Metal Substrates:

1. Epoxy System MPI EXT 5.3C:
   a. Prime Coat: Primer, epoxy, anti-corrosive, for metal, MPI #101.
   c. Topcoat: Epoxy, gloss, MPI #77.

3.5 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE

A. CMU Substrates:

1. Epoxy System MPI INT 4.2F:
   a. Block Filler: Block filler, epoxy, MPI #116.
   c. Topcoat: Two Component High Performance Institutional, gloss, MPI 255.
B. Steel Substrates:

1. Pigmented Polyurethane over Epoxy Zinc-Rich and Epoxy System MPI INT 5.1J:
   b. Intermediate Coat: Epoxy, gloss, MPI #77.
   c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6), MPI #72.

C. Gypsum Board Surfaces:

1. Polyurethane Two-Component over Primer System MPI INT 174:
   a. Prime Coat: Primer, epoxy, for gypsum board.
   c. Topcoat: Epoxy, gloss, MPI #174.

END OF SECTION 099600
SECTION 101473 - SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Field-lettered signs painted directly on substrates in good condition.
      2. Wall-identification signs for conduct requirements.

1.2 PREINSTALLATION MEETINGS
   A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Shop Drawings: For painted signs.
      1. Show sign locations and mounting heights.
      2. Show message list, typestyles, graphic elements, and layout for each sign at least half size.
   C. Samples: For each exposed product and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS
   A. Color Matching Certificate: For computer color matching of colors.

1.5 QUALITY ASSURANCE
   A. Mock-up: Provide a sample of the restroom signage and the shower room signage for acceptance.

PART 2 - PRODUCTS

2.1 SIGN-PAINT MANUFACTURERS
   A. Manufacturers include Fast Signs – Basis of Design, other manufacturers that meet criteria may be accepted.
2.2 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1.

2.3 SIGNS

A. Room-Identification and Conduct Signs: Sign applied directly on indicated substrate to identify fire and smoke assemblies, including preparatory treatment as required.

1. Sign Material: 1/8" brushed finish Aluminum Plate
2. Stenciled-on alkyd paint.
3. Font: Minimum 3 inches high characters in a contrasting color, with minimum wide strokes.
4. Text: as Indicated – Room Signage with number and title and symbols; Conduct signage to be 2’ x 3’ and contain rules for use in a minimum 1” high letter.
5. Braille: Include braille conforming to AHJ requirements for all signs except conduct signage.

2.4 MATERIALS

A. Sign Paints and Coatings: Paints that are recommended in writing by manufacturer for optimum adherence to substrate and are UV and water resistant for colors and exposure indicated.

1. Compatibility: Provide paint materials that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. Transition Coat: Paint manufacturer's recommended coating for use where a residual existing coating is incompatible with the paint system.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Install signs level, plumb, true to line, with uniform delineation and borders, and at locations and heights indicated.

C.

END OF SECTION 101473
SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Public-use washroom accessories.
   2. Public-use shower room accessories.
   3. Warm-air dryers.
   4. Childcare accessories.
   5. Underlavatory guards.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

A. Toilet Tissue (Roll) Dispenser:
   1. Manufacturer Basis of Design: ASI (Amrical Specialties) Model 0264-12 with vandal resistant hood Model 0267. Other manufacturers that may offer comparables include:
      a. Bradley
      b. Bobrick
2. Description: Double-roll dispenser- controlled delivery, theft resistant spindal with vandal resistant hood (stainless steel).
4. Capacity: Designed for up to 6” diameter tissue rolls.
5. Material and Finish: Stainless steel, No. 4 finish (satin).

B. Liquid-Soap Dispenser <Insert drawing designation>:
1. Manufacturer Basis of Design: ASI (Americal Specialties) Model 0374. Other manufacturers that offer comparables include:
   a. Bradley
   b. Bobrick
2. Description: Designed for dispensing soap in liquid form.
5. Materials: Stainless Steel with all purpose valve.
7. Refill Indicator: Window type.

C. Sanitary-Napkin Disposal Unit (at all Female and Gender Neutral water closets):
1. Manufacturer Basis of Design: ASI (Americal Specialties) Model 0473-A. Other manufacturers that offer comparables include:
   a. Bradley
   b. Bobrick
3. Door or Cover: Self-closing, disposal-opening cover.
5. Material and Finish: Stainless steel, No. 4 finish (satin).

D. Coat Hook: 2 each at all toilet and shower room locations.
1. Manufacturer BOD (Basis of Design) shall be ASI (American Specialties) Model # 7312. Other manufacturers offering comparable products include:
   a. Bradley
   b. Bobrick
2. Description: Single-prong unit.

2.3 PUBLIC-USE SHOWER ROOM ACCESSORIES

A. Shower Curtain Rod:
1. Manufacturer BOD (Basis of Design) shall be ASI (American Specialties). Other manufacturers offering comparable products include:
   a. Bradley
   b. Bobrick.
2. Description: 1-1/4-inch OD; fabricated from nominal 0.05-inch- thick stainless steel.
4. Finish: Stainless steel, No. 4 finish (satin).

B. Shower Curtain: at all shower locations:
1. Manufacturer Basis of Design shall be ASI (American Specialties) Model 1200 V42. Other manufacturers offering comparable products include:
   a. Bradley
   b. Bobrick.
2. Size: Minimum 6 inches wider than opening by 72 inches high.
3. Material: 0.008-inch thick vinyl, with integral antibacterial agent.
5. Grommets: Corrosion resistant at minimum 6 inches o.c. through top hem.
6. Shower Curtain Hooks: Chrome-plated or stainless-steel, spring wire curtain hooks with snap fasteners, sized to accommodate specified curtain rod. Provide one hook per curtain grommet.

2.4 WARM-AIR DRYERS

A. Warm-Air Dryer at all locations:
1. Manufacturer Basis of Design shall be World Dryer Hand Dryer A5-974 with swivel nozzle. Other manufacturers that may comparable products include:
   a. Excelerator
   b. Sani-Flow
2. Description: Standard-speed, warm-air hand dryer.
3. Mounting: Surface mounted, with low-profile design.
5. Cover Material and Finish: Cast Iron, with white enamel finish.

2.5 CHILDCARE ACCESSORIES

A. Diaper-Changing Station:
1. Manufacture Basis of Design shall be ASI (American Specialties) Model 9013-9. Other manufacturers offering comparable products include:
   a. Bradley
   b. Bobrick
   c. Koala
2. Description: Horizontal unit that opens by folding down from stored position and with child-protection strap.
   a. Engineered to support minimum of 250-lb static load when opened.
3. Mounting: Surface mounted, with unit projecting not more than 4 inches from wall when closed.
5. Material and Finish: Stainless steel, No. 4 finish (satin), exterior shell with rounded plastic corners; HDPE interior in manufacturer’s standard color.

2.6 UNDERLAVATORY GUARDS

A. Underlavatory Guard (at all lavatories):
   1. Manufacturer Basis of Design shall be ASI.
   2. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.

2.7 CUSTODIAL ACCESSORIES

A. Utility Shelf at all shower rooms and custodial area:
   1. Manufacturer Basis of Design Shall be ASI.
   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, No. 4 finish (satin).

B. Mop and Broom Holder:
   1. Manufacturer Basis of Design is American Specialties.
   2. Description: Unit with shelf, hooks and holders.
   3. Length: 36 inches.
   4. Hooks: Four
   5. Mop/Broom Holders: Three spring-loaded, rubber hat, cam type.
      a. Shelf: Not less than nominal 0.05-inch-thick stainless steel.

2.8 FABRICATION

A. 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

3.1 INSTALLATION

A. Install accessories according to 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.

END OF SECTION 102800
SECTION 102813.63 - DETENTION TOILET ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Safety hooks.
   2. Miscellaneous toilet accessories.

B. Related Requirements:
   1. Section 102800 "Toilet, Bath, and Laundry Accessories" for nondetention toilet accessories.

1.2 COORDINATION

A. Detention Specialist: Coordinate with Section 013513.16 "Special Project Procedures for Detention Facilities" for requirements of this Section that are to be performed by a Detention Specialist or other entity.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

C. Samples: For each detention toilet accessory indicated.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Location of each built-in anchor supporting detention toilet accessories, including anchors to be installed as work of other Sections, drawn to scale and coordinated with each other, using input from installers of the items involved.

B. Anchor inspection reports.

C. Field quality-control certification signed by Contractor.
1.6 CLOSEOUT SUBMITTALS
   A. Maintenance data.

1.7 WARRANTY
   A. Special Warranty: Manufacturer agrees to repair or replace detention toilet accessories that fail in materials or workmanship within specified warranty period.
      1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 DETENTION SAFETY HOOKS
   A. Individual, Curved, Detention Safety Hook: 0.188-inch nominal-thickness, stainless-steel curved hook held by 0.109-inch thick, stainless-steel bracket punched with not less than two holes for fastening with security fastener. Provide friction washer assembly, adjustable with a nonremovable security screw that maintains pressure on hook and allows hook to pivot when load exceeds preset limit indicated in Part 3.

   B. Materials:
      1. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666 or ASTM A 240/A 240M, austenitic stainless steel, Type 304.

   C. Stainless-Steel Finish:
      1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
      2. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.
         a. Run grain of directional finishes with long dimension of each piece.
         b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
         c. Directional Satin Finish: No. 4.

2.2 DETENTION GRAB BARS
   A. Grab Bars: 1-1/2 inches (38.1 mm) in diameter; formed from 0.038-inch- (0.95-mm-) thick, stainless-steel tubing, with 3-inch- (76.2-mm-) diameter flanges formed from 0.125-inch- (3.18-mm-) thick, stainless steel. Closure plates formed from 0.125-inch- (3.18-mm-) thick, stainless steel. All-welded construction.
      1. Length: As indicated on Drawings.

   B. Materials:
1. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666 or ASTM A 240/A 240M, austenitic stainless steel, Type 304.

2. Stainless-Steel Tubing: ASTM A 1016/A 1016M, austenitic stainless steel, Type 304, seamless.

C. Stainless-Steel Finish:

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

2. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.
   a. Run grain of directional finishes with long dimension of each piece.
   b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
   c. Directional Satin Finish: No. 4.

2.3 FABRICATION

A. Coordinate dimensions and attachment methods of detention toilet accessories with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.

B. Shear and punch metals cleanly and accurately. Remove burrs.

C. Form edges and corners to be free of sharp edges and rough areas. Fold back exposed edges of unsupported sheet metal to form a 1/2-inch-wide hem on the concealed side, or ease edges to a radius of approximately 1/32 inch and support with concealed stiffeners.

D. Form metal in maximum lengths to minimize joints. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Weld corners and seams continuously to comply with referenced AWS standard.

F. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure detention toilet accessories rigidly in place and to support expected loads.

G. Cut, reinforce, drill, and tap detention toilet accessories to receive hardware, security fasteners, and similar items.

H. Form exposed work true to line and level with accurate angles and surfaces. Grind off and ease edges unless otherwise indicated.

I. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.

2.4 SECURITY FASTENERS

A. Operable only by tools produced by fastener manufacturer or other licensed fabricator.
for use on specific type of fastener.

2.5 ACCESSORIES

A. Concealed Bolts: ASTM A 307, Grade A unless otherwise indicated.

B. Cast-in-Place Anchors in Concrete: Fabricated from corrosion-resistant materials capable of sustaining, without failure, a load equal to four times the load imposed, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified testing agency; of type indicated below:

1. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed; hot-dip galvanized according to ASTM A 153/A 153M or ASTM F 2329/F 2329M.

2.6 INSTALLATION

A. Inspect built-in and cast-in anchor installations before installing detention toilet accessories to verify that anchor installations comply with requirements. Prepare inspection reports.

B. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing detention toilet accessories to in-place construction. Include threaded fasteners for inserts, security fasteners, and other connectors.

C. Provide temporary bracing or anchors in formwork for items that are to be built into construction.

D. Security Fasteners: Install detention toilet accessories using security fasteners with head style appropriate for installation requirements, strength, and finish of adjacent materials. Provide stainless-steel security fasteners in stainless-steel materials.

E. Grab Bars: Install to withstand a downward load of not less than 250 lbf per ASTM F 446.

2.7 FIELD QUALITY CONTROL

A. Inspect installed products to verify compliance with requirements. Prepare inspection reports and indicate compliance with and deviations from the Contract Documents.

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SECTION 220500 - 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.

1.2 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Transition fittings.
   3. Dielectric fittings.
   4. Mechanical sleeve seals.
   5. Sleeves.
   7. Grout.
   8. Equipment installation requirements common to equipment sections.
   10. Concrete bases.
   11. Supports and anchorages.
   12. Link Seal

1.3 SEISMIC REQUIREMENTS

A. Seismic Performance: Equipment, pipe hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment.

   1. For components with a seismic importance factor of 1.0 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."

   2. For components with a seismic importance factor of 1.5 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
1.4 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, and crawlspaces.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms, accessible pipe shafts, accessible plumbing chases and accessible tunnels.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.
   4. Escutcheons.

B. Welding certificates.

1.6 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
1.7 DELIVERY, STORAGE, AND HANDLING

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

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

1.8 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.

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."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

2.4 TRANSITION FITTINGS

A. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

1. Manufacturers:
   b. Fernco, Inc.
   d. Plastic Oddities, Inc.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

1. Manufacturers:
   a. Capitol Manufacturing Co.
   b. Central Plastics Company.
   c. Eclipse, Inc.
   d. Epco Sales, Inc.
   g. Zurn Industries, Inc.; Wilkins Div.
D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

1. Manufacturers:
   a. Capitol Manufacturing Co.
   b. Central Plastics Company.
   c. Epco Sales, Inc.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:
   a. Calpico, Inc.
   b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:
   a. Perfection Corp.
   b. Precision Plumbing Products, Inc.
   c. Sioux Chief Manufacturing Co., Inc.
   d. Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:
a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Stainless steel. Include two for each sealing element.

4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

   1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Floor-Plate Type: Cast-iron floor plate.

D. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

2. Design Mix: 5000-psi, 28-day compressive strength.

2.10 LINK SEAL

A. Link-Seal® Modular Seal Pressure Plates

1. Link-Seal® modular seal pressure plates shall be molded of glass reinforced Nylon Polymer with the following properties:
   a. Izod Impact - Notched = 2.05ft-lb/in. per ASTM D-256
      Flexural Strength @ Yield = 30,750 psi per ASTM D-790
      Flexural Modulus = 1,124,000 psi per ASTM D-790
      Elongation Break = 11.07% per ASTM D-638
      Specific Gravity = 1.38 per ASTM D-792

2. Models LS200-275-300-315 shall incorporate the most current Link-Seal® Modular Seal design modifications and shall include an integrally molded compression assist boss on the top (bolt entry side) of the pressure plate, which permits increased compressive loading of the rubber sealing element. Models 315-325-340-400-425-475-500-525-600 shall incorporate an integral recess known as a “Hex Nut Interlock” designed to accommodate commercially available fasteners to insure proper thread engagement for the class and service of metal hardware. All pressure plates shall have a permanent identification of the manufacturer’s name molded into it.

3. For fire and Hi-Temp service, pressure plates shall be steel with 2-part Zinc Dichromate Coating.

4. Link-Seal® Modular Seal Hardware: All fasteners shall be sized according to latest Link-Seal® modular seal technical data. Bolts, flange hex nuts shall be: 316 Stainless Steel per ASTM F593-95, with a 85,000 psi average tensile strength.

PART 3 - EXECUTION

3.1 SEISMIC REQUIREMENTS

A. Comply with SEI/ASCE 7 and with requirements for seismic restraint devices in Section 220548 “Vibration and Seismic Controls for Plumbing Piping and Equipment.”

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
   c. Insulated Piping: One-piece, stamped-steel type with spring clips.
   d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
   e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
   f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

M. Sleeves are not required for core-drilled holes.

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
1. Cut sleeves to length for mounting flush with both surfaces.
   a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
   b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
   c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

   1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

   1. Install steel pipe for sleeves smaller than 6 inches in diameter.
   2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
   3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

   1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.


F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.6 PAINTING

A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

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

3.7 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. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGEs

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

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

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

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

3.10 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION
SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

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

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

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

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS
   A. Comply with requirements in this Section except when the requirements in plumbing equipment schedules, other specification sections, drawing notes or in other contract documents are more stringent.
   B. Comply with NEMA MG 1 unless otherwise indicated.
   C. Comply with IEEE 841 for severe-duty motors.

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

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Rotor: Random-wound, squirrel cage.

E. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

F. Temperature Rise: Match insulation rating.

G. Insulation: Class F. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors smaller than 15 HP: Manufacturer's standard starting characteristic.

H. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
5. Shaft Grounding Ring: Microfiber type.

a. Provide grounded discharge path for VFD induced voltage in the shaft to prevent arching in the motor bearings.
2.5 Electronically Commutated Motor (ECM)
   1. Motor enclosures: Open type
   2. Motor to be a DC electronic commutation type motor (ECM).
      a. AC induction type motors are not acceptable.
   3. Permanently lubricated motor with heavy duty ball bearing
   4. Internal motor circuitry to convert AC power supplied to the fan to DC power to
      operate the motor.
   5. Speed controllable to 20% of full speed (80% turndown).
      a. Potentiometer dial mounted at the motor speed controller
      b. 0-10 VDC signal.
   6. 85% efficient at all speeds minimum.
   7. Motors smaller than 2.0 hp.

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

PART 3 - EXECUTION (Not Applicable)

END OF SECTION
SECTION 220517 - 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. Sleeve-seal systems.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

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, Schedule 40, with plain ends and welded steel collar; zinc coated.
C. Galvanized-Steel-Pipe Sleeves: ASTM A 53, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
2.2 SLEEVE-SEAL SYSTEMS

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Link-Seal
4. Metraflex Company (The).
5. Pipeline Seal and Insulator, Inc.
6. 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: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 GROUT


B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
1. 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 Division 07 Section "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 Division 07 Section "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE 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.
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:


b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

5. Interior Partitions:


END OF SECTION
SECTION 220518 - 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.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated 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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to 2 inch (50mm), 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 with polished, chrome-plated finish.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type with chrome-plated finish.
d. Bare Piping 2 inch and Smaller at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
e. Bare Piping Larger than 2 inch at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type with polished, chrome-plated finish.
f. Bare Piping 2 inch and Smaller at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
g. Bare Piping Larger than 2 inch at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type with polished, chrome-plated finish.
h. Bare Piping 2 inch and Smaller in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated or rough-brass finish.
i. Bare Piping Larger than 2 inch in Unfinished Service Spaces: One-piece, stamped-steel type with polished, chrome-plated finish.
j. Bare Piping 2 inch and Smaller in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated or rough-brass finish.
k. Bare Piping in Equipment Rooms Larger than 2 inch: One-piece, stamped-steel type with chrome- or cadmium-plated finish.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION
SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Bimetallic-actuated thermometers.
      2. Liquid-in-glass thermometers.
      3. Thermowells.
      4. Dial-type pressure gages.
      5. Gage attachments.

1.2 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS
   A. Product certificates.

1.4 CLOSEOUT SUBMITTALS
   A. Operation and maintenance data.

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.
      8. REOTEMP Instrument Corporation.
     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.
15. Weksler


C. Case: Liquid-filled and sealed type(s); stainless steel with 5 inch nominal diameter.

D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F and deg C.

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: 0.25 or 0.375 inch in diameter; stainless steel.

H. Window: Plain glass or plastic.

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 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   a. Flo Fab Inc.
   b. Miljoco Corporation.
   d. Tel-Tru Manufacturing Company.
   e. Trerice, H. O. Co.
   f. Weiss Instruments, Inc.
   g. Winters Instruments - U.S.
   h. Weksler


3. Case: Cast aluminum 7-inch nominal size unless otherwise indicated.

4. Case Form: Adjustable angle unless otherwise indicated.

5. Tube: Glass with magnifying lens and blue or red organic liquid.

6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.

7. Window: Glass or plastic.

8. Stem: Aluminum and of length to suit installation.
a. Design for Thermowell Installation: Bare stem.

10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.3 THERMOWELLS

A. Thermowells:

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.
7. Internal Threads: 1/2, 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.

C. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.4 PRESSURE GAGES

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   a. AMETEK, 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.
2.5 GAGE ATTACH TEST PLUGS

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

1. Flow Design, Inc.
2. MG Piping Products Co.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Co.
6. Trerice, H. O. Co.
7. Weksler.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

D. Core Inserts: One or two self-sealing rubber valves.

1. Insert material for water service at 20 to 200 deg F shall be CR.
2. Insert material for water service at minus 30 to plus 275 deg F shall be EPDM.

E. Test Kit: Furnish one test kit(s) containing one pressure gage and adaptor, one thermometer, and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.

1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be 0 to 200 psig.
2. Low-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 125 deg F.
3. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.
4. Carrying case shall have formed instrument padding.

2.6 ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston porous-metal-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending a minimum of 2 inches into fluid one-third of pipe diameter to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gage for fluids.

H. 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. Inlet and outlet of each remote domestic water chiller.

I. Install pressure gages in the following locations:
   1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.

J. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

K. Adjust faces of meters and gages to proper angle for best visibility.

L. Install remote-mounting dial thermometers on panel, with tubing connecting panel and thermometer bulb supported to prevent kinds. Use minimum tubing length.

M. Install test plugs in tees in piping.

N. Install permanent indicator on walls or brackets in accessible and readable positions.

3.2 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:
   1. Liquid-filled Sealed, bimetallic-actuated type.
   2. Industrial-style, liquid-in-glass type.

B. Thermometers at inlets and outlets of each domestic water heat exchanger shall be one of the following:
   1. Liquid-filled Sealed, bimetallic-actuated type.
   2. Industrial-style, liquid-in-glass type.

C. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be one of the following:
   1. Liquid-filled Sealed, bimetallic-actuated type.
   2. Industrial-style, liquid-in-glass type.

D. Thermometer stems shall be of length to match thermowell insertion length.

3.3 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 150 deg F and minus 20 to plus 70 deg C.

B. Scale Range for Domestic Hot-Water Piping: 20 to 240 deg F and 0 to 150 deg C.

3.4 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each water service into building shall be one of the following:
   1. Liquid-filled Sealed Open-front, pressure-relief, direct-mounted, metal case.
B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:
   1. Liquid-filled Sealed Open-front, pressure-relief, direct mounted, metal case.

C. Pressure gages at suction and discharge of each domestic water pump shall be one of the following:
   1. Liquid-filled Sealed Open-front, pressure-relief, direct-mounted, metal case.

3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping 0 to 160 psi and 0 to 1100 kPa.

B. Scale Range for Domestic Water Piping: 0 to 160 psi and 0 to 1100 kPa.

END OF SECTION
SECTION 220523 - 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.
   4. Bronze lift check valves.
   5. Bronze swing check valves.
   7. Bronze globe valves.
   8. Iron globe valves.

B. Related Sections:
   1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
   2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
   3. Division 33 water distribution piping Sections for general-duty and specialty valves for site construction piping.

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

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

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   2. ASME B31.1 for power piping valves.
   3. ASME B31.9 for building services piping valves.

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 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 5 plug valves, for each size square plug-valve head.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE ANGLE VALVES

A. Class 125, 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.
   d. Ends: Threaded.
   e. Stem and Disc: Bronze.
   f. Packing: Asbestos free.
   g. Handwheel: Malleable iron, bronze, or aluminum.

2.3 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Description:

   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Bronze.
   i. Ball: Chrome-plated brass.
   j. Port: Full.

B. 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:

   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Hammond Valve.
   d. Lance Valves; a division of Advanced Thermal Systems, Inc.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Stainless steel.
   i. Ball: Stainless steel, vented.
   j. Port: Full.

C. Three-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. DynaQuip Controls.
   c. Hammond Valve.
   d. Milwaukee Valve Company.
   e. NIBCO INC.
   f. Red-White Valve Corporation.

2. Description:
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Three piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Bronze.
   i. Ball: Chrome-plated brass.
   j. Port: Full.

D. Three-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Hammond Valve.
   c. Milwaukee Valve Company.
   d. NIBCO INC.

2. Description:
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Three piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Stainless steel.
   i. Ball: Stainless steel, vented.
   j. Port: Full.

2.4 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
   b. Conbraco Industries, Inc.; Apollo Valves.
   c. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
   d. Crane Co.; Crane Valve Group; Jenkins Valves.
   e. Crane Co.; Crane Valve Group; Stockham Division.
   f. DeZurik Water Controls.
   g. Flo Fab Inc.
   h. Hammond Valve.
   i. Kitz Corporation.
   j. Legend Valve.
   k. Milwaukee Valve Company.
   l. NIBCO INC.
   m. Norriseal; a Dover Corporation company.
   n. Red-White Valve Corporation.
   o. Spence Strainers International; a division of CIRCOR International, Inc.
   p. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

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 126, cast iron or ASTM A 536, ductile iron.
   e. Seat: EPDM.
   f. Stem: One- or two-piece stainless steel.
   g. Disc: Aluminum bronze.

   B. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:

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

      a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
      b. American Valve, Inc.
      c. Conbraco Industries, Inc.; Apollo Valves.
      d. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
      e. Crane Co.; Crane Valve Group; Center Line.
      f. Crane Co.; Crane Valve Group; Stockham Division.
      g. DeZurik Water Controls.
      h. Flo Fab Inc.
      i. Hammond Valve.
      j. Kitz Corporation.
      k. Legend Valve.
      l. Milwaukee Valve Company.
      m. Mueller Steam Specialty; a division of SPX Corporation.
      n. NIBCO INC.
      o. Norriseal; a Dover Corporation company.
q. Sure Flow Equipment Inc.
r. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

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 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Nickel-plated or -coated ductile iron.

C. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the:

a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
b. American Valve, Inc.
c. Conbraco Industries, Inc.; Apollo Valves.
d. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
e. Crane Co.; Crane Valve Group; Jenkins Valves.
f. Crane Co.; Crane Valve Group; Stockham Division.
g. DeZurik Water Controls.
h. Flo Fab Inc.
i. Hammond Valve.
j. Kitz Corporation.
k. Legend Valve.
l. Milwaukee Valve Company.
m. Mueller Steam Specialty; a division of SPX Corporation.
n. NIBCO INC.
o. Norriseal; a Dover Corporation company.
q. Spence Strainers International; a division of CIRCOR International, Inc.
r. Sure Flow Equipment Inc.
s. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

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 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Stainless steel.
2.5 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Division.

2. Description:
   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 200 psig.
   e. Ends: Threaded.
   f. Disc: Bronze.

2.6 BRONZE SWING 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. American Valve, Inc.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
   d. Crane Co.; Crane Valve Group; Stockham Division.
   e. Hammond Valve.
   f. Kitz Corporation.
   g. Milwaukee Valve Company.
   h. NIBCO INC.
   i. Powell Valves.
   j. Red-White Valve Corporation.
   k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   l. Zy-Tech Global Industries, Inc.

2. Description:
   a. Standard: MSS SP-80, Type 3.
   b. CWP Rating: 200 psig.
   c. Body Design: Horizontal flow.
   e. Ends: Threaded.
   f. Disc: Bronze.

B. Class 150, Bronze Swing Check Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Valve, Inc.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
   d. Crane Co.; Crane Valve Group; Stockham Division.
   e. Kitz Corporation.
   f. Milwaukee Valve Company.
   g. NIBCO INC.
   h. Red-White Valve Corporation.
   i. Zy-Tech Global Industries, Inc.

2. Description:
   a. Standard: MSS SP-80, Type 3.
   b. CWP Rating: 300 psig.
   c. Body Design: Horizontal flow.
   e. Ends: Threaded.
   f. Disc: Bronze.

2.7 IRON SWING CHECK VALVES

A. 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 Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Division.
   d. Hammond Valve.
   e. Kitz Corporation.
   f. Legend Valve.
   g. Milwaukee Valve Company.
   h. NIBCO INC.
   i. Powell Valves.
   j. Red-White Valve Corporation.
   k. Sure Flow Equipment Inc.
   l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   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. Trim: Bronze.
g. Gasket: Asbestos free.

B. Class 250, Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Division.
   d. Hammond Valve.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   a. Standard: MSS SP-71, Type I.
   b. CWP Rating: 500 psig.
   c. Body Design: Clear or full waterway.
   d. Body Material: ASTM A 126, gray iron with bolted bonnet.
   e. Ends: Flanged.
   f. Trim: Bronze.
   g. Gasket: Asbestos free.

2.8 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Stockham Division.
   c. Hammond Valve.
   d. Kitz Corporation.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Powell Valves.
   h. Red-White Valve Corporation.
   i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   j. Zy-Tech Global Industries, Inc.

2. Description:
   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 200 psig.
   d. Ends: Threaded or solder joint.
   e. Stem and Disc: Bronze.
   f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

2.9 IRON GLOBE VALVES

A. Class 125, Iron Globe Valves:

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

   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Division.
   d. Hammond Valve.
   e. Kitz Corporation.
   f. Milwaukee Valve Company.
   g. NIBCO INC.
   h. Powell Valves.
   i. Red-White Valve Corporation.
   j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   k. 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: Bronze.
   f. Packing and Gasket: Asbestos free.

B. Class 250, Iron Globe Valves:

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

   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Division.
   d. Hammond Valve.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

   a. Standard: MSS SP-85, Type I.
   b. CWP Rating: 500 psig.
   c. Body Material: ASTM A 126, gray iron with bolted bonnet.
   d. Ends: Flanged.
   e. Trim: Bronze.
   f. Packing and Gasket: Asbestos free.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Lift Check Valves: With stem upright and plumb.

3.3 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: Ball or butterfly valves.
   3. Throttling Service Globe, angle, ball or butterfly valves.
4. Pump-Discharge Check Valves:
   a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
   b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or check valves.
   c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
   2. For Copper Tubing, 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 Steel Piping, NPS 2 and Smaller: Threaded ends.
   5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Bronze Angle Valves: Class 125 or Class 150, bronze disc.
   3. Ball Valves: One, Two or Three piece, full or, regular port, bronze with bronze or stainless-steel trim.
   4. Bronze Swing Check Valves: Class 125 or Class 150, bronze disc.
   5. Bronze Globe Valves: Class 125 or Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:
   1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
   2. Ball Valves: One, Two or Three piece, full or, regular port, bronze with bronze or stainless-steel trim.
   4. Iron Swing Check Valves: Class 125 or Class 250, metal seats.
   5. Iron Globe Valves: Class 125 or Class 250.

END OF SECTION
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 hangers and supports for plumbing 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. Pipe positioning systems.
8. Equipment supports.

B. Related Sections include the following:

1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-suppression piping.
3. Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

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 SEISMIC REQUIREMENTS

A. Component Importance Factor. All plumbing components shall be assigned a component importance factor. The component importance factor, $I_p$, shall be taken as 1.5 if any of the following conditions apply:
1. The component is required to function for life-safety purposes after an earthquake.
2. The component contains hazardous materials.
3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, $I_p$, equal to 1.0.

1.5 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. Seismic Performance: Plumbing equipment, hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment.

1. For components with a seismic importance factor of 1.0 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."

2. For components with a seismic importance factor of 1.5 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."

1.6 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Powder-actuated fastener systems.
4. Pipe positioning systems.
5. Mechanical Anchors: ICC-ES Evaluation Reports validating ‘Cracked Concrete’ testing per A.C. 193 must be provided for anchors resisting seismic loads and/or supporting life-safety systems including fire sprinkler systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers. Include Product Data for components.
2. Metal framing systems. Include Product Data for components.
3. Pipe stands. Include Product Data for components.
4. Equipment supports.

C. Welding certificates.

D. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Seismic calculations and detailed analysis: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices. Project specific design documentation and calculations shall be prepared and stamped by a registered professional engineer who is responsible for the seismic restraint design and who is licensed in the state where the project is being constructed (ASCE 7, 13.2.1.1).

1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel.", AWS D1.4, "Structural Welding Code--Reinforcing Steel." and ASME Boiler and Pressure Vessel Code: Section IX.

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
4. 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. Anvil International.
2. AAA Technology & Specialties Co., Inc.
5. Carpenter & Paterson, Inc.
6. Empire Industries, Inc.
7. ERICO/Michigan Hanger Co.
8. FNW/Ferguson Enterprises
10. Grinnell Corp.
11. GS Metals Corp.
13. PHD Manufacturing, Inc.
14. PHS Industries, Inc.
15. Piping Technology & Products, Inc.
16. Tolco Inc.
17. Simpson Strong-Tie Co.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

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

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

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

2.4 METAL FRAMING SYSTEMS

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

B. Manufacturers:

1. Anvil International.
2. B-Line Systems, Inc.; a division of Cooper Industries.
3. ERICO/Michigan Hanger Co.; ERISTRUT Div.
4. FNW/Ferguson Enterprises
5. GS Metals Corp.
6. Hilti, Inc.
8. Thomas & Betts Corporation.
9. Tolco Inc.
10. 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 SHIELD INSERTS

A. Description: 100-psig- 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 533, Type I calcium silicate with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:

   a. Hilti, Inc.
b. MKT Fastening, LLC.
c. Powers Fasteners.
d. Simpson Strong-Tie Co.

B. Mechanical-Expansion Anchors and Concrete Screws: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used. For anchors resisting seismic loads and/or supporting life-safety systems including fire sprinkler systems, Anchors shall have been tested for ‘Cracked Concrete’ per A.C. 193 per a valid ICC-ES Evaluation Report. Manufacturers with these anchors have been designated below with: ‘*’

1. Manufacturers:
   b. Empire Industries, Inc.
   c. Hilti, Inc.
   d. ITW Ramset/Red Head.
   e. MKT Fastening, LLC.
   f. Powers Fasteners.
   g. Simpson Strong-Tie Co. *

2.7 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

1. Manufacturers:
   a. Anvil International.
   b. ERICO/Michigan Hanger Co.
   c. MIRO Industries.
   d. Unipure

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

1. Manufacturers:
   a. MIRO Industries.

D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

1. Manufacturers:
   a. Anvil International.
b. ERICO/Michigan Hanger Co.
c. MIRO Industries.
d. Portable Pipe Hangers.

3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

1. Manufacturers:
   a. Anvil International.
   b. Portable Pipe Hangers.

2. Bases: One or more plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

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

2.8 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

B. Manufacturers:
   2. HOLDRITE Corp.; Hubbard Enterprises.
   3. Samco Stamping, Inc.

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, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
   4. 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 2.
  10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
11. Extension Hinged or 2-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.
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 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 2 rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, 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.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

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 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.

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 or Simpson Blue Banger Concrete insert with UL & FM approvals): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Light (MSS Type 31): 750 lb.
   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.

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.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.

4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.

5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.

6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.

8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
   
   a. Horizontal (MSS Type 54): Mounted horizontally.
   b. Vertical (MSS Type 55): Mounted vertically.
   c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

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

O. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

A. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. 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.

C. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

F. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Powder actuated fasteners shall not be used for seismic bracing attachments.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. For anchors resisting seismic loads and/or supporting life-safety systems including fire sprinkler systems, anchors shall have been tested for ‘Cracked Concrete’ per A.C. 193 and shall have a valid ICC-ES Evaluation Report.

G. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.

H. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.

I. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.


K. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

L. Install lateral bracing with pipe hangers and supports to prevent swaying.
M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

N. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

P. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits according to ASME B31.9 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 inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports. For applications where seismic bracing is required, ‘Cracked Concrete’ expansion anchors or concrete screws tested per A.C. 193 must be provided for seismic bracing anchorage where post-installed anchors are required.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

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

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

3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION
SECTION 220548 - VIBRATION AND SEISMIC CONTROLS 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. This Section includes the following restraints and vibration isolation as defined in Section 230548 “Vibration Isolation and Seismic Controls for HVAC” for the following:

1. Plumbing Piping.
2. Plumbing Equipment.

PART 2 - PRODUCTS

2.1 (NOT USED)

PART 3 - EXECUTION

3.1 (NOT USED)

END OF SECTION
SECTION 220553 - 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. Product Data: For each type of product indicated.
   B. Samples: For color, letter style, and graphic representation required for each identification material and device.
   C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
   D. Valve numbering scheme.
   E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION
   A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
   B. Coordinate installation of identifying devices with locations of access panels and doors.
   C. Install identifying devices before installing acoustical ceilings and similar concealment.
PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

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

B. 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.

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

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

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, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
   3. Identification Paint: Exterior, alkyd 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 minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link or beaded chain; or S-hook.
B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch 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."

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, on each piping system.

1. Identification Paint: Use for contrasting background.

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 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

D. Pipe Label Color Schedule:

1. Low-Pressure, Compressed-Air Piping:

2. Medium-Pressure, Compressed-Air Piping:

3. Domestic Water Piping:

4. Sanitary Waste and Storm Drainage Piping:

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:
   c. Low-Pressure Compressed Air: 1-1/2 inches, round.
   d. High-Pressure Compressed Air: 1-1/2 inches, round.
2. Valve-Tag Color:
   c. Low-Pressure Compressed Air: Comply with ASME A13.1.
   d. High-Pressure Compressed Air: Comply with ASME A13.1.

3. Letter Color:
   c. Low-Pressure Compressed Air: Comply with ASME A13.1.
   d. High-Pressure Compressed Air: Comply with ASME A13.1.

3.5 WARNING-TAG INSTALLATION
   A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION
SECTION 220719 - 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. Roof drains and rainwater leaders.
5. Supplies and drains for handicap-accessible lavatories and sinks.

B. Related Sections:

1. Section 220716 "Plumbing Equipment Insulation."

1.3 DEFINITIONS:

A. Refer to Section 220500 “Common Work Results for Plumbing”.

1.4 ACTION SUBMITTALS

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

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.
1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.7 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.

1.8 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 “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.

1.9 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


B. Insulation for below-ambient service requires a vapor-barrier.

C. Products shall not contain asbestos, lead, mercury, or mercury compounds.

D. 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.

E. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

F. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Aeroflex USA, Inc.; Aerocel.
   b. Armacell LLC; AP Armaflex.
   c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553:

1. Type II and ASTM C 1290, Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; SoftTouch Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Friendly Feel Duct Wrap.
   d. Manson Insulation Inc.; Alley Wrap.
   e. Owens Corning; SOFTR All-Service Duct Wrap.

I. 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; 1000-Degree Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A,
a. Without factory-applied jacket with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

J. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.2 INSULATING CEMENTS


1. Products: Subject to compliance with requirements, provide the following:
   a. Ramco Insulation, Inc.; Super-Stik.


1. Products: Subject to compliance with requirements, provide the following:
   a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

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 Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Aeroflex USA, Inc.; Aeroseal.
   b. Armacell LLC; Armaflex 520 Adhesive.
   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).

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:
b. Eagle Bridges - Marathon Industries; 225.
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).


1. Products: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges - Marathon Industries; 225.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Corning Corporation; 739, Dow Silicone.
   d. Speedline Corporation; Polyco VP Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 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: Water based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
   b. Vimasco Corporation; 749.
2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges - Marathon Industries; 501.
   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 deg F.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges - Marathon Industries; 570.

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 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges - Marathon Industries; 550.
   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 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.

2.5 SEALANTS

A. ASJ Flashing Sealants, and PVC Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide the following:
   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.
   6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 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-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

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, provide one of the following:
      a. Johns Manville; Zeston.
      c. Proto Corporation; LoSmoke.
      d. Speedline Corporation; SmokeSafe.
   2. Adhesive: As recommended by jacket material manufacturer.
   3. Color: Color-code jackets based on system.
      a. 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.

C. Metal Jacket:

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

   b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
   c. RPR Products, Inc.; Insul-Mate.


   a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper. [3-mil- thick, heat-bonded polyethylene and kraft paper] [2.5-mil- thick polysurlyn].
   d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper. [2.5-mil- thick polysurlyn].
   e. Factory-Fabricated Fitting Covers:

      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.8 TAPES

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

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

      a. ABI, Ideal Tape Division; 428 AWF ASJ.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
      c. Compac Corporation; 104 and 105.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

   2. Width: 3 inches.
   3. Thickness: 11.5 mils.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. ABI, Ideal Tape Division; 370 White PVC tape.
   b. Compac Corporation; 130.
   c. Venture Tape; 1506 CW NS.

2. Width: 2 inches.
3. Thickness: 6 mils.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. ABI, Ideal Tape Division; 488 AWF.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   c. Compac Corporation; 120.
   d. Venture Tape; 3520 CW.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.9 SECUREMENTS

A. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

2.10 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
   a. Engineered Brass Company.
   b. Insul-Tect Products Co.; a subsidiary of MVG Molded Products.
   c. McGuire Manufacturing.
   d. Plumberex.
   e. Truebro; a brand of IPS Corporation.
   f. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures:

1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
   a. Truebro; a brand of IPS Corporation.
   b. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.

2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

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. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of 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:
      a. 2 inches o.c.
      b. 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.

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, 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 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. Insulation shall have a k value that meets the minimum requirements of the latest International Energy Conservation Code (IECC).

C. 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.

3.10 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:
   1. NPS 1-1/2 and Smaller: Insulation shall be one of the following;
      a. Flexible Elastomeric:
         1) 1 inch thick
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I:
         1) 1 inch thick
   2. NPS 2 and Larger: Insulation shall be one of the following:
      a. Flexible Elastomeric:
1) 1-1/2 inches thick.
   b. Mineral-Fiber, Preformed Pipe Insulation:
      1) 1-1/2 inches thick.

B. Domestic Hot and Recirculated Hot Water:
   1. NPS 1-1/2 and Smaller: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I:
         1) 1 inch thick.

   2. NPS 2 and Larger: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I:
         1) 1-1/2 inches 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. Storm Water and Overflow:
   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.

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, Blanket Insulation, Type I: 1 inch thick.
      c. Drain Manufacturer’s Pre-formed bowl Insulation: 1 inch thick.

F. Sanitary Waste Piping Where Heat Tracing Is Installed:
   1. All Pipe Sizes: Insulation shall be 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 Deg F:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric:
         1) 3/4 inch thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I:
1) 3/4 inch thick.

H. Hot Service Drains:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch thick.

I. Hot Service Vents:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch thick.

3.11 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping:
   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. Domestic Hot and Recirculated Hot Water:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

C. 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.

D. Hot Service Drains:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

E. Hot Service Vents:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type II: 1 inch thick.

3.12 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:
      a. White: 30 mils thick

3.13 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. None.

D. Piping, Exposed:
   1. Aluminum, Stucco Embossed: 0.016 inch thick.

3.14 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET
A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION
SECTION 221116 - 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. Division 22 Section "Facility Water Distribution Piping" for water-service piping outside the building from source to the point where water-service piping enters the building.

C. Additional Comments:

1. Victaulic couplings, fittings, and valves may be used in the domestic hot & cold water piping that is 2" or greater in diameter.

1.3 SEISMIC REQUIREMENTS

A. Seismic Performance: Pipe hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 230548 "Vibration and Seismic Controls for HVAC."

1. For piping with a seismic importance factor of 1.0 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."

2. For piping with a seismic importance factor of 1.5 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."

1.4 ACTION SUBMITTALS

A. Product Data: For transition fittings and dielectric fittings.
B. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.

1.5 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.
B. Field quality-control reports.

1.6 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 Construction Manager or owner no fewer than two days in advance of proposed interruption of water service.

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."
C. All piping shall be American made and tested; no import pipe will be permitted.
D. All exposed water supply piping in toilet rooms, custodial rooms and kitchens shall be chromium plated.
E. All piping installed in or passing through a plenum must be plenum rated, fire wrapped, or installed in a metal conduit.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, drawn temper.
B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.


E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

F. Copper Unions:
   1. MSS SP-123.
   4. Solder-joint or threaded ends.

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.


2.4 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.

2.5 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, provide products by one of 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, provide products by one of the following:
      b. Harvel Plastics, Inc.
      c. Spears Manufacturing Company.

2. Description:

   a. CPVC or PVC 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, provide products by one of the following:
      a. Colonial Engineering, Inc.
      b. NIBCO Inc.
2. Description:
   a. CPVC four-part union.
   b. Brass threaded end.
   c. Solvent-cement-joint plastic end.
   d. Rubber O-ring.
   e. Union nut.

2.6 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 Nipples and Waterways:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Elster Perfection Corporation.
      b. Grinnell Mechanical Products; Tyco Fire Products LP.
      c. Matco-Norca.
      d. Clearflow/Perfection Corp.
      e. Precision Plumbing Products, Inc.
      f. Victaulic Company.
   3. Electroplated steel nipple or waterway complying with ASTM F 1545 or ANSI/NSF-61 Compliant.
   4. Pressure Rating and Temperature: 300 psig at 225 deg F.
   5. End Connections: Male threaded or grooved.
   6. Lining: Inert and noncorrosive, propylene or LTHS.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Division 31 Section "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. Polypropylene pipe in or passing through plenums must be fire wrapped or installed in a metal conduit.

C. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

D. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

E. Install underground copper tube in PE encasement according to ASTM A674 or AWWA C105/A21.5.

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 Division 22 Section "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Division 22 Section "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 Division 22 Section "Domestic Water Piping Specialties."

I. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.
   1. Piping will be drained seasonally for freeze protection.

J. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

K. Install seismic restraints on piping. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices in Division 22 Section "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 unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

T. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Division 22 Section "Meters and Gages for Plumbing Piping."

U. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Division 22 Section "Domestic Water Pumps."

V. Install thermometers on inlet piping from each water heater. Comply with requirements for thermometers in Division 22 Section "Meters and Gages for Plumbing Piping."

W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

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. 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.

G. 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 fittings.

3.5 DIELECTRIC FITTING INSTALLATION
A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples/waterways.
C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric nipples/waterways.
D. Dielectric Fittings for NPS 5 and Larger: Use dielectric nipples/waterways.

3.6 HANGER AND SUPPORT INSTALLATION
A. Comply with requirements for seismic-restraint devices in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
B. Comply with requirements for pipe hanger, support products, and installation in Division 22 Section "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 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 piping every 15 feet.

I. 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. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code. Comply with requirements for connection sizes in Division 22 plumbing fixture Sections.
3. 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 Division 22 Section "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.
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. Some piping types and sizes mentioned in this section may not be used on this project.

B. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

C. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

D. All exposed water supply piping in toilet rooms, custodial rooms and kitchens shall be chromium plated.

E. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be the following:
   1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed-joints.

F. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be one of the following:
   1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
   2. Mechanical-joint, ductile-iron pipe; standard, mechanical-joint fittings; and mechanical joints.
G. Under-building-slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12, shall be the following:

1. Mechanical-joint, ductile-iron pipe; standard, mechanical-joint fittings; and mechanical joints.

H. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be the following:

1. Hard copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.

I. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:

1. Hard copper tube, ASTM B 88, Type L; cast-copper, solder-joint fittings; and soldered joints.

J. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be the following:

1. Hard copper tube, ASTM B 88, Type L; cast-copper, solder-joint fittings; and soldered joints.

K. Aboveground domestic water piping, NPS 5 and larger, shall be the following:

1. Hard copper tube, ASTM B 88, Type L; cast-copper, solder-joint fittings; and soldered 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 for piping NPS 3 and smaller. Use butterfly or ball, with flanged ends for piping NPS 4 and larger.
2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION
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 domestic water piping specialties:

1. Vacuum breakers.
2. Backflow preventers.
5. Temperature-actuated water mixing valves.
7. Outlet boxes.
8. Hose bibbs.
9. Wall hydrants.
10. Drain valves.

B. Related Sections include the following:

1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Division 22 Section "Emergency Plumbing Fixtures" for water tempering equipment.
3. Division 22 Section "Drinking Fountains and Water Coolers" for water filters for water coolers.

1.3 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.4 SUBMITTALS

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

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.
D. Operation and Maintenance Data: For domestic water piping specialties 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. NSF Compliance:

2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ames Co.
   b. Cash Acme.
   c. Conbraco Industries, Inc.
   d. FEBCO; SPX Valves & Controls.
   e. Rain Bird Corporation.
   f. Toro Company (The); Irrigation Div.
   g. Watts Industries, Inc.; Water Products Div.
   h. Zurn Plumbing Products Group; Wilkins Div.
3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Chrome plated.

B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Arrowhead Brass Products, Inc.
   b. Cash Acme.
   c. Conbraco Industries, Inc.
   d. Legend Valve.
5. Finish: Chrome or nickel plated.

2.2 WATER PRESSURE-REDUCING VALVES

A. Water Regulators: (Direct Type)

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cash Acme.
   b. Conbraco Industries, Inc.
   c. Honeywell Water Controls.
   e. Zurn Plumbing Products Group; Wilkins Div.

4. Body: Bronze, provide chrome-plated finish if connected to chrome plated or stainless steel piping for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.3 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Flo Fab Inc.
   c. ITT Industries; Bell & Gossett Div.
   d. NIBCO INC.
   e. TAC Americas.
   f. Taco, Inc.
   g. Victaulic
   h. Watts Industries, Inc.; Water Products Div.
2. **Type**: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
3. **Body**: bronze,
4. **Size**: Same as connected piping, but not larger than NPS 2.
5. **Accessories**: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

### 2.4 TEMPERATURE-ACTUATED WATER MIXING VALVES

#### A. Water-Temperature Limiting Devices:

1. **Manufacturers**: Subject to compliance with requirements, provide products by one of the following:
   b. Cash Acme.
   c. Conbraco Industries, Inc.
   d. Honeywell Water Controls.
   e. Legend Valve.
   f. Leonard Valve Company.
   g. Powers; a Watts Industries Co.
   h. Symmons Industries, Inc.
   i. Taco, Inc.
   k. Zurn Plumbing Products Group; Wilkins Div.

2. **Standard**: ASSE 1017.
3. **Pressure Rating**: 125 psig.
4. **Type**: Thermostatically controlled water mixing valve.
5. **Material**: Bronze body with corrosion-resistant interior components.
6. **Connections**: Threaded union inlets and outlet.
7. **Accessories**: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. **Valve Finish**: Rough bronze.

#### B. Primary, Thermostatic, Water Mixing Valves:

1. **Manufacturers**: Subject to compliance with requirements, provide products by one of the following:
   b. Lawler Manufacturing Company, Inc.
   c. Leonard Valve Company.
   d. Powers; a Watts Industries Co.
   e. Symmons Industries, Inc.

2. **Standard**: ASSE 1017.
3. **Pressure Rating**: 125 psig.
4. **Type**: Exposed-mounting, thermostatically controlled water mixing valve.
5. **Material**: Bronze body with corrosion-resistant interior components.
6. **Connections**: Threaded union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.

C. Individual-Fixture, Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cash Acme.
   b. Conbraco Industries, Inc.
   c. Honeywell Water Controls.
   d. Lawler Manufacturing Company, Inc.
   e. Leonard Valve Company.
   f. Powers; a Watts Industries Co.
   g. Watts Industries, Inc.; Water Products Div.
   h. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1070, thermostatically controlled water tempering valve.
3. Pressure Rating: 125 psig minimum, unless otherwise indicated.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.

2.5 STRainers FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
   a. Strainers NPS 2 and Smaller: 0.020 inch.
   b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
   c. Strainers NPS 5 and Larger: 0.10 inch.

2.6 HOSE BIBBS

A. Hose Bibbs:

4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
7. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.7 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. MIFAB, Inc.
   c. Prier Products, Inc.
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products Inc.
   g. Woodford Manufacturing Company.
   h. Zurn Plumbing Products Group; Light Commercial Operation.
   i. Zurn Plumbing Products Group; Specification Drainage Operation.

4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounting with cover.
10. Operating Keys: Two with each wall hydrant.

2.8 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:
2. Pressure Rating: 400-psig minimum CWP.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
8. Inlet: Threaded or solder joint.

2.9 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AMTROL, Inc.
   b. Josam Company.
   c. MIFAB, Inc.
   d. PPP Inc.
   e. Sioux Chief Manufacturing Company, Inc.
   g. Tyler Pipe; Wade Div.
   h. Watts Drainage Products Inc.
   i. Zurn Plumbing Products Group; Specification Drainage Operation.

3. Type: Metal bellows or Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install water control valves with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.

C. Install balancing valves in locations where they can easily be adjusted.

D. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
   1. Install thermometers and water regulators if specified.
   2. Install cabinet-type units recessed in or surface mounted on wall as specified.

E. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.
F. Install water hammer arresters in water piping according to PDI-WH 201.

3.2 CONNECTIONS
A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

3.3 LABELING AND IDENTIFYING
A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
   1. Water pressure-reducing valves.
   2. Calibrated balancing valves.
   3. Primary, thermostatic, water mixing valves.
   4. Primary water tempering valves.
   5. Outlet boxes.
   7. Trap-seal primer systems.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL
A. Perform the following tests and prepare test reports:
   1. Test each backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING
A. Set field-adjustable pressure set points of water pressure-reducing valves.
B. Set field-adjustable flow set points of balancing valves.
C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 221119
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.

1.3 DEFINITIONS
   A. EPDM:  Ethylene-propylene-diene terpolymer rubber.
   B. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS
   A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
   B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 230548 "Vibration and Seismic Controls for HVAC."
      1. For piping with a seismic importance factor of 1.0 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."
      2. For piping with a seismic importance factor of 1.5 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 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.
1.6 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.


1.8 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 Construction Manager no fewer than two days in advance of proposed interruption of sanitary waste service.

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 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: All cast-iron waste, vent and sewer pipe and fittings shall conform to the requirements of CISPI Standard 301 and ASTM A 888. All products shall be marked with the collective trademark of the Cast Soil Pipe Institute and shall be listed by NSF International or receive prior approval of the engineer. All cast-iron pipe and fittings shall be American made and tested. Non-compliant import cast-iron products will not be permitted. Any non-compliant cast-iron product installed by the contractor on this project will be replaced at the contractor’s expense and shall include all repairs,
patching, painting and other incidental work required to return the project to its pre-remediation state.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AB&I Foundry
   b. Charoltte Pipe
   c. Tyler Pipe

B. CISPI, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ANACO.
   b. Ideal
   c. Mission Rubber Company; a division of MCP Industries, Inc.
   d. Tyler Pipe.

3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
4. Listing: Couplings shall be listed by NSF International. Each coupling shall be embossed with the NSF seal.

C. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Husky SD 4000.
   b. Clamp-All Corp HI-TORQ 125.

3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

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).

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 Section "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 SEI/ASCE 7 and with requirements for seismic-restraint devices specified in Division 22 Section "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 long-turn, double Y-branch and 1/8-bend fittings if two
fixtures are installed back to back or side by side with common 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 soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

N. 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.

O. Install underground PVC piping according to ASTM D 2321.

P. Install engineered soil and waste drainage and vent piping systems as follows:


Q. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary 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 Division 22 Section "Sanitary Waste Piping Specialties."
2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Sanitary Waste Piping Specialties."
3. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. 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.

B. 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.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "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 and coupling or 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 soil 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 soil piping every 15 feet.

H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 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. Comply with requirements for cleanouts and drains specified in Division 22 Section "Sanitary Waste Piping Specialties."
   6. 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. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make fixture and equipment 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.

3.6 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.7 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.
3.8 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.

3.9 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 3 and smaller shall be the following:
   1. Hubless, cast-iron soil pipe and fittings CISPI hubless-piping couplings; and coupled joints.

C. Aboveground, soil and waste piping NPS 4 and larger shall be the following:
   1. Hubless, cast-iron soil pipe and fittings heavy-duty hubless-piping couplings; and coupled joints.

D. Aboveground, vent piping NPS 3 and smaller shall be the following:
   1. Hubless, cast-iron soil pipe and fittings CISPI hubless-piping couplings; and coupled joints.

E. Aboveground, vent piping NPS 4 and larger shall be the following:
   1. Hubless, cast-iron soil pipe and fittings CISPI hubless-piping couplings; and coupled joints.

F. Underground, soil, waste, and vent piping NPS 3 and smaller shall be any of the following:
   1. Hubless, cast-iron soil pipe and fittings CISPI hubless-piping couplings; and coupled joints.
   2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

G. Underground, soil and waste piping NPS 4 and larger shall be the following:
   1. Hubless, cast-iron soil pipe and fittings heavy-duty hubless-piping couplings; and coupled joints.
   2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

END OF SECTION
SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

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 sanitary drainage piping specialties:

1. Cleanouts.
2. Floor drains.
3. Roof flashing assemblies.
4. Through-penetration firestop assemblies.
5. Miscellaneous sanitary drainage piping specialties.
6. Flashing materials.

B. Related Sections include the following:

1. Division 22 Section "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.

1.3 DEFINITIONS

A. FOG: Fats, oils, and greases.
B. FRP: Fiberglass-reinforced plastic.
C. HDPE: High-density polyethylene plastic.
D. PE: Polyethylene plastic.
E. PP: Polypropylene plastic.
F. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.
1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing 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.


1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. MIFAB, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.

3. Size: Same as connected drainage piping.

4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.

5. Closure: Countersunk, brass plug.

6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.


B. Metal Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
b. Oatey.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Light Commercial Operation.
g. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M for adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Adjustable housing.
5. Body or Ferrule: Cast iron.
7. Outlet Connection: Inside calk.
8. Closure: Brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Heavy Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
15. Size: Same as connected branch.
17. Closure: Stainless steel with seal.
18. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:

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

   b. MIFAB, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
5. Closure: Countersunk, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
2.2  FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: See Schedule at end of this Section:
   b. MIFAB, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.

5. Seepage Flange: Required.
6. Anchor Flange: Not required.
7. Outlet: Bottom.
8. Trap Material: Cast iron.
10. Trap Features: Trap-seal primer valve drain connection.

2.3  MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
   a. NPS 2: 4-inch minimum water seal.
   b. NPS 2-1/2 and Larger: 5-inch minimum water seal.

B. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

C. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.
2.4 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
   1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
   2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.


C. Fasteners: Metal compatible with material and substrate being fastened.

D. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

C. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

D. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
   4. Locate at base of each vertical soil and waste stack.

E. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

F. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
G. 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.

H. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

I. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

J. Install wood-blocking reinforcement for wall-mounting-type specialties.

K. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

L. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
   1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
C. Set flashing on floors and roofs in solid coating of bituminous cement.
D. Secure flashing into sleeve and specialty clamping ring or device.
E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."
F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 FIELD QUALITY CONTROL
A. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled grease removal devices and their installation, including piping and electrical 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. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 PROTECTION
A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION
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, electric, storage, domestic-water heaters.
   2. Thermostat-control, electric, tankless, domestic-water heaters.
   3. Domestic-water heater accessories.

1.3 SEISMIC REQUIREMENTS

A. Component Importance Factor: All plumbing components shall be assigned a component importance factor. The component importance factor, \(I_p\), shall be taken as 1.5 if any of the following conditions apply:

   1. The component is required to function for life-safety purposes after an earthquake.
   2. The component contains hazardous materials.
   3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, \(I_p\), equal to 1.0.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Plumbing equipment, hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment.

   1. For components with a seismic importance factor of 1.0 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."

   2. For components with a seismic importance factor of 1.5 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
1.5 ACTION 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. Shop Drawings:
   1. Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Manufacturer Seismic Qualification Certification: Submit certification that plumbing equipment and components will withstand seismic forces defined in Division 22 Section "Mechanical Vibration and Seismic Controls." Include the following:
   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.

B. Product Certificates: For each type of commercial, electric, domestic-water heater, from manufacturer.

C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

D. Source quality-control reports.

E. Field quality-control reports.

F. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric, domestic-water heaters to include in emergency, operation, and maintenance manuals.

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. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
C. ASME Compliance: 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.

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."

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, 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. Commercial, Electric, Storage, Domestic-Water Heaters:
      1) Storage Tank: Five years.
      2) Controls and Other Components: Three years.

   b. Electric, Tankless, Domestic-Water Heaters: Five year(s).

   c. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, ELECTRIC, domestic-WATER HEATERS

A. Commercial, Electric, Storage, Domestic-Water Heaters:

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

   c. Lochinvar Corporation.
   d. PVI Industries, LLC.
   e. RECO USA.
   f. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
g. State Industries.

   a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
      1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
      2) 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.
   b. Pressure Rating: 150 psig.
   c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
   d. Lining: Glass.
4. Factory-Installed Storage-Tank Appurtenances:
   a. Anode Rod: Replaceable magnesium.
   b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
   c. Insulation: Comply with ASHRAE/IESNA 90.1.
   d. Jacket: Steel with enameled finish.
   e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
   f. Temperature Control: Adjustable thermostat.
   g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
   h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. 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.
5. Special Requirements: NSF 5 construction.

2.2 WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AMTROL Inc.
      b. Honeywell International Inc.
      c. Pentair Pump Group (The); Myers.
      d. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
      e. State Industries.
      f. 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.


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 or ASHRAE 90.2.

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 Division 22 Section "General-Duty Valves for Plumbing Piping."
   2. Comply with requirements for balancing valves specified in Division 22 Section "Domestic Water Piping Specialties."

F. Pressure-Reducing Valves: ASSE 1003 for water. Set at 25-psig maximum outlet pressure unless otherwise indicated.

G. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. 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.

H. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than domestic-water heater working-pressure rating.


J. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.

K. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Include dimension that will support bottom of domestic-water heater a minimum of 18 inches above the floor.
L. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

3.2 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Division 03 Section ".

1. Exception: Omit concrete bases for commercial, electric, 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. Electric, Tankless, Domestic-Water Heater Mounting: Install electric, tankless, domestic-water heaters at least 18 inches above floor on wall bracket.
1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Anchor domestic-water heaters to substrate.

C. Install electric, 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 Division 22 Section "General-Duty Valves for Plumbing Piping."

D. Install commercial, electric, domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Division 22 Section "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 electric, 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 electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Division 22 Section "Domestic Water Piping Specialties."

H. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Division 22 Section "Meters and Gages for Plumbing Piping."

I. Install thermometers on inlet and outlet piping of residential, solar, electric, domestic-water heaters. Comply with requirements for thermometers specified in Division 22 Section "Meters and Gages for Plumbing Piping."

J. Assemble and install inlet and outlet piping manifold kits for multiple electric, domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each electric, domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each electric, domestic-water heater outlet. Comply with requirements for valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping," and comply with requirements for thermometers specified in Division 22 Section "Meters and Gages for Plumbing Piping."
K. Install pressure-reducing valve with integral bypass relief valve in electric, domestic-water booster-heater inlet piping and water hammer arrester in booster-heater outlet piping. Set pressure-reducing valve for outlet pressure of 25 psig. Comply with requirements for pressure-reducing valves and water hammer arresters specified in Division 22 Section "Domestic Water Piping Specialties."

L. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.

M. Fill electric, domestic-water heaters with water.

N. Charge domestic-water compression tanks with air.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Section "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

C. Install a brass nipple fitting on the inlet and outlet of all water heaters.

3.4 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.5 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. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

C. 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 domestic-water heaters.

END OF SECTION 223300
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 conventional plumbing fixtures and related components:

1. Faucets for lavatories, showers and sinks.
2. Flushometers.
3. Toilet seats.
4. Protective shielding guards.
5. Fixture supports.
7. Urinals.
8. Lavatories.
11. Service sinks.

B. Related Sections include the following:

1. Division 10 Section "Toilet, Bath, and Laundry Accessories."
2. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.
3. Division 22 Section "Drinking Fountains and Water Coolers."

1.3 DEFINITIONS

A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

C. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

D. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.
E. FRP: Fiberglass-reinforced plastic.

F. PMMA: Polymethyl methacrylate (acrylic) plastic.

G. PVC: Polyvinyl chloride plastic.


1.4 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

D. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

   1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

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.


E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
PLUMBING FIXTURES

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
2. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
6. Vitreous-China Fixtures: ASME A112.19.2M.
8. Whirlpool Bathtub Fittings: ASME A112.19.8M.

H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
5. Hose-Connection Vacuum Breakers: ASSE 1011.

I. Comply with the following applicable standards and other requirements specified for bathtub/shower and shower faucets:

1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.

J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

2. Brass and Copper Supplies: ASME A112.18.1.

K. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Disposers: ASSE 1008 and UL 430.
4. Floor Drains: ASME A112.6.3.
5. Grab Bars: ASTM F 446.
7. Off-Floor Fixture Supports: ASME A112.6.1M.

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. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
3. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than 12 of each type.
4. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.
5. Toilet Seats: Equal to 5 percent of amount of each type installed.

PART 2 - PRODUCTS

2.1 LAVATORY FAUCETS

A. Lavatory Faucets:

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

   a. Chicago Faucets.
   b. Moen, Inc.
c. Acorn Engineering

2.2 SHOWER FAUCETS

A. Shower Faucets:

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

   a. Chicago Faucets.
   b. Leonard Valve Company.
   c. Moen, Inc.
   d. Powers; a Watts Industries Co.
   e. Symmons Industries, Inc.
   f. Acorn Engineering

2.3 SINK FAUCETS

A. Sink Faucets:

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

   a. Chicago Faucets.
   b. Moen, Inc.

2.4 FLUSHOMETERS

A. Flushometers:

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

   a. Sloan Valve Company.
   b. Zurn Plumbing Products Group; Commercial Brass Operation.

2.5 TOILET SEATS

A. Toilet Seats:

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

   b. Centoco Manufacturing Corp.
   c. Church Seats.
   d. Olsonite Corp.
   e. Sperzel.
2. Description: Toilet seat for water-closet-type fixture.
   a. Material: Molded, solid plastic with antimicrobial agent.
   b. Configuration: Open front without cover.
   c. Size: Elongated.
   d. Hinge Type: CK, check.
   e. Class: Heavy-duty commercial.

2.6 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Engineered Brass Co.
   b. Insul-Tect Products Co.; a Subsidiary of MVG Molded Products.
   c. McGuire Manufacturing Co., Inc.
   d. Plumberex Specialty Products Inc.
   e. TCI Products.
   f. TRUEBRO, Inc.
   g. Zurn Plumbing Products Group; Tubular Brass Plumbing Products Operation.

2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements. Product shall also meet the ASTM E 84 25/450 smoke and flame rating.

B. Protective Shielding Piping Enclosures:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. TRUEBRO, Inc.

2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

2.7 FIXTURE SUPPORTS

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

1. Josam Company.
2. MIFAB Manufacturing Inc.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.

B. Urinal Supports:

1. Description: Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture for wall-mounting, urinal-type fixture. Include steel uprights with feet.

C. Lavatory Supports:

1. Description: Type II, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.

2.8 WATER CLOSETS

A. Water Closets:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard Companies, Inc.
   b. Crane Plumbing, L.L.C./Fiat Products.
   c. Eljer.
   d. Kohler Co.
   e. Acorn Engineering

2.9 URINALS

A. Urinals:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard Companies, Inc.
   b. Briggs Plumbing Products, Inc.
   c. Crane Plumbing, L.L.C./Fiat Products.
   d. Eljer.
   e. Kohler Co.
   f. Acorn engineering

2.10 LAVATORIES

A. Lavatories:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Standard Companies, Inc.
b. Briggs Plumbing Products, Inc.
c. Crane Plumbing, L.L.C./Fiat Products.
d. Eljer.
e. Kohler Co.
f. Acorn Engineering

2.11 SERVICE SINKS

A. Service Sinks:

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

   a. American Standard Companies, Inc.
   b. Eljer.
   c. Kohler Co.
   d. Crane Plumbing, L.L.C./Fiat Products.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

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

3.2 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers’ written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting 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-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install counter-mounting fixtures in and attached to casework.

G. Install fixtures level and plumb according to roughing-in drawings.

H. 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 valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

J. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

K. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

L. Install toilet seats on water closets.

M. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

N. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

O. 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.

P. Install shower flow-control fittings with specified maximum flow rates in shower arms.

Q. Install traps on fixture outlets.
   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

R. 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. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

S. Set service basins in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results for Plumbing."
T. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

U. All plumbing fixtures are to be mounted at the height specified on the Architectural drawings.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

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. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

D. Install fresh batteries in sensor-operated mechanisms.
3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION
SECTION 224716 – DRINKING FOUNTAINS

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 pressure water coolers and related components.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of pressure water cooler.
      1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
      2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS
   A. Maintenance Data: For drinking fountains to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 DRINKING FOUNTAINS
   A. Drinking Fountains:
      1. Wall mounted:
         a. Wheelchair accessible.
      2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. Elkay Manufacturing Co.
         b. Halsey Taylor.
c. Haws Corporation.
d. Larco Inc.
e. Tri Palm International, LLC.

3. Construction:
   a. Bi-level with two attached cabinets
      1) 14G stainless steel with stainless-steel top and freeze protection system.
   b. [Other details]

4. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
5. Drain: Grid with NPS 1-1/4 tailpiece.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
B. Examine walls and floors for suitable conditions where fixtures will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
C. Install mounting frames, affixed to building construction, and attach recessed, drinking fountains to mounting frames.
D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523 "General-Duty Valves for Plumbing Piping."
E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings.
Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

G. Seal joints between fixtures 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."

3.3 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Install ball shutoff valve on water supply to each fixture. Comply with valve requirements specified in Section 220523 "General-Duty Valves for Plumbing Piping."

D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

3.5 CLEANING

A. After installing fixture, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

C. Provide protective covering for installed fixtures.

D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION
SECTION 230100 - MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL CONDITIONS

A. The General Conditions of the Contract, with the amendments, supplements, forms and requirements in Division 1, and herewith made a part of this Division.

B. All sections of Division 21, 22, & 23 shall comply with the Mechanical General Requirements. The standards established in this section as to quality of materials and equipment, the type and quality of workmanship, mode of operations, safety rules, code requirements, etc., shall apply to all sections of this Division as though they were repeated in each Division.

C. Mechanical equipment that is pre-purchased if any will be assigned to the Mechanical Contractor. By assignment to the Mechanical Contractor, the Mechanical Contractor shall accept and installed the equipment and provide all warrantees and guarantees as if the Mechanical Contractor had purchased the equipment.

D. Construction Indoor-Air Quality Management

1. Comply with SMACNA’s “SMACNA IAQ Guideline for Occupied Buildings under Construction.”
   a. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period as specified in Division 01 Section “Temporary Facilities and Controls,” install filter media having a MERV 8 according to ASHRAE 52.2 at each return-air inlet for the air-handling system used during construction.
   b. Replace all air filters immediately prior to occupancy.

2. Comply with one of the following requirements:
   a. After Construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying a total volume of 14000 cu. Ft. (4 300 000L) of outdoor air per sq. ft. (sq. m) of floor area while maintaining an internal temperature of at least 60 deg F (16 deg C) and a relative humidity no higher than 60 percent.
   b. If occupancy is desired prior to flush-out completion, the space may be occupied following delivery of a minimum of 3500 cu. ft. (1 070 000 L) of outdoor air per sq. ft. (sq. m) of floor area to the space. Once a space is occupied, it shall be ventilated at a minimum rate of 0.30 cfm per sq. ft. (1.52 L/s per sq. m) of outside air or the design minimum outside air rate determined in EQ Prerequisite 1, whichever is greater. During each day of the flush-out period, ventilation shall begin a minimum of three hours prior to occupancy and continue during occupancy. These conditions shall be maintained until a total of 14000 cu. ft./sq. ft. (4 300 000 L/sq. m) of outside air has been delivered to the space.
1.2 SCOPE OF WORK

A. The project described herein is the Salt Lake County Equestrian Center Addition. This work shall include all labor, materials, equipment, fixtures, and devices for the entire mechanical work and a complete operating and tested installation as required for this project.

B. This Division will schedule the boiler inspection and pay for all costs associated with certifying the boiler with the state.

1.3 CODES & ORDINANCES

A. All work shall be executed in accordance with all underwriters, public utilities, local and state rules and regulations applicable to the trade affected. Should any change in the plans and Specifications be required to comply with these regulations, the Contractor shall notify the Architect before the time of submitting his bid. After entering into contract, the Contractor will be held to complete all work necessary to meet these requirements without extra expense to the Owner. Where work required by drawings or specifications is above the standard required, it shall be done as shown or specified.

B. Applicable codes:


1.4 INDUSTRY STANDARDS

A. All work shall comply with the following standards.

1. Associated Air Balance council (AABC)
2. Air Conditioning and Refrigeration Institute (ARI)
3. Air Diffusion council (ADC)
4. Air Movement and Control Association (AMCA)
5. American Gas Association (AGA)
6. American National Standards Institute (ANSI)
7. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)
8. American Society of Mechanical Engineers (ASME)
10. American Water Works Association (AWWA)
11. Cooling Tower Institute (CTI)
12. ETL Testing Laboratories (ETL)
13. Institute of Electrical and Electronic Engineers (IEEE)
14. Hydronics Institute (HI)
15. Manufacturers Standardization Society of the Valve and Fitting Industry (MSS)
17. National Electrical Code (NEC)
18. National Electrical Manufacturers Association (NEMA)
19. National Electrical Safety code (NESC)
21. Sheet Metal and Air Conditioning Contractor’s National Association (SMACNA)
22. Underwriters Laboratories (UL)
23. Tubular Exchanger Manufacturers Association, Inc. (TEMA)
24. Heat Exchanger Institute (HEI)
25. Hydraulic Institute (HI)
26. Thermal Insulation Manufacturers Association (TIMA)
27. Scientific Apparatus Makers Association (SAMA)

B. Compliance Verification:
1. All items required by code or specified to conform to the ASME code shall be stamped with the ASME seal.
2. Form U-1, the manufacturer's data report for pressure vessels, is to be included in the Operation and Maintenance Manuals. National Board Register (NBR) numbers shall be provided where required by code.
3. Manufactured equipment which is represented by a UL classification and/or listing, shall bear the UL or equivalent ETL label.

1.5 UTILITIES & FEES

A. All fees for permits required by this work will be paid by this division. The contractor shall obtain the necessary permits to perform this work. Unless noted otherwise, all systems furnished and or installed by this Contractor, shall be complete with all utilities, components, commodities and accessories required for a fully functioning system. This Contractor shall furnish smoke generators when required for testing, furnish glycol for glycol piping systems, full load of salt to fill brine tank for water softening system, furnish cleaners and water treatment additives.

1.6 SUBMITTALS AND SHOP DRAWINGS

A. General: As soon as possible after the contract is awarded, but in no case more than 45 calendar days thereafter, the Contractor shall submit to the Architect manufacturer's data on products and materials to be used in the installation of mechanical systems for this project. The review of the submitted data will require a minimum of 14 days. The first day starts after the day they are received in the engineer’s office to which the project is being constructed from. If the Contractors schedule requires return of submitted literature in less than the allotted time, the Contractor shall accelerate his submittal delivery date. The Contractor shall resubmit all items requiring re-review within 14 days of returned submittals. Refer to each specification section for items requiring submittal review. If the re-submittal is returned a 2nd time for correction the Contractor will provide the specific equipment that is specified on the drawings and/or the specifications. Written approval of the Owner's Representative shall be obtained before installing any such equipment or materials for the project.
B. Review by the Owner's Representative is for general conformance of the submitted equipment to the project specification. **In no way** does such review relieve this Contractor of his obligation to furnish equipment and materials that comply in detail to the specification **nor does it relieve** the Contractor of his obligation to determine actual field dimensions and conditions that may affect his work. **Regardless of any items overlooked** by the submittal review, the requirements of the contract drawings and specifications **must be followed** and are not waived or superseded **in any way** by the review.

C. By description, catalog number, and manufacturer's names, standards of quality have been established by the Architect and the Engineer for certain manufactured equipment items and specialties that are to be furnished by this Division. Alternate products and equipment may be proposed for use only if specifically named in the specifications or if given written prior approval in published addenda. Design equipment is the equipment listed on the drawings or if not listed on the drawings is the equipment first named in the specifications.

D. If the Engineer is required to do additional design work to incorporate changes caused by submitting equipment or products, different than the design equipment specified, as defined above, the contractor shall reimburse the engineer for additional time and expenses at the engineer's current, recognized, hourly rates.

E. Submittal Format: At the contractor’s discretion, project submittals may be in either of the formats described in the following paragraphs, but mixing the two formats is not acceptable.

1. **Hardcopy Submittal Format:** Six (6) copies of the descriptive literature covering products and materials to be used in the installation of mechanical systems for this project will be provided for review. The submittals shall be prepared in an orderly manner, contained in a 3-ring loose-leaf binder with index and identification tab for each item or group of items and for each specification section. All items shall be submitted at one time except automatic temperature control drawings and seismic restraint drawings which may be submitted separately within 120 days of the contract award date. Partial submittals will not be reviewed until the complete submittal is received.
   a. Submitted literature shall bear the Contractor's stamp, indicating that he has checked all equipment being submitted; that each item will fit into the available space with the accesses shown on the drawings; and, further, that each item conforms to the capacity and quality standards given in the contract documents.
   b. Submitted literature shall clearly indicate performance, quality, and utility requirements; shall show dimension and size of connection points; and shall include derating factors that were applied for each item of equipment to provide capacity at job site elevation. Temperature control submittals shall include piping and wiring diagrams, sequence of operation and equipment. Equipment must fit into the available space with allowance for operation, maintenance, etc. Factory piped and wired equipment shall include shop drawings for all internal wiring and piping furnished with the unit.
c. Submitted literature shall clearly show all required field install wiring, piping, and accessory installations required by the Contractor to provide a complete operating system.

2. Electronic Submittal Format: Identify and incorporate information in each electronic submittal file as follows:
   a. All items shall be submitted at one time except automatic temperature control drawings and seismic restraint drawings which may be submitted separately within **120 days** of the contract award date. Partial submittals will not be reviewed until the complete submittal is received.
   b. Submitted electronic file shall bear the Contractor's stamp, indicating that he has checked all equipment being submitted; that each item will fit into the available space with the accesses shown on the drawings; and, further, that each item conforms to the capacity and quality standards given in the contract documents.
   c. Submitted electronic file shall clearly indicate performance, quality, and utility requirements; shall show dimension and size of connection points; and shall include derating factors that were applied for each item of equipment to provide capacity at job site elevation. Temperature control submittals shall include piping and wiring diagrams, sequence of operation and equipment. Equipment must fit into the available space with allowance for operation, maintenance, etc. Factory piped and wired equipment shall include shop drawings for all internal wiring and piping furnished with the unit.
   d. Submitted electronic file shall clearly show all required field install wiring, piping, and accessory installations required by the Contractor to provide a complete operating system.
   e. 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.
   f. Name file with submittal number or other unique identifier, including revision identifier.
   g. Electronic file shall be completely electronically searchable or it will be rejected.
   h. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by:
      1) Architect.
   i. Transmittal Form for Electronic Submittals:
      1) Use one of the following options acceptable to the Owner;
         a) **Software-generated form from electronic project management software.**
         b) **Electronic form.**
      2) The Electronic Submittal shall contain the following information:
         a) Project name.
         b) Date.
         c) Name and address of Architect.
         d) Name of Construction Manager.
         e) Name of Contractor.
f) Name of firm or entity that prepared submittal.
g) Names of subcontractor, manufacturer, and supplier.
h) Category and type of submittal.
i) Submittal purpose and description.
j) Specification Section number and title.
k) Specification paragraph number or drawing designation and
generic name for each of multiple items.
l) Drawing number and detail references, as appropriate.
m) Location(s) where product is to be installed, as appropriate.
n) Related physical samples submitted directly.
o) Indication of full or partial submittal.
p) Transmittal number [numbered consecutively].
q) Submittal and transmittal distribution record.
r) Other necessary identification.
s) Remarks.

j. Metadata: Include the following information as keywords in the electronic
submittal file metadata:

1) Project name.
2) Number and title of appropriate Specification Section.
3) Manufacturer name.
4) Product name.

1.7 DRAWINGS AND MEASUREMENTS

A. Construction Drawings: The contract document drawings show the general design,
arrangements, and extent of the system. In certain cases, the drawings may include
details that show more nearly exact locations and arrangements; however, the
locations, as shown diagrammatically, are to be regarded as general.

B. It shall be the work of this Section to make such slight alterations as may be necessary
to make adjustable parts fit to fixed parts, leaving all complete and in proper shape
when done. All dimensions given on the drawings shall be verified as related to this
work and with the Architect's office before work is started.

C. This Section shall carefully study building sections, space, clearances, etc., and then
provide offsets in piping or ductwork as required to accommodate the building
structure without additional cost to the Owner. In any case and at any time during the
construction process, a change in location required by obstacles or the installation of
other trades not shown on the mechanical plans shall be made without charge.

D. The drawings shall not be scaled for roughing in measurements nor shall they be used
as shop drawings. Where drawings are required for these purposes or where
drawings must be made from field measurements, the Contractor shall take the
necessary measurements and prepare the drawings. Shop drawings of the various
subcontractors shall be coordinated to eliminate all interferences and to provide
sufficient space for the installation of all equipment, piping, ductwork, etc.

E. The drawings and specifications have been prepared to supplement each other and
they shall be interpreted as an integral unit with items shown on one and not the other
being furnished and installed as though shown and called out on both.
F. Coordination Drawings: The contractor shall provide coordination drawings for mechanical rooms, fan rooms, equipment rooms, and congested areas to eliminate conflicts with equipment, piping, or work of other trades. The drawings shall be a minimum scale of 1/4 inch= 1 foot and of such detail as may be required by the Engineer to fully illustrate the work. These drawings shall include all piping, conduit, valves, equipment, and ductwork.

G. Sheet-metal shop drawings will be required for all ductwork in the entire building. These drawings will show all ductwork in the entire building and shall be coordinated with architectural, structural and electrical portions of the project. The contractor shall specifically obtain copies of the structural shop drawings and shall coordinate the ductwork shop drawings with approved structural members. These drawings shall be submitted to the engineer for review prior to any fabrication. The contractor is responsible for all modifications necessary to accommodate duct installation within the structural, architectural and electrical restrictions. These drawings, once reviewed by the engineer, will be made available to all mechanical, electrical, and fire sprinkler subcontractors to coordinate installation of their work.

1.8 CONTRACTOR'S USE OF BUILDING EQUIPMENT

A. The Contractor may use equipment such as electric motors, fans, heat exchangers, filters, etc., with the written permission of the Owner. As each piece of equipment is used (such as electric motors and fans), maintenance procedures approved by the manufacturer are to be followed. A careful record is to be kept of the length of the time the equipment is used, maintenance procedures followed, and any difficulty encountered. The record is to be submitted to the Owner upon acceptance. All fan belts and filter media (such as bearings) shall be carefully inspected just prior to acceptance. Any excessive wear noted shall require replacement. New filter media shall be installed in air handlers at the time systems are turned over to the owner.

1.9 EXISTING CONDITIONS

A. The Contractor shall carefully examine all existing conditions that might affect the mechanical system and shall compare these conditions with all drawings and specifications for work included under this contract. He shall, at such time, ascertain and check all conditions that may affect his work. No allowance shall subsequently be made in his behalf for an extra expense incurred as a result of his failure or neglect to make such examination. This Contractor shall include in his bid proposal all necessary allowances to repair or replace any item that will remain or will be removed, and any item that will be damaged or destroyed by new construction.

B. The Contractor shall remove all abandoned piping, etc., required by new construction and cap or plug openings. No capping, etc., shall be exposed in occupied areas. All openings of items removed shall be sealed to match adjacent surfaces.

C. The Contractor shall verify the exact location of all existing services, utilities, piping, etc., and make connections to existing systems as required or as shown on the drawings. The exact location of each utility line, together with size and elevation, shall be established before any on-site lines are installed. Should elevation or size of existing main utility lines make connections to them impossible as shown on drawings,
then notification of such shall immediately be given to the Owners Representative for a decision.

1.10 EQUIPMENT CAPACITIES

A. Capacities shown for equipment in the specifications and on the drawings are the minimum acceptable. No equipment shall be considered as an alternate that has capacities or performance less than that of design equipment.

B. All equipment shall give the specified capacity and performance at the job-site elevation. Manufacturers’ standard ratings shall be adjusted accordingly. All capacities and performances listed on drawings or in specifications are for job-site conditions.

1.11 SEISMIC REQUIREMENTS FOR EQUIPMENT

A. All equipment shall be furnished structurally adequate to withstand seismic forces as outlined in the International Building Code. Refer to section Mechanical Vibration Controls and Seismic Restraints. Equipment bases shall be designed for direct attachment of seismic snubbers and/or seismic anchors.

1.12 COOPERATION WITH OTHER TRADES

A. The Contractor shall refer to other drawings and parts of this specification that cover work of other trades that is carried on in conjunction with the mechanical work such that all work can proceed without interference resulting from lack of coordination.

B. The Contractor shall properly size and locate all openings, chases, sleeves, equipment bases, and accesses. He shall provide accurate wiring diagrams to the Electrical Contractor for all equipment furnished under this Division.

C. The ceiling cavity must be carefully reviewed and coordinated with all trades. In the event of conflict, the installation of the mechanical equipment and piping shall be in the following order: plumbing, waste, and soil lines; supply, return, and exhaust ductwork; water piping; medical gases; fire protection piping; and pneumatic control piping.

D. The mechanical Contractor shall insure that the installation of all piping, ducts and equipment is in compliance with Articles 110-16 and 384-4 of the National Electrical Code relative to proper clearances in front of and over all electrical panels and equipment. No piping or ductwork will be allowed to run over electrical panel.

1.13 RESPONSIBILITY OF CONTRACTOR

A. The Contractor is responsible for the installation of a satisfactory piece of work in accordance with the true intent of the drawings and specifications. He shall provide, as a part of his work and without expense, all incidental items required even though these items are not particularly specified or indicated. The installation shall be made so that its several component parts will function together as a workable system and
shall be left with all equipment properly adjusted and in working order. The Contractor shall familiarize the Owner's Representative with maintenance and lubrication instructions as prepared by the Contractor and shall explain and fully instruct him relative to operating, servicing, and maintenance of them.

B. If a conflict arises between the drawings and the specifications the most stringent procedure/action shall be followed. A clarification to the engineer will help to determine the course of action to be taken. If a conflict arises between specification sections the engineer will determine which course of action is to be followed.

1.14 PIPE AND DUCT OPENINGS AND EQUIPMENT RECESSES
A. Pipe and duct chases, openings, and equipment recesses shall be provided by others only if shown on architectural or structural drawings. All openings for the mechanical work, except where plans and specifications indicate otherwise, shall be provided as work of this Division. Include openings information with coordination drawings.

B. Whether chases, recesses, and openings are provided as work of this Division or by others, this Contractor shall supervise their construction and be responsible for the correct size and location even though detailed and dimensioned on the drawings. This Contractor shall pay for all necessary cutting, repairing, and finishing if any are left out or incorrectly made. All necessary openings thru existing walls, ceilings, floors, roofs, etc. shall be provided by this Contractor unless indicated otherwise by the drawing and/or specifications.

1.15 UNFIT OR DAMAGED WORK
A. Any part of this installation that fails, is unfit, or becomes damaged during construction, shall be replaced or otherwise made good. The cost of such remedy shall be the responsibility of this Division.

1.16 WORKMANSHIP
A. Workmanship shall be the best quality of its kind for the respective industries, trades, crafts, and practices, and shall be acceptable in every respect to the Owner's representative. Nothing contained herein shall relieve the Contractor from making good and perfect work in all details in construction.

1.17 SAFETY REGULATION
A. The Contractor shall comply with all local, Federal, and OSHA safety requirements in performance with this work. (See General Conditions). This Contractor shall be required to provide equipment, supervision, construction, procedures, and all other necessary items to assure safety to life and property.
1.18 ELECTRICAL SERVICES

A. All equipment control wiring and all automatic temperature control wiring including all necessary contacts, relays, and interlocks, whether low or line voltage, except power wiring, shall be furnished and installed as work of this Division unless shown to be furnished by Division 26. All such wiring shall be in conduit as required by electrical codes. Wiring in the mechanical rooms, fans rooms and inaccessible ceilings and walls shall be installed in conduit as well. Installation of any and all wiring done under Division 21, 22 and 23 shall be in accordance with the requirements of Division 26, Electrical.

B. All equipment that requires an electrical connection shall be furnished so that it will operate properly and deliver full capacity on the electrical service available.

C. Refer to the electrical control equipment and wiring shown on the diagrams. Any changes or additions required by specific equipment furnished shall be the complete responsibility of the Contractor furnishing the equipment.

D. The Mechanical Contractor must coordinate with the Electrical Contractor to insure that all required components of control work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of such coordination.

1.19 WORK, MATERIALS, AND QUALITY OF EQUIPMENT

A. Unless otherwise specified, all materials shall be new and of the best quality of their respective kinds and all labor shall be done in a most thorough and workmanlike manner.

B. Products or equipment of any of the manufacturers cited herein or any of the products approved by the Addenda may be used. However, where lists of products are cited herein, the one first listed in the design equipment used in drawings and schedules to establish size, quality, function, and capacity standards. If other than design equipment is used, it shall be carefully checked for access to equipment, electrical and control requirements, valving, and piping. Should changes or additions occur in piping, valving, electrical work, etc., or if the work of other Contractors would be revised by the alternate equipment, the cost of all changes shall be borne as work of this Division.

C. The Execution portions of the specifications specify what products and materials may be used. Any products listed in the Product section of the specification that are not listed in the Execution portion of the specification may not be used without written approval by the Engineer.

D. The access to equipment shown on the drawings is the minimum acceptable space requirements. No equipment that reduces or restricts accessibility to this or any other equipment will be considered.

E. All major items of equipment are specified in the equipment schedules on the drawings or in these specifications and shall be furnished complete with all accessories normally supplied with the catalog item listed and all other accessories necessary for a complete and satisfactory installation.
F. All welders shall be certified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code, latest Edition.

1.20 PROTECTION AGAINST WEATHER AND STORING OF MATERIALS

A. All equipment and materials shall be properly stored and protected against moisture, dust, and wind. Coverings or other protection shall be used on all items that may be damaged or rusted or may have performance impaired by adverse weather or moisture conditions. Damage or defect developing before acceptance of the work shall be made good at the Contractor's expense.

B. All open duct and pipe openings shall be adequately covered at all times.

1.21 INSTALLATION CHECK

A. An experienced, competent, and authorized representative of the manufacturer or supplier of each item of equipment indicated in the equipment schedule and the seismic supplier shall visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The equipment supplier's representative shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation is satisfactory to the Engineer.

B. Each equipment supplier's representative shall furnish to the Owner, through the Engineer, a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and, (4) has been operated under full load conditions and that it operated satisfactorily.

C. All costs for this work shall be included in the prices quoted by equipment suppliers.

1.22 EQUIPMENT LUBRICATION

A. The Contractor shall properly lubricate all pieces of equipment before turning the building over to the Owner. A linen tag shall be attached to each piece of equipment, showing the date of lubrication and the lubricant used. No equipment shall be started until it is properly lubricated.

B. Necessary time shall be spent with the Owner's Representative to thoroughly familiarize him with all necessary lubrications and maintenance that will be required of him.

C. Detergent oil as used for automotive purposes shall not be used for this work.
1.23 CUTTING AND PATCHING

A. No cutting or drilling in structural members shall be done without written approval of the Architect. The work shall be carefully laid out in advance, and cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces necessary for the mechanical work shall be carefully done. Any damage to building, piping, or equipment shall be repaired by professional plasterers, masons, concrete workers, etc., and all such work shall be paid for as work of this Division.

B. When concrete, grading, etc., is disturbed, it shall be restored to original condition as described in the applicable Division of this Specification.

1.24 EXCAVATION AND BACKFILLING

A. All necessary excavations and backfilling for the Mechanical phase of this project shall be provided as work of this Division. Trenches for all underground pipelines shall be excavated to the required depths. The bottom of trenches shall be compacted hard and graded to obtain required fall. Backfill shall be placed in horizontal layers, not exceeding 12 inches in thickness, and properly moistened. Each layer shall be compacted, by suitable equipment, to a density of not less than 95 percent as determined by ASTM D-1557. After pipelines have been tested, inspected, and approved, the trench shall be backfilled with selected material. Excess earth shall be hauled from the job site. Fill materials approved by the Architect shall be provided as work of this Division.

B. No trenches shall be cut near or under any footings without consultation first with the Architect's office. Any trenches or excavations more than 30 inches deep shall be tapered, shored, covered, or otherwise made absolutely safe so that no vehicle or persons can be injured by falling into such excavations, or in any way be harmed by cave-ins, shifting earth, rolling rocks, or by drowning. This protection shall be extended to all persons approaching excavation related to this work whether or not such persons are authorized to be in the vicinity of the construction.

1.25 ACCESS

A. Provide access doors in walls, ceilings and floors by this division unless otherwise noted. For access to mechanical equipment such as valves, dampers, VAV boxes, fans, controls, etc. Refer to Division 8 for door specifications. All access doors shall be 24" x 24" unless otherwise indicated or required. Coordinate location of doors with the Architect prior to installation. If doors are not specified in Division 8, provide the following: Doors in ceilings and wall shall be equal to JR Smith No. 4760 bonderized and painted. Doors in tile walls shall be equal to JR Smith No. 4730 chrome plated. Doors in floors shall be equal to JR Smith No. 4910

B. Valves: Valve must be installed in locations where access is readily available. If access is compromised, as judged by the Mechanical Engineer, these valves shall be relocated where directed at the Contractors expense.

C. Equipment: Equipment must be installed in locations and orientations so that access to all components requiring service or maintenance will not be compromised. If access is
compromised, as judged by the Mechanical Engineer, the contractor shall modify the installation as directed by the Engineer at the Contractors expense.

D. It is the responsibility of this division to install terminal boxes, valves and all other equipment and devices so they can be accessed. If any equipment or devices are installed so they cannot be accessed on a ladder a catwalk and ladder system shall be installed above the ceiling to access and service this equipment.

1.26 CONCRETE BASES AND INSERTS

A. Bases: The concrete bases shall be provided and installed as work by this division. This Division shall be responsible for the proper size and location of bases and shall furnish all required anchor bolts and sleeves with templates to be installed as work of Division 3, Concrete.

B. All floor-mounted mechanical equipment shall be set on 6-inch high concrete bases, unless otherwise noted or shown on drawings. Such bases shall extend 6 inches beyond equipment or mounting rails on all sides or as shown on the drawings and shall have a 1-inch beveled edge all around.

C. Inserts: Where slotted or other types of inserts required for this work are to be cast into concrete, they shall be furnished as work of this Division.

D. Concrete inserts and pipe support systems shall be equal to Unistrut P3200 series for all piping where more than one pipe is suspended at a common location. Spacing of the inserts shall match the size and type of pipe and of ductwork being supported. The Unistrut insert and pipe support system shall include all inserts, vertical supports, horizontal support members, clamps, hangers, rollers, bolts, nuts, and any other accessory items for a complete pipe-supporting system.

1.27 CLEANING AND PAINTING

A. Cleaning: After all tests and adjustments have been made and all systems pronounced satisfactory for permanent operation, this Contractor shall clean all exposed piping, ductwork, insulated members, fixture, and equipment installed under this Section and leave them ready for painting. He shall refinish any damaged finish and leave everything in proper working order. The Contractor shall remove all stains or grease marks on walls, floors, glass, hardware, fixtures, or elsewhere, caused by his workman or for which he is responsible. He shall remove all stickers on plumbing fixtures, do all required patching up and repair all work of others damaged by this division of the work, and leave the premises in a clean and orderly condition.

B. Painting: Painting of exposed pipe, insulated pipe, ducts, or equipment is work of Division 9, Painting.

C. Mechanical Contractor: All equipment which is to be furnished in factory prefinished conditions by the mechanical Contractor shall be left without mark, scratch, or impairment to finish upon completion of job. Any necessary refinishing to match original shall be done. Do not paint over nameplates, serial numbers, or other identifying marks.
D. Removal of Debris, Etc: Upon completion of this division of the work, remove all surplus material and rubbish resulting from this work, and leave the premises in a clean and orderly condition.

1.28 CONTRACT COMPLETION

A. Incomplete and Unacceptable Work: If additional site visits or design work is required by the Engineer or Architect because of the use of incomplete or unacceptable work by the Contractor, then the Contractor shall reimburse the Engineer and Architect for all additional time and expenses involved.

B. Maintenance Instructions: The Contractor shall furnish the Owner complete printed and illustrated operating and maintenance instructions covering all units of mechanical equipment, together with parts lists.

C. Instructions To Owner’s Representatives: In addition to any detailed instructions called for, the mechanical Contractor must provide, without expense to the Owner, competent instructors to train the Owner’s representatives who will be in charge of the apparatus and equipment, in the care, adjustment, and operation of all parts on the heating, air conditioning, ventilating, plumbing, fire protection, and automatic temperature control equipment. Instruction dates shall be scheduled at time of final inspection. A written report specifying times, dates, and name of personnel instructed shall be forwarded to the Architect. A minimum of four 8-hour instruction periods shall be provided. The instruction periods will be broken down to shorter periods when requested by the Owner. The total instruction hours shall not reduced. The ATC Contractor shall provide 4 hours of instructions. The remaining hours shall be divided between the mechanical and sheet metal Contractor.

D. Guarantee: By the acceptance of any contract award for the work herein described or shown on the drawings, the Contractor assumes the full responsibility imposed by the guarantee as set forth herein and in the General Conditions, and should protect himself through proper guarantees from equipment and special equipment Contractors and from subcontractors as their interests may appear.

E. The guarantee so assumed by the Contractor and as work of this Section is as follows:

1. That the entire mechanical system, including plumbing, heating, and air-conditioning system shall be quiet in operation.
2. That the circulation of water shall be complete and even.
3. That all pipes, conduit, and connections shall be perfectly free from foreign matter and pockets and that all other obstructions to the free passage of air, water, liquid, sewage, and vent shall be removed.
4. That he shall make promptly and free of charge, upon notice from the Owner, any necessary repairs due to defective workmanship or materials that may occur during a period of one year from date of Substantial Completion.
5. That all specialties, mechanical, and patent devices incorporated in these systems shall be adjusted in a manner that each shall develop its maximum efficiency in the operation of the system; i.e., diffusers shall deliver the designed amount of air shown on drawings, thermostats shall operate to the specified limits, etc.
6. All equipment and the complete mechanical, ductwork, piping and plumbing systems shall be guaranteed for a period of one year from the date of the Architect's Certificate of Substantial Completion, this includes all mechanical, ductwork, piping and plumbing equipment and products and is not limited to boiler, chillers, coils, fans, filters etc. Any equipment supplier not willing to comply with this guarantee period shall not submit a bid price for this project. The Contractor shall be responsible for a 100-percent guarantee for the system and all items of equipment for this period. If the contractor needs to provide temporary heating or cooling to the building and or needs to insure systems are installed properly and or to meet the project schedule the guaranteed of all systems and equipment shall be as indicated above, on year from the date of the Architect’s Certificate of Substantial Completion.

7. All filters used during construction shall be replaced just before equipment is turned over to the Owner, and all required equipment and parts shall be oiled. Any worn parts shall also be replaced.

8. If any systems or equipment is used for temporary heating or cooling the systems shall be protected so they remain clean. I.e. if the ductwork systems are used temporary filters and a filter holder (not duct-taped to ducts or grilles) shall be installed to insure the systems and the equipment remain clean.

1.29 CURBS

A. Unless otherwise noted in these specifications or on the documents all roof curbs for all equipment are to be provided by Division 22 and 23.

1.30 TEST RUN

A. The Mechanical Contractor shall operate the mechanical system for a minimum of 30 days to prove the operation of the system.

1.31 EQUIPMENT STARTUP AND CHECKOUT:

A. Each major piece of equipment shall be started and checked out by an authorized representative of the equipment manufacturer. A certificate indicating the equipment is operating to the satisfaction of the manufacturer shall be provided and shall be included in the commissioning report.

B. This contractor shall coordinate commissioning procedures and activities with the commissioning agent.

1.32 DEMOLITION

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
B. Proceed with demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.

C. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.

D. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

E. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.

F. Maintain adequate ventilation when using cutting torches.

G. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.

H. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.

I. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

J. Dispose of demolished items and materials promptly.

K. Return elements of construction and surfaces that are to remain to condition existing before selective demolition operations began.

L. Existing Facilities: Comply with building manager's requirements for using and protecting elevators, stairs, walkways, loading docks, building entries, and other building facilities during selective demolition operations.

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

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

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

P. Air-Conditioning Equipment: Remove equipment without releasing refrigerants.

END OF SECTION
SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
7. Grout.
8. Equipment installation requirements common to equipment sections.
10. Concrete bases.
11. Supports and anchorages.
12. Link-Seal

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, and crawlspaces.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces, mechanical equipment rooms, accessible pipe shafts, accessible plumbing chases, and accessible tunnels.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
F. The following are industry abbreviations for plastic materials:
   1. CPVC: Chlorinated polyvinyl chloride plastic.
   2. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS
A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.
   4. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE
A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

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

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

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

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. 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.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers:
   a. Eslon Thermoplastics.

B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers:
   a. Thompson Plastics, Inc.

2.5 DIELECTRIC FITTINGS

A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.

B. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.

C. Insulating Material: Suitable for system fluid, pressure, and temperature.

D. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

F. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure as required to suit system pressures.
G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

H. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:
   a. Capitol Manufacturing Co.
   b. Central Plastics Company.
   c. Watts Industries, Inc.; Water Products Div

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Stainless steel. Include two for each sealing element.

4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated and rough brass.

D. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

E. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

2. Design Mix: 5000-psi, 28-day compressive strength.


2.10 LINK-SEAL MODULAR SEAL PRESSURE PLATES

A. Link-Seal® modular seal pressure plates shall be molded of glass reinforced Nylon Polymer with the following properties:
   1. Izod Impact - Notched = 2.05ft-lb/in. per ASTM D-256
   2. Flexural Strength @ Yield = 30,750 psi per ASTM D-790
   3. Flexural Modulus = 1,124,000 psi per ASTM D-790
   4. Elongation Break = 11.07% per ASTM D-638
   5. Specific Gravity = 1.38 per ASTM D-792

B. Models LS200-275-300-315 shall incorporate the most current Link-Seal® Modular Seal design modifications and shall include an integrally molded compression assist boss on the top (bolt entry side) of the pressure plate, which permits increased compressive loading of the rubber sealing element. Models 315-325-340-400-410-425-475-500-525-575-600 shall incorporate an integral recess known as a “Hex Nut Interlock” designed to accommodate commercially available fasteners to insure proper
thread engagement for the class and service of metal hardware. All pressure plates shall have a permanent identification of the manufacturer’s name molded into it.

C. For fire service, pressure plates shall be steel with 2-part Zinc Dichromate Coating.

D. Link-Seal® Modular Seal Hardware: All fasteners shall be sized according to latest Link-Seal® modular seal technical data. Bolts, flange hex nuts shall be:
   1. 316 Stainless Steel per ASTM F593-95, with a 85,000 psi average tensile strength.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type with spring clips.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.

M. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
      a. PVC Steel Pipe Sleeves: For pipes smaller than NPS 6.
      b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
      c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
         1) Seal space outside of sleeve fittings with grout.
   4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

R. Verify final equipment locations for roughing-in.

S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.


F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.


3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install 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.

D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
3.6 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. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section “Miscellaneous Cast-in-Place Concrete.”

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

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

3.8 GROUTING

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

3.9 LINK SEAL

A. Provide Link Seal at all piping penetrations from the outside.

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

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

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS
A. Comply with requirements in this Section except when the requirements in equipment schedules, other specification sections, drawing notes or in other contract documents are more stringent.
B. Comply with NEMA MG 1 unless otherwise indicated.

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

C. Motors 3/4 HP and larger: Polyphase.

D. Motors smaller than 3/4 HP: Single phase.

E. All motors shall have ASTM Grade 5 hardware that is Yellow Zinc-dichromate plated.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Rotor: Random-wound, squirrel cage.

E. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

F. Temperature Rise: Match insulation rating.

G. Insulation: Class F. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors smaller than 15 HP: Manufacturer's standard starting characteristic.

H. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
5. Shaft Grounding Ring: Microfiber type.
a. Provide grounded discharge path for VFD induced voltage in the shaft to prevent arching in the motor bearings.

2.5 Electronically Commutated Motor (ECM)
   1. Motor enclosures: Open type
   2. Motor to be a DC electronic commutation type motor (ECM).
      a. AC induction type motors are not acceptable.
   3. Permanently lubricated motor with heavy duty ball bearing
   4. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor.
   5. Speed controllable to 20% of full speed (80% turndown).
      a. Potentiometer dial mounted at the motor speed controller
      b. 0-10 VDC signal.
   6. 85% efficient at all speeds minimum.
   7. Motors smaller than 2.0 hp.

2.6 SINGLE-PHASE MOTORS
   A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
      1. Permanent-split capacitor.
      2. Split phase.
      3. Capacitor start, inductor run.
      4. Capacitor start, capacitor run.
   B. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
   C. Motors 1/20 HP and Smaller: Shaded-pole type.
   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, unless otherwise indicated.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION
SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE

A. Provide engineered vibration isolation and restraint systems in accordance with the requirements of this section including design, engineering, materials, testing, inspections and reports.

B. Mechanical equipment with moving parts shall be mounted on or suspended from vibration isolators to reduce the transmission of vibration and mechanically transmitted sound to the building structure.

C. All mechanical equipment, piping and ductwork shall be restrained as required by Federal, State and Local building codes to preserve the integrity of nonstructural building components during seismic events to minimize hazards to occupants and reduce property damage.

1.3 SUMMARY

A. This Section includes the following:
   1. Elastomeric isolation pads.
   2. Elastomeric isolation mounts.
   3. Restrained elastomeric isolation mounts.
   4. Open-spring isolators.
   5. Housed-spring isolators.
   6. Restrained-spring isolators.
   8. Pipe-riser resilient supports.
   9. Resilient pipe guides.
  10. Air-spring isolators.
  11. Restrained-air-spring isolators.
  12. Elastomeric hangers.
  13. Spring hangers.
  15. Restraint channel bracings.
  17. Seismic-restraint accessories.
  18. Mechanical anchor bolts.
  19. Adhesive anchor bolts.
20. Vibration isolation equipment bases.
22. Certification of seismic restraint designs.
23. Installation supervision.
24. Design of attachment of housekeeping pads.
25. All components requiring IBC compliance and certification.
26. All inspection and test procedures for components requiring IBC compliance.
27. Restraint of all mechanical equipment, pipe and ductwork, within, on, or outdoors of the building and entry of services to the building, up to but not including, the utility connection, is part of this Specification.
28. Seismic certification of equipment

B. Related Requirements:

1. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for devices for plumbing equipment and systems.

1.4 DEFINITIONS


C. ASCE: American Society of Civil Engineers

D. OSHPD: Office of Statewide Health Planning and Development for the State of California.

E. Ip: Importance Factor.

F. ESSENTIAL FACILITIES, (Occupancy Category IV, IBC-2015)

1. Buildings and other structures that are intended to remain operational in the event of extreme environmental loading from flood, wind, snow or earthquakes.

G. LIFE SAFETY

1. All systems involved with fire protection, including sprinkler piping, jockey pumps, fire pumps, control panels, service water supply piping, water tanks, fire dampers, smoke exhaust systems and fire alarm panels.

2. All mechanical, electrical, plumbing or fire protection systems that support the operation of, or are connected to, emergency power equipment, including all lighting, generators, transfer switches and transformers.

3. All medical and life support systems.

4. Hospital heating systems and air conditioning systems for maintaining normal ambient temperature.
5. Automated supply, exhaust, fresh air and relief air systems on emergency control sequence, including air handlers, duct, dampers, etc., or manually-operated systems used for smoke evacuation, purge or fresh air relief by the fire department.

6. Heating systems in any facility with Occupancy Category IV, IBC-2015 where the ambient temperature can fall below 32 degrees Fahrenheit.

H. HIGH HAZARD

1. All gases or fluids that must be contained in a closed system which are flammable or combustible. Any gas that poses a health hazard if released into the environment and vented Fuel Cells.

1.5 REFERENCE CODES AND STANDARDS

A. Codes and Standards: The following shall apply and conform to good engineering practices unless otherwise directed by the Federal, State or Local authorities having jurisdiction.

1. IBC
2. ASCE 7
3. NFPA 13 (National Fire Protection Association)

B. The following guides may be used for supplemental information on typical seismic installation practices. Where a conflict exists between the guides and these construction documents, the construction documents will preside.


1.6 ISOLATOR AND RESTRAINT MANUFACTURER’S RESPONSIBILITIES:

A. Provide project specific vibration isolation and seismic restraint design prepared by a registered design professional in the state were the project is being constructed, and manufacturer certifications that the components are seismically qualified.

1. Provide calculations to determine restraint loads resulting from seismic forces as required by IBC, Chapter 16 and ASCE 7, latest editions. Seismic calculations
shall be certified by an engineer licensed in the state where the project is being constructed.

B. Provide installation instructions and shop drawings for all materials supplied under this section of the specifications.
   1. Provide seismic restraint details with specific information relating to the materials, type, size, and locations of anchorages; materials used for bracing; attachment requirements of bracing to structure and component; and locations of transverse and longitudinal sway bracing and rod stiffeners.
   2. Provide seismic bracing layout drawings indicating the location of all seismic restraints.
      a. Each piece of rotating isolated equipment shall be tagged to clearly identify quantity and size of vibration isolators and seismic restraints.

C. Provide, in writing, the special inspection requirements for all Designated Seismic Systems as indicated in Chapter 17 of the IBC.

D. Provide training for installation, operation and maintenance of isolation and restraint systems.

1.7 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading: Per the structural drawings and specifications.

B. Flood-Restraint Loading: Per the structural drawings and specifications.

C. Seismic-Restraint Loading:
   1. Site Class as Defined in the IBC: Per the structural drawings and specifications.
   2. Assigned Occupancy Category as Defined in the IBC: Per the structural drawings and specifications.
      a. Component Importance Factor: 1.5.
         1) Life safety components required to function after an earthquake.
         2) Components containing hazardous or flammable materials in quantities that exceed the exempted amounts for an open system listed in Chapter 4.
         3) For structures with an Occupancy Category IV, components needed for continued operation of the facility or whose failure could impair the continued operation of the facility.
         4) Storage racks in occupancies open to the general public (e.g., warehouse retail stores).
      b. Component Importance Factor: 1.0.
         1) All other components
      c. Component Response Modification Factor: Per the structural drawings and specifications.
      d. Component Amplification Factor: Per the structural drawings and specifications.
3. Design Spectral Response Acceleration at Short Periods: Per the structural drawings and specifications.
4. Design Spectral Response Acceleration at 1-Second Period: Per the structural drawings and specifications.

1.8 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Submittals shall include catalog cut sheets and installation instructions for each type of anchor and seismic restraint used on equipment or components being isolated and/or restrained.
   2. Submittals for mountings and hangers incorporating springs shall include spring diameter and free height, rated load, rated deflection, and overload capacity for each vibration isolation device.
   3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
      a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES.
      b. Annotate to indicate application of each product submitted and compliance with requirements.
   4. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:
   1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. “Basis for Design” report: Statement from the registered design professional that the design complies with the requirements of the ASCE 7-05 Chapter 13, IBC 2009 chapter 1912 and ACI 318. In addition, the basis for compliance must also be noted, as listed below:
      a. Project specific design documentation prepared and submitted by a registered design professional (ASCE 7, 13.2.1.1)
      b. Submittal of the manufacturer’s certification that the isolation equipment is seismically qualified by:
      c. An engineered analysis conforming to the requirements of Chapter 13 of ASCE 7.
d. Testing by a nationally recognized testing standard procedure such as ICC-ES AC 156. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.

e. Experience data conforming to a nationally recognized procedure. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.

2. Seismic restraint load ratings must be certified and substantiated by testing or calculations under direct control of a registered professional engineer. Copies of testing and calculations must be submitted as part of submittal documents. OSHPD pre-approved restraint systems are exempt from this requirement if their pre-approval is current and based upon the IBC 2009 (i.e. OPA-07 pre-approval numbers).

3. Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

4. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators, seismic restraints, and for designing vibration isolation bases.

a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.

5. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.

6. Vibration Isolation Base Details: Detail overall dimensions, 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.

7. Seismic-Restraint Details:

a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.

b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

c. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
1.9 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

1. Submittal drawings and calculations must be stamped by a registered professional engineer in the State where the project is being constructed who is responsible for the seismic restraint design.

2. Calculations and restraint device submittal drawings shall specify anchor bolt type, embedment, concrete compressive strength, minimum spacing between anchors, and minimum distances of anchors from concrete edges. Concrete anchor locations shall not be near edges, stress joints, or an existing fracture. All bolts shall be ASTM A307 or better.

B. Qualification Data: For professional engineer and testing agency.

C. Welding certificates.

D. Field quality-control test reports.

1.10 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by 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 seismic-restraint designs must be signed and sealed by a qualified professional engineer.

1.11 SEISMIC CERTIFICATION OF EQUIPMENT

A. Component Importance Factor. All plumbing and mechanical components shall be assigned a component importance factor. The component importance factor, I_p, shall be taken as 1.5 if any of the following conditions apply:
1. The component is required to function for life-safety purposes after an earthquake.
2. The component contains hazardous materials.
3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, $I_p$, equal to 1.0.

C. For equipment or components where $I_p = 1.0$.
   1. Submit manufacturer’s certification that the equipment is seismically qualified by:
      a. An engineered analysis conforming to the requirements of Chapter 13 of ASCE 7.
      b. Testing by a nationally recognized testing standard procedure such as ICC-ES AC 156. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.
      c. Experience data conforming to a nationally recognized procedure. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.

2. The equipment and components listed below are considered rugged and shall not require Special Seismic Certification:
   a. Valves (not in cast-iron housings, except for ductile cast iron).
   b. Pneumatic operators.
   c. Hydraulic operators.
   d. Motors and motor operators.
   e. Horizontal and vertical pumps (including vacuum pumps).
   f. Air compressors
   g. Refrigerators and freezers.
   h. Elevator cabs.
   i. Underground tanks.
   j. Equipment and components weighing not more than 20 lbs. supported directly on structures (and not mounted on other equipment or components) with supports and attachments in accordance with Chapter 13, ASCE 7.

3. Rugged equipment and components in this section are for factory assembled discrete equipment and components only and do not apply to site assembled or field assembled equipment or equipment anchorage. The list is based in part on OSHPD Code Application Notice 2-1708A.5.

D. Special Certification requirements for Designated Seismic Systems (i.e. $I_p = 1.5$): Seismic Certificates of Compliance supplied by manufacturers shall be submitted for all components that are part of Designated Seismic Systems. In accordance with the ASCE 7, certification shall be via one of the following methods:
   1. For active mechanical and electrical equipment that must remain operable following the design earthquake:
a. Testing as detailed by part C.1.b above.

b. Experience data as detailed by part C.1.c above.

c. Equipment that is considered "rugged" per part C.2 above.

2. Components with hazardous contents shall be certified by the manufacturer as maintaining containment following the design earthquake by:

a. Testing as detailed by part C.1.b above.

b. Experience data as detailed by part C.1.c above.

c. Engineering analysis utilizing dynamic characteristics and forces. Tanks (without vibration isolators) designed by a registered design professional in accordance with ASME Boiler and Pressure Vessel Code, and satisfying the force and displacement requirements of Sections 13.3.1 and 13.3.2 of ASCE 7 having an importance factor, $I_p = 1.0$ shall be considered to satisfy the Special Seismic Certification requirements on the basis of ASCE 7 Section 13.6.9.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

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

1. Amber/Booth Company, Inc.
2. CalDyn (California Dynamics Corporation).
3. ISAT (International Seismic Application Technology).
5. Mason Industries.
6. Vibro-Acoustics
7. VMC (Vibration Mountings & Controls, Inc.)

B. Elastomeric Isolation Pads P1:

1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
2. Size: Factory or field cut to match requirements of supported equipment.
3. Pad Material: Oil and water resistant with elastomeric properties.
4. Surface Pattern: Ribbed pattern.
5. Load-bearing metal plates adhered to pads.

C. Double-Deflection, Elastomeric Isolation Mounts M1:

1. Mounting Plates:

   a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded, or with threaded studs or bolts.
   b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
2. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

D. Restrained Elastomeric Isolation Mounts M2:

1. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
   a. Housing: Cast-ductile iron or welded steel.
   b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

E. Spring Isolators S1: 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 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-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

F. Restrained Spring Isolators S2: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation. Baseplates shall limit floor load to 500 psig.
2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

G. Housed Restrained Spring Isolators S3: Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:

1. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

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 rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric pad: For high frequency absorption at the base of the spring.

H. Elastomeric Hangers H1:

1. Description: Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods
   a. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
   b. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

I. Spring Hangers H2: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Description: Combination Coil-Spring and Elastomeric-Insert Hanger with spring and insert in compression.
   a. 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.
   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 rated vertical stiffness.
   e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   f. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
   g. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

J. Spring Hangers with Vertical-Limit Stop H3: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Description: Combination Coil-Spring and Elastomeric-Insert Hanger with spring and insert in Compression and vertical limit stop.
a. 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.

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 rated vertical stiffness.

e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

f. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

g. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

h. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

K. Pipe Riser Resilient Support R1:

1. Description: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch-thick neoprene.

a. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.

b. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

L. Resilient Pipe Guides R2:

1. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch-thick neoprene.

a. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

M. Horizontal Thrust Restraints T1: Modified specification S2 isolator.

1. Horizontal thrust restraints shall consist of a modified specification S2 spring mounting. Restraint springs shall have the same deflection as the isolator springs.

2. The assembly shall be preset at the factory and fine tuned in the field to allow for a maximum of 1/4" movement from stop to maximum thrust.

3. The assemblies shall be furnished with rod and angle brackets for attachment to both the equipment and duct work or the equipment and the structure.

4. Restraints shall be attached at the center line of thrust and symmetrically on both sides of the unit.
2.2 RESTRAINED VIBRATION ISOLATION ROOF-CURB RAILS

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

1. Amber/Booth Company, Inc.
2. CalDyn (California Dynamics Corporation).
3. ISAT (International Seismic Application Technology).
5. Mason Industries.
6. Vibro-Acoustics
7. VMC (Vibration Mountings & Controls, Inc.)

B. Restrained Vibration Isolation Roof-Curb Rails: RC1:

C. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.

D. Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic forces.

E. Lower Support Assembly: The lower support assembly shall be a formed sheet-metal section containing adjustable and removable steel springs that support upper frame. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.

F. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch-thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

1. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic and 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 rated vertical stiffness.
   e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

G. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch-thick.

H. 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.
2.3 VIBRATION ISOLATION EQUIPMENT BASES

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

1. Amber/Booth Company, Inc.
2. CalDyn (California Dynamics Corporation).
3. ISAT (International Seismic Application Technology).
5. Mason Industries.
6. Vibro-Acoustics
7. VMC (Vibration Mountings & Controls, Inc.)

B. Steel Bases and Rails SB1: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
   a. 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 brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.


1. Design Requirements: Lowest possible mounting height with not less than 2-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
   a. 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 brackets 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.

2.4 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amber/Booth Company, Inc.
2. CalDyn (California Dynamics Corporation).
3. ISAT (International Seismic Application Technology).
5. Mason Industries.
6. Vibro-Acoustics
7. VMC (Vibration Mountings & Controls, Inc.)

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES.

1. 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.

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: Oil- and water-resistant neoprene.
3. Maximum 1/4-inch air gap, and minimum 1/4-inch-thick resilient cushion.

D. Channel Support System: MFMA-4, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

E. Restraint Cables: ASTM A 603 galvanized or ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement. Cables located in exterior or other wet locations such as wash-down areas shall be stainless steel.

F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.

G. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

H. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

I. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

J. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

K. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select
anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

L. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

M. All post installed anchors utilized in the seismic design must be qualified for use in cracked concrete and approved for use with seismic loads.

N. Expansion anchors shall not be used for anchorage of equipment with motors rated over 10 HP with the exception of undercut expansion anchors. Spring or internally isolated equipment are exempt from this requirement.

O. All beam clamps utilized for vertical support must also incorporate retention straps.

P. All seismic brace arm anchorages to include concrete anchors, beam clamps, truss connections, etc., must be approved for use with seismic loads.

2.5 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 galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat 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 seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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 COORDINATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 03 Section "Cast-in-Place Concrete."

B. Coordinate size, shape, reinforcement and attachment of all housekeeping pads supporting vibration/seismically rated equipment. Concrete shall have a minimum compressive strength of 4,000 psi or as specified by the project engineer. Coordinate size, thickness, doweling, and reinforcing of concrete equipment housekeeping pads and piers with vibration isolation and seismic restraint device manufacturer to ensure adequate space, embedment and prevent edge breakout failures. Pads and piers must be adequately doweled in to structural slab.

C. Housekeeping pads shall have adequate space to mount equipment and seismic restraint devices.

D. Housekeeping Pads must be adequately reinforced and adequately sized for proper installation of equipment anchors and shall also be large enough and thick enough to ensure adequate edge distance and embedment depth for restraint anchor bolts to avoid housekeeping pad breakout failure. Refer seismic restraint manufacturer's written instructions.

E. Coordinate with vibration/seismic restraint manufacturer and the structural engineer of record to locate and size structural supports underneath vibration/seismically restrained equipment (e.g. roof curbs, cooling towers and other similar equipment). Installation of all seismic restraint materials specified in this section shall be accomplished as per the manufacturer's written instructions. Adjust isolators and restraints after piping systems have been filled and equipment is at its operating weight, following the manufacturer's written instructions.

3.3 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES and per the seismic restraint manufacturer’s design.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.4 VIBRATION-CONTROL DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
B. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

C. Isolate all mechanical equipment 0.75 hp and over per the isolator and seismic restraint schedule and these specifications. Vibration isolators shall be selected in accordance with the equipment, pipe or duct weight distribution so as to produce reasonably uniform deflections.

D. All isolation materials and seismic restraints shall be of the same vendor and shall be selected and certified using published or factory certified data.

E. Installation of all vibration isolation materials, flexible connectors and supplemental equipment bases specified in this section shall be accomplished as per the manufacturer's written instructions with mountings adjusted to level equipment. Any variance or non-compliance with the manufacturer’s instructions shall be reviewed and approved in writing by the manufacturer or corrected by the contractor in an approved manner.

F. Installation of vibration isolators must not cause any change of position of equipment, piping or duct work resulting in stresses or misalignment.

G. Locate isolation hangers as near to the overhead support structure as possible.

H. No rigid connections between isolated components and the building structure shall be made that degrades the noise and vibration control system herein specified. “Building” includes, but is not limited to, slabs, beams, columns, studs and walls. “Components” includes, but is not limited to, mechanical equipment, piping and ducts.

I. Coordinate work with other trades to avoid rigid contact with the building.

J. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor’s expense.

K. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractor’s expense.

L. Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the contractor’s expense.

M. Use horizontal thrust restraints T1 to protect Air handling equipment and centrifugal fans against excessive displacement which results from high air thrust when thrust forces exceed 10% of the equipment weight.

N. Isolated equipment, duct and piping located on roofs must be attached to the structure. Supports (e.g., sleepers) that are not attached to the structure will not be acceptable.
O. On completion of installation of all isolation materials and before startup of isolated equipment all debris shall be cleared from areas surrounding and from beneath all isolated equipment, leaving equipment free to move on the isolation supports.

P. All floor mounted isolated equipment shall be protected with specification M1, M2, S1, S2 or S3 isolator.

Q. Horizontal Pipe Isolation: All HVAC pumped water, pumped condensate, glycol, and refrigerant piping size 1-1/4” and larger within mechanical rooms shall be isolated. Outside equipment rooms this piping shall be isolated for the greater of 50’ or 100 pipe diameters from rotating equipment. For the first three (3) support locations from externally isolated equipment provide specification H2 or H3 hangers or specification S1, S2 or S3 mounts with the same deflection as equipment isolators (max 2”). All other piping within the equipment rooms shall be isolated with the same specification isolators with a 3/4” minimum deflection. Steam piping size 1-1/4” and larger which is within an equipment room and connected to rotating equipment shall be isolated for three (3) support locations from the equipment. Provide specification H2 or H3 hangers, or specification S1 or S2 mounts with the same deflection as equipment isolators but a minimum of ¾”.

R. Install full line size flexible pipe connectors at the inlet and outlet of each pump, cooling tower, condenser, chiller, coiling connections and where shown on the drawings. All connectors shall be suitable for use at the temperature, pressure, and service encountered at the point of installation and operation. End fitting connectors shall conform to the pipefitting schedule. Control rods or protective braid must be used to limit elongation to 3/8”. Flexible connectors shall not be required for suspended in-line pumps.

S. All plumbing pumped water, piping size 1-1/4” and larger within mechanical rooms shall be isolated the same as HVAC piping above. Isolators are not required for any plumbing pumped water, pumped condensate, and steam piping outside of mechanical rooms unless listed in the isolation schedule.

T. Pipe Riser Isolation: The operating weight of all variable temperature vertical pipe risers 1-1/4” and larger, requiring isolation where specifically shown and detailed on riser drawings shall be fully supported by specification M1, M2 or R1 supports. S1, S2, S3, H2 or H3 steel spring deflection isolators with minimum 3/4-inch minimum shall be in those locations where added deflection is required due to pipe expansion and contraction. Spring deflection shall be a minimum of 4 times the anticipated deflection change. Springs shall be selected to keep the riser in tension. Height saving brackets used with isolators having 2.5” deflection or greater shall be of the precompression type to limit exposed bolt length. Specification R1 riser supports shall be installed near the center point of the riser to anchor the riser when spring isolation is used. Specification R2 riser guides may be used in conjunction with spring isolators per design calculations. Pipe risers up through 16” shall be supported at intervals of every third floor of the building. Pipe risers 18” and over, every second floor. Wall sleeves for take-offs from riser shall be sized for insulation O.D. plus two times the anticipated movement to prevent binding. Horizontal take-offs and at upper and lower elbows shall be supported with spring isolators as required to accommodate anticipated movement. In addition to submittal data requirements previously outlined, riser diagrams and calculations shall be submitted for approval. Calculations must show anticipated expansion and contraction at each support point, initial and final loads on the building.
structure, and spring deflection changes. Submittal data shall include certification that
the riser system has been examined for excessive stresses and that none will exist if
installed per design proposed.

U. Where riser pipes pass through cored holes, core diameters shall be a maximum of 2"
larger than pipe O.D. including insulation. Cored holes must be packed with resilient
material or firestop as provided by other sections of this specification or local codes.
Where seismic restraint is required specification isolator S3 shall support risers and
provide longitudinal restraint at floors where thermal expansion is minimal and will not
bind isolator restraints.

V. Duct Isolation: Isolate all duct work with a static pressure 2" W.C. and over in
equipment rooms and to minimum of 50 feet from the fan or air handler. Use
specification type H2 or H3 hangers or type S1 or S2 floor mounts.

3.5 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment Restraints:

1. On projects with Seismic Site Class A or B, seismic design or restraint is not
required.

2. On projects with Seismic Design Category C: Components with an importance
factor of 1.0 do not require seismic design or restraint.

3. Install seismic snubbers on HVAC equipment mounted on vibration isolators.
Locate snubbers as close as possible to vibration isolators and bolt to equipment
base and supporting structure.

4. Install resilient bolt isolation washers on equipment anchor bolts where clearance
between anchor and adjacent surface exceeds 0.125 inch.

5. Install seismic-restraint devices using methods approved by an evaluation
service member of ICC-ES providing required submittals for component.

6. Suspended Equipment: All suspended equipment that meets any of the following
conditions requires seismic restraints as specified by the supplier:

a. Rigidly attached to pipe or duct that is 75 lbs. and greater,

b. Items greater than 20 lbs and distribution systems weighing more than 5
lbs/lineal foot, with an importance factor of 1.0 hung independently or with
flexible connections.

c. Possibility of consequential damage.

d. For importance factors greater than 1.0 all suspended equipment requires
seismic restraint regardless of the above notes.

e. Wall mounted equipment weighing more than 20 lbs.

f. Exemptions:

1) Equipment weighing less than 20 lbs and distribution systems
weighing less than 5 lbs/lineal foot, with an Ip = 1.0 and where
flexible connections exist between the component and associated ductwork, piping or conduit.

7. Base Mounted Equipment: All base mounted equipment that meets any of the following conditions requires attachments and seismic restraints as specified by the supplier:
   a. Connections to or containing hazardous material,
   b. With an overturning moment.
   c. Weight greater than 400 lbs.
   d. Mounted on a stand 4 ft. or more from the floor
   e. Possibility of consequential damage.
   f. For importance factors greater than 1.0 all base mounted items require seismic restraints regardless of the above notes.
   g. For equipment with high center of gravity additional cable restraints shall be furnished, as required by isolation manufacturer, to limit forces and motion caused by rocking.
   h. Exemptions:
      1) Floor or curb-mounted equipment weighing less than 400 lbs and not resiliently mounted, where the Importance Factor, Ip = 1.0, the components are mounted at 4 feet or less above a floor level, flexible connections between the components and associated duct work, piping and conduit are provided and there is no possibility of consequential damage.

8. Roof Mounted Equipment:
   a. To be installed on a structural frame, seismically rated roof curb, or structural curb frame mechanically connected to the structure. Items shall not be mounted onto sleepers or pads that are not mechanically and rigidly attached to the structure. Restraint must be adequate to resist both seismic and wind forces.
   b. Roof curbs shall be installed directly to building structural steel or concrete roof deck and not to top of steel deck or roofing material.
   c. Exemptions:
      1) Curb-mounted mushroom, exhaust and vent fans with curb area less than nine square feet are excluded.

9. Rigid Mounted Equipment:
   a. Anchor floor and wall mounted equipment to the structure as per the stamped seismic certifications / drawings.
   b. For equipment with high center of gravity additional cable restraints shall be furnished, as required by isolation manufacturer, to limit forces and motion caused by rocking.
   c. Suspended equipment shall be restrained using seismic cable restraints, or struts, and hanger rods as per the stamped seismic certifications / drawings.

10. Vibration Isolated Equipment:
a. Seismic control shall not compromise the performance of noise control, vibration isolation or fire stopping systems.
b. Equipment supported by vibration-isolation hangers shall be detailed and installed with approximately a 1/8” gap between the isolation hangers and the structure. Isolators at restraint locations must be fitted with uplift limit stops.

B. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

C. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

D. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES providing required submittals for component.

E. Installation and adjustment of all seismic restraints specified in this section shall be accomplished as per the manufacturer’s written instructions. Any deviation from the manufacturer’s instructions shall be reviewed and approved by the manufacturer.

F. Piping Restraints:

1. Comply with requirements in MSS SP-127.
4. Seismically restrain piping, with an Ip = 1.0, located in boiler rooms, mechanical equipment rooms and refrigeration equipment rooms that is 1¼” I.D. and larger.
5. Seismically restrain all other Ip = 1.0 piping 2½” diameter and larger.
6. Seismically restrain all Ip = 1.5 piping larger than 1” diameter.
7. Branch lines may not be used to brace main lines.
8. Exemptions:

   a. All high deformability pipe 3” or less in diameter suspended by individual hanger rods where Ip = 1.0.
   b. High deformability pipe or conduit in Seismic Design Category C, 2” or less in diameter suspended by individual hanger rods where Ip = 1.5.
   c. High deformability pipe in Seismic Design Category D, E or F, 1” or less in diameter suspended by individual hanger rods where Ip = 1.5.
   d. All clevis supported pipe runs installed less than 12” from the top of the pipe to the underside of the support point and trapeze supported pipe suspended by hanger rods having a distance less than 12” in length from the underside of the pipe support to the support point of the structure.
   e. Piping systems, including their supports, designed and constructed in accordance with ASME B31.
   f. Piping systems, including their supports, designed and constructed in accordance with NFPA, provided they meet the force and displacement requirements of Section 13.3.1 and 13.3.2 (ASCE 7).

G. Install flexible metal hose loops in piping which crosses building seismic joints, sized for the anticipated amount of movement.

H. Install flexible piping connectors 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.

I. Where pipe sizes reduce below dimensions required for seismic, the final restraint shall be installed at the transition location.

J. Restraint Spacing For Piping: Sizes shown are maximum. Actual spacing determined by calculation.

1. For non-ductile piping (e.g., cast iron, PVC) space transverse supports a maximum of 20’ o.c., and longitudinal supports a maximum of 40’ o.c.
2. For piping with hazardous material inside (e.g., natural gas, medical gas) space Transverse supports a maximum of 20’ o.c., and longitudinal supports a maximum of 40’ o.c.
3. For pipe risers, restrain the piping at floor penetrations using the same spacing requirements as above.
4. For all other ductile piping see Table “A” below

K. Seismic Restraint of Ductwork: Seismically restrain per specific code requirements, all ductwork listed below (unless otherwise indicated on the drawings), using seismic cable restraints: (Ductwork not meeting criteria listed below is to be “Exempt”)

1. Restrain rectangular ductwork with cross sectional area of 6 square feet or larger. Duct with and an importance factor of 1.5 must be braced with no exceptions regardless of size or distance requirements.
2. Restrain round ducts with diameters of 28” or larger. Duct with an importance factor of 1.5 must be braced with no exceptions regardless of size or distance requirements.
3. Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
4. Duct must be reinforced at the restraint locations. Reinforcement shall consist of an additional angle on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze. Additional reinforcing is not required if duct sections are mechanically fastened together with frame bolts and positively fastened to the duct support suspension system.
5. A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
6. Walls, including gypsum board non-bearing partitions, which have ducts running through them, may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame.
7. If ducts are supported by angles, channels or struts, ducts shall be fastened to it at seismic brace locations in lieu of duct reinforcement.
8. All ductwork weighing more than 17 lb/ft.
9. Exemptions:
   a. Duct runs supported at locations by two rods less than 12 inches in length from the structural support to the structural connection to the ductwork. This exemption does not apply to ducts with an importance factor of 1.5.
10. See Table “A” below for restraint spacing.
L. Exemptions do not apply for:

1. Life Safety or High Hazard Components
   
a. Including gas, fire protection, medical gas, fuel oil and compressed air needed for the continued operation of the facility or whose failure could impair the facility's continued operation, Occupancy Category IV, IBC-2009 as listed in Section 1.3 B regardless of governing code for HVAC, Plumbing, Electrical piping or equipment. (A partial list is illustrated.) High Hazard is additionally classified as any system handling flammable, combustible or toxic material. Typical systems not excluded are additionally listed below.

2. Piping
   
a. Fuel oil, gasoline, natural gas, medical gas, steam, compressed air or any piping containing hazardous, flammable, combustible, toxic or corrosive materials. Fire protection standpipe, risers and mains. Fire Sprinkler Branch Lines must be end tied.

3. Duct
   
a. Smoke evacuation duct or fresh air make up connected to emergency system, emergency generator exhaust, boiler breeching or as used by the fire department on manual override.

4. Equipment
   
a. Previously excluded non life safety duct mounted systems such as fans, variable air volume boxes, heat exchangers and humidifiers having a weight greater than 75 lbs require independent seismic bracing.

M. Spacing Chart For Suspended Components:

<table>
<thead>
<tr>
<th>Table &quot;A&quot; Seismic Bracing</th>
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<tbody>
<tr>
<td>(Maximum Allowable Spacing Shown- Actual Spacing to Be Determined by Calculation)</td>
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<table>
<thead>
<tr>
<th>Equipment</th>
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<th>On Center Longitudinal</th>
<th>Change Of Direction</th>
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<tr>
<td>All Sizes</td>
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<td>Pipe Threaded, Welded, Soldered Or Grooved</td>
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<td>To 16”</td>
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</table>

N. Roof mounted duct is to be installed on sleepers or frames mechanically connected to the building structure. Roof anchors and seismic cables or frames shall be used to resist seismic and wind loading. Wind loading factors shall be determined by the registered design professional.
O. Where duct sizes reduce below dimensions required for seismic restraint the final restraint shall be installed at the transition location.

P. Install cables so they do not bend across edges of adjacent equipment or building structure.

Q. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

R. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

S. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

T. Seismically Rated Beam Clamps are required where welding to or penetrations to steel beams are not approved.

U. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed 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. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.6 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic 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.
3.7 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.
   1. A representative of the vibration isolation system manufacturer shall review the project installation and provide documentation indicating conformance to vibration isolation design intent.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.
   1. The installing contractor shall submit a report upon request to the building architect and/or engineer, including the manufacturer’s representative’s final report, indicating that all seismic restraint material has been properly installed, or steps that are to be taken by the contractor to properly complete the seismic restraint work as per the specifications.

3.8 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust leveling devices as required to distribute loading uniformly on isolators. Shim units as required where leveling devices cannot be used to distribute loading properly.
   1. Adjust active height of spring isolators.

C. 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.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>A' CRITICAL (35'-50' SPAN) ISOLATOR MINIMUM DEFLECTION (IN)</th>
<th>B' UPPER STORY (20'-35' SPAN) ISOLATOR MINIMUM DEFLECTION (IN)</th>
<th>C' GRAD E ISOLATOR MINIMUM DEFLECTION (IN)</th>
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<td>ISOLATOR TYPE</td>
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VIBRATION AND SEISMIC CONTROLS FOR HVAC 230548 - 26
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<tr>
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<th>FLOOR MOUNTED</th>
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<th>HIGH PRESSURE FAN SECTIONS</th>
<th>CENTRIFUGAL FANS CL. I &amp; II UP TO 54-112&quot; W.D.</th>
<th>AXIAL FLOWFANS</th>
<th>VENT (UTILITY SETS)</th>
<th>CABINET FANS, FANS SECTIONS</th>
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NOTES:

1) Thrust restraints required on all high-pressure fan section, suspended axial-flow fans and on floor-mounted axial fans operating at 3.0” S.P. or greater.

END OF SECTION
SECTION 230550 - OPERATION AND MAINTENANCE OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. All pertinent sections of Division 21, 22, & 23 Mechanical General Requirements, are part of the work of this Section. Division 1 is part of this and all other sections of these specifications.
   1. Testing and Balancing is specified in section 230594.
   2. Training and Instructions to Owner’s Representative is specified in section 230100.

1.2 SCOPE OF WORK
A. Submission of Operating and Maintenance Manuals complete with Balancing reports. (Coordinate with Division 1).
B. Coordination of work required for system commissioning.
C. Provide a hard copy and an electronic copy on CD of the O and M manual fully searchable in PDF format.

1.3 SUBMITTALS
A. Submit product data in accordance with Division 1 and Section 230100. Submit the following:

PART 2 - PRODUCTS

2.1 O & M MANUALS
A. The operating and maintenance manuals shall be as follows:
   1. Binders shall be red buckram with easy-view metal for size 8-1/2 x 11-inch sheets, with capacity expandable from 2 inches to 3-1/2 inches as required for the project. Construction shall be rivet-through with library corners. No. 12 backbone and lining shall be the same material as the cover. The front cover and backbone shall be foil-stamped in white as follows: (coordinate with Division 01)
PART 3 - EXECUTION

3.1 OPERATING AND MAINTENANCE MANUALS:

A. Work under this section shall be performed in concert with the contractor performing the system testing and balancing. Six (6) copies of the manuals shall be furnished to the Architect for distribution to the owner.

B. The "Start-Up and Operation" section is one of the most important in the manual. Information in this section shall be complete and accurately written and shall be verified with the actual equipment on the job, such as switches, starters, relays, automatic controls, etc. A step-by-step start-up procedure shall be described.

C. The manuals shall include air and water-balancing reports, system commissioning procedures, start-up tests and reports, equipment and system performance test reports, warranties, and certificates of training given to the owner’s representatives.

An index sheet typed on AICO Gold-Line indexes shall be provided in the front of the binder. The manual shall include the following:

SYSTEM DESCRIPTIONS

START-UP PROCEDURE AND OPERATION OF SYSTEM

MAINTENANCE AND LUBRICATION TABLE

OPERATION AND MAINTENANCE BULLETINS

AUTOMATIC TEMPERATURE CONTROL DESCRIPTION OF OPERATION, INTERLOCK AND CONTROL DIAGRAMS, AND CONTROL PANELS.

AIR AND WATER SYSTEM BALANCING REPORTS

EQUIPMENT WARRANTIES AND TRAINING CERTIFICATES

SYSTEM COMMISSIONING REPORTS
EQUIPMENT START-UP CERTIFICATES

END OF SECTION
SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:
   a. Constant-volume air systems.
   b. Variable-air-volume systems.

2. Balancing Hydronic Piping Systems:
   a. Constant-flow hydronic systems.
   b. Variable-flow hydronic systems.
   c. Primary-secondary hydronic systems.


4. Various HVAC Equipment.
   b. Motors.
   c. Chillers.
   d. Cooling Towers.
   e. Condensing Units.
   f. Boilers.
   g. Heat Transfer Coils.


1.3 DEFINITIONS


C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.
E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within the following number of days of the 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;
   1. 30 days.

B. Certified TAB reports.

C. Instrument calibration reports, to include the following:
   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Dates of calibration.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.
   1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB and shall be the same as the TAB Contractor.
   2. TAB Technician: Employee of the TAB contractor and who is certified by AABC or NEBB as a TAB technician and shall be the same as the TAB Contractor.

B. 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.

C. TAB Report Forms: Use standard TAB contractor's forms approved by:
   1. Architect.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

F. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."
1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on the following distribution systems have been satisfactorily completed:
   1. Air and water.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 TAB SPECIALISTS

A. Subject to compliance with requirements, engage one of the following:
   1. BTC Service.
   2. Certified Test & Balance.
   4. RS Analysis.
   5. Test & Balance Inc.
   6. Payson Sheetmetal.

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 approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine:
1. 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:
   a. Section 233113 "Metal Ducts"
2. Verify ceiling plenums and underfloor air plenums used for supply, return or relief air are properly separated from adjacent areas.
3. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.
   1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
   2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.3 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 this section and:
   1. AABC's "National Standards for Total System Balance"
   2. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
   1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
   2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP).

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.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

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 one of the following entities for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC
Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance:

a. Architect.

7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.

   a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.

3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.

2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
   a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
8. Record final fan-performance data.

C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Balance variable-air-volume systems the same as described for constant-volume air systems.
2. Set terminal units and supply fan at full-airflow condition.
3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
4. Readjust fan airflow for final maximum readings.
5. Measure operating static pressure at the sensor that controls the supply fan if one is installed, and verify operation of the static-pressure controller.
6. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
   a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.

3. Set terminal units at full-airflow condition.

4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.

5. Adjust terminal units for minimum airflow.

6. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

3.8 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems’ "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check liquid level in expansion tank.
3. Check makeup water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.9 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and
correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from the following entity and comply with requirements in Section 232123 "Hydronic Pumps."
   1) Architect.

2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.

   a. Monitor motor performance during procedures and do not operate motors in overload conditions.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.

4. Report flow rates that are not within plus or minus 10 percent of design.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

D. Set calibrated balancing valves, if installed, at calculated settings.

E. Measure flow at all stations and adjust, where necessary, to obtain first balance.

   1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

   1. Determine the balancing station with the highest percentage over indicated flow.
   2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
   3. Record settings and mark balancing devices.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

J. Check settings and operation of each safety valve. Record settings.

3.10 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS
A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.11 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS
A. Balance the primary circuit flow first and then balance the secondary circuits.

3.12 PROCEDURES FOR STEAM SYSTEMS
A. Measure and record upstream and downstream pressure of each piece of equipment.
B. Measure and record upstream and downstream steam pressure of pressure-reducing valves.
C. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
D. Check settings and operation of each safety valve. Record settings.
E. Verify the operation of each steam trap.

3.13 PROCEDURES FOR HEAT EXCHANGERS
A. Measure water flow through all circuits.
B. Adjust water flow to within specified tolerances.
C. Measure inlet and outlet water temperatures.
D. Measure inlet steam pressure.
E. Check settings and operation of safety and relief valves. Record settings.

3.14 PROCEDURES FOR MOTORS
A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
   1. Manufacturer's name, model number, and serial number.
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.

3.15 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.16 PROCEDURES FOR COOLING TOWERS

A. Shut off makeup water for the duration of the test, and verify that makeup and blowdown systems are fully operational after tests and before leaving the equipment. Perform the following tests and record the results:

1. Measure condenser-water flow to each cell of the cooling tower.
2. Measure entering- and leaving-water temperatures.
3. Measure wet- and dry-bulb temperatures of entering air.
4. Measure wet- and dry-bulb temperatures of leaving air.
5. Measure condenser-water flow rate recirculating through the cooling tower.
6. Measure cooling-tower spray pump discharge pressure.
7. Adjust water level and feed rate of makeup water system.
8. Measure flow through bypass.
3.17 PROCEDURES FOR CONDENSING UNITS
   A. Verify proper rotation of fans.
   B. Measure entering- and leaving-air temperatures.
   C. Record compressor data.

3.18 PROCEDURES FOR BOILERS
   A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and
      water flow.
   B. Steam Boilers: Measure and record entering-water temperature and flow and leaving-
      steam pressure, temperature, and flow.

3.19 PROCEDURES FOR HEAT-TRANSFER COILS
   A. Measure, adjust, and record the following data for each water coil:
      1. Entering- and leaving-water temperature.
      2. Water flow rate.
      3. Water pressure drop.
      4. Dry-bulb temperature of entering and leaving air.
      5. Wet-bulb temperature of entering and leaving air for cooling coils.
      6. Airflow.
      7. Air pressure drop.

   B. Measure, adjust, and record the following data for each electric heating coil:
      1. Nameplate data.
      2. Airflow.
      3. Entering- and leaving-air temperature at full load.
      4. Voltage and amperage input of each phase at full load and at each incremental
         stage.
      5. Calculated kilowatt at full load.
      6. Fuse or circuit-breaker rating for overload protection.

   C. Measure, adjust, and record the following data for each steam coil:
      1. Dry-bulb temperature of entering and leaving air.
      2. Airflow.
      3. Air pressure drop.
      4. Inlet steam pressure.

   D. Measure, adjust, and record the following data for each refrigerant coil:
      1. Dry-bulb temperature of entering and leaving air.
      2. Wet-bulb temperature of entering and leaving air.
      3. Airflow.
      4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.20 DOMESTIC HEATER SYSTEMS

A. Test domestic heater system per Engineer's instructions.

3.21 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
   2. Air Outlets and Inlets: Plus or minus 10 percent.
   3. Heating-Water Flow Rate: Plus or minus 10 percent.
   4. Cooling-Water Flow Rate: Plus or minus 10 percent.

3.22 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare progress reports on the following interval 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;
   1. Weekly.

3.23 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.
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.

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, and bore.
   i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
   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, and bore.
   f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):
   a. Total air flow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Filter static-pressure differential in inches wg.
   f. Preheat-coil static-pressure differential in inches wg.
   g. Cooling-coil static-pressure differential in inches wg.
   h. Heating-coil static-pressure differential in inches wg.
   i. Outdoor airflow in cfm.
   j. Return airflow in cfm.
   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 o.c.
   f. Make and model number.
   g. Face area in sq. ft.
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.
o. Inlet steam pressure in psig.

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.
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, and bore.
n. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.
f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btu/h.
i. High-fire fuel input in Btu/h.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btu/h.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h.

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.
   e. Number of stages.
   f. Connected volts, phase, and hertz.
   g. Rated amperage.
   h. Air flow rate in cfm.
   i. Face area in sq. ft..
   j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):
   a. Heat output in Btu/h.
   b. Air flow rate in cfm.
   c. Air velocity in fpm.
   d. Entering-air temperature in deg F.
   e. Leaving-air temperature in deg F.
   f. Voltage at each connection.
   g. Amperage for each phase.

I. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:
   a. System identification.
   b. Location.
   c. Make and type.
   d. Model number and size.
   e. Manufacturer's serial number.
   f. Arrangement and class.
   g. Sheave make, size in inches, and bore.
   h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

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, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Suction static pressure in inches wg.

J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:
   a. System and air-handling-unit number.
   b. Location and zone.
   c. Traverse air temperature in deg F.
   d. Duct static pressure in inches wg.
   e. Duct size in inches.
   f. Duct area in sq. ft.
   g. Indicated air flow rate in cfm.
   h. Indicated velocity in fpm.
   i. Actual air flow rate in cfm.
   j. Actual average velocity in fpm.
   k. Barometric pressure in psig.

K. Air-Terminal-Device Reports:

1. Unit Data:
   a. System and air-handling unit identification.
   b. Location and zone.
   c. 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.

2. Test Data (Indicated and Actual Values):
   a. Air flow rate in cfm.
   b. Air velocity in fpm.
   c. Preliminary air flow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final air flow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:
   a. System and air-handling-unit identification.
   b. Location and zone.
   c. Room or riser served.
   d. Coil make and size.
   e. Flowmeter type.

2. Test Data (Indicated and Actual Values):
   a. Air flow rate in cfm.
   b. Entering-water temperature in deg F.
   c. Leaving-water temperature in deg F.
   d. Water pressure drop in feet of head or psig.
   e. Entering-air temperature in deg F.
   f. Leaving-air temperature in deg F.

M. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Service.
   d. Make and size.
   e. Model number and serial number.
   f. Water flow rate in gpm.
   g. Water pressure differential in feet of head or psig.
   h. Required net positive suction head in feet of head or psig.
   i. Pump rpm.
   j. Impeller diameter in inches.
   k. Motor make and frame size.
   l. Motor horsepower and rpm.
   m. Voltage at each connection.
   n. Amperage for each phase.
   o. Full-load amperage and service factor.
   p. Seal type.

2. Test Data (Indicated and Actual Values):
   a. Static head in feet of head or psig.
   b. Pump shutoff pressure in feet of head or psig.
   c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

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.

3.24 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:
   a. Architect.

2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of:
   a. Architect.

3. The following entity 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:
   a. Architect.
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.

3.25 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION
SECTION 230713 - DUCT 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 duct services:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Indoor, concealed combustion air.
8. Indoor, exposed combustion air.
9. Outdoor, concealed supply and return.
10. Outdoor, exposed supply and return.

B. Related Sections:

1. Section 230716 "HVAC Equipment Insulation."
2. Section 230719 "HVAC Piping Insulation."
3. Section 233113 "Metal Ducts" for duct liners.

1.3 ACTION SUBMITTALS

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

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.
1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.
1.8 SCHEDULING

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

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS


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 II for sheet materials.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Aeroflex USA, Inc.; Aerocel.
   b. Armacell LLC; AP Armaflex.
   c. K-Flex USA; Insul-Sheet, K-Flex Gray Duct Liner, and K-FLEX LS.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; SoftTouch Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Friendly Feel Duct Wrap.
   d. Manson Insulation Inc.; Alley Wrap.
   e. Owens Corning; SOFTR All-Service Duct Wrap.
H. 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 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.

I. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

1. **Products:** Subject to compliance with requirements, provide one of the following:
   a. Armacell LLC; Tubolit.
   b. Nomaco Insulation; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.

2.2 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C 656, Type II, Grade 6. Tested and certified to provide a:
   a. 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction

1. **Products:** Subject to compliance with requirements, provide the following:
   a. Johns Manville; Super Firetemp M.

B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a:
   a. 2-hour fire rating by an NRTL acceptable to authorities

2. **Products:** Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; FlameChek.
   b. Johns Manville; Firetemp Wrap.
   c. Nelson Fire Stop Products; Nelson FSB Flameshield Blanket.
   d. Thermal Ceramics; FireMaster Duct Wrap.
   e. 3M; Fire Barrier Wrap Products.
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, provide one of the following:
   a. Aeroflex USA, Inc.; Aeroseal.
   b. Armacell LLC; Armaflex 520 Adhesive.
   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).

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. **Products**: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges - Marathon Industries; 225.
   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).


1. **Products**: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges - Marathon Industries; 225.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
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: Water based; suitable for indoor use on below ambient services.

1. **Products**: Subject to compliance with requirements, provide one of the following:
   b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. **Products**: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges - Marathon Industries; 550.
   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 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.

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, provide one of the following:
   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 duct insulation.
4. Service Temperature Range: 0 to plus 180 deg F.

2.6 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the following:
      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 deg 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).

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. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
C. Metal Jacket:

1. **Products**: Subject to compliance with requirements, provide one of the following:
   
   b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
   c. RPR Products, Inc.; Insul-Mate.

   
a. Sheet and roll stock ready for shop or field sizing
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
   d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft.

2.9 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. **Products**: Subject to compliance with requirements, provide one of the following:
   
a. ABI, Ideal Tape Division; 491 AWF FSK.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   c. Compac Corporation; 110 and 111.
   d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. **Products**: Subject to compliance with requirements, provide one of the following:
   
a. ABI, Ideal Tape Division; 488 AWF.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   c. Compac Corporation; 120.
   d. Venture Tape; 3520 CW.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.10 SECUREMENTS

A. Bands:

1. **Products:** Subject to compliance with requirements, provide one of the following:
   
   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal.


B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch-diameter shank, length to suit depth of insulation indicated.
   
   a. **Products:** Subject to compliance with requirements, provide one of the following:
      
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; CD.
      3) Midwest Fasteners, Inc.; CD.
      4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   
   a. **Products:** Subject to compliance with requirements, provide one of the following:
      
      1) AGM Industries, Inc.; CHP-1.
      2) GEMCO; Cupped Head Weld Pin.
      3) Midwest Fasteners, Inc.; Cupped Head.
      4) Nelson Stud Welding; CHP.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   
   a. **Products:** Subject to compliance with requirements, provide one of the following:
1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
2) GEMCO; Perforated Base.
3) Midwest Fasteners, Inc.; Spindle.

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: Copper- or zinc-coated, low-carbon steel fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

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

   1) GEMCO; Nylon Hangers.
   2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.

b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

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

   1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
   2) GEMCO; Peel & Press.
   3) Midwest Fasteners, Inc.; Self Stick.

b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
d. Adhesive-backed base with a peel-off protective cover.
PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 PREPARATION

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

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at:
   a. 2 inches o.c.
   b. For below ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 078413 "Penetration Firestopping" firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

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

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for:
   a. 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not overcompress insulation during installation.
e. Impale insulation over pins and attach speed washers.
f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for:
      a. 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 and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.
   e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

   1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
   2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
   3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.

4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch wide joint strips at end joints.

5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.8 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 Section 078413 "Penetration Firestopping."

3.9 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "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.


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.
3.10 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

C. Tests and Inspections:
   1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location (s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
   1. Indoor, concealed supply and outdoor air.
   2. Indoor, exposed supply and outdoor air.
   3. Indoor, concealed return located in unconditioned space.
   4. Indoor, exposed return located in unconditioned space.
   5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
   6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
   7. Indoor, concealed combustion air.
   8. Indoor, exposed combustion air.
   9. Outdoor, concealed supply and return.
  10. Outdoor, exposed supply and return.

B. Items Not Insulated:
   1. Fibrous-glass ducts.
   2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
   3. Factory-insulated flexible ducts.
   5. Flexible connectors.
   7. Factory-insulated access panels and doors.
3.12 Insulation shall have an R value that meets the minimum requirements of the latest International Energy Conservation Code (IECC).

3.13 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round and flat-oval, supply-air duct insulation shall be one of the following:
   1. Flexible Elastomeric: 1 inch thick.
   2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

B. Concealed, round and flat-oval, return-air duct insulation shall be one of the following:
   1. Flexible Elastomeric: 1 inch thick.
   2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

C. Concealed, round and flat-oval, outdoor-air and combustion-air duct insulation shall be one of the following:
   1. Flexible Elastomeric: 1 inch thick.
   2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

D. Concealed, round and flat-oval, exhaust-air duct insulation shall be one of the following:
   1. Flexible Elastomeric: 1 inch thick.
   2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

E. Concealed, rectangular, supply-air duct insulation shall be one of the following:
   1. Flexible Elastomeric: 1 inch thick.
   2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

F. Concealed, rectangular, return-air duct insulation shall be one of the following:
   1. Flexible Elastomeric: 1 inch thick.
   2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

G. Concealed, rectangular, outdoor-air and combustion-air duct insulation shall be one of the following:
   1. Flexible Elastomeric: 1 inch thick.
   2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

H. Concealed, supply-air plenum insulation shall be one of the following:
   1. Flexible Elastomeric: 1 inch thick.
   2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

I. Concealed, return-air plenum insulation shall be one of the following:
   1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

J. Concealed, outdoor-air plenum insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

K. Exposed, round and flat-oval, supply-air duct insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

L. Exposed, round and flat-oval, return-air duct insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

M. Exposed, round and flat-oval, outdoor-air and combustion-air duct insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

N. Exposed, rectangular, supply-air duct insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

O. Exposed, rectangular, return-air duct insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

P. Exposed, rectangular, outdoor-air and combustion-air duct insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

Q. Exposed, supply-air plenum insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

R. Exposed, return-air plenum insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
3.14 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.

B. Exposed, round and flat-oval, supply-air duct insulation shall be one of the following:
   1. Flexible Elastomeric: 1 inch thick.
   2. Polyolefin: 1 inch thick.

C. Exposed, round and flat-oval, return-air duct insulation shall be one of the following:
   1. Flexible Elastomeric: 1 inch thick.
   2. Polyolefin: 1 inch thick.

D. Exposed, rectangular, supply-air duct insulation shall be one of the following:
   1. Flexible Elastomeric: 1 inch thick.
   2. Polyolefin: 1 inch thick.

E. Exposed, rectangular, return-air duct insulation shall be one of the following:
   1. Flexible Elastomeric: 1 inch thick.
   2. Polyolefin: 1 inch thick.

F. Exposed, supply-air plenum insulation shall be one of the following:
   1. Flexible Elastomeric: 1 inch thick.
   2. Polyolefin: 1 inch thick.

G. Exposed, return-air plenum insulation shall be one of the following:
   1. Flexible Elastomeric: 1 inch thick.
   2. Polyolefin: 1 inch 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. Ducts and Plenums, Concealed:
   1. Aluminum, Corrugated: 0.032 inch thick.

D. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
   1. Aluminum, Corrugated: 0.032 inch thick.
E. Ducts and Plenums, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. Aluminum, with 1-1/4-Inch- Deep Corrugations: 0.032 inch thick.

END OF SECTION
SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Includes but not limited to:

1. Furnish and install piping and specialties for refrigeration systems as described in Contract Documents.

B. Related Sections:

1. Section 230500: Common HVAC Requirements.
2. Section 230719: HVAC Piping Insulation.
1.2 REFERENCES

A. American Society for Testing and Materials:
   1. ASTM A 36-03a, 'Standard Specification for Carbon Structural Steel.'
   2. ASTM B 280-03, 'Standard Specification for Seamless Copper Tube for Air
      Conditioning and Refrigeration Field Service.'

B. American Welding Society / American National Standards Institute:
   1. AWS / ANSI A5.8-2009, 'Specification for Brazing Filler Metal.'

1.3 SUBMITTALS

A. Shop Drawings:  Show each individual equipment and piping support.

B. Quality Assurance / Control:  Technician certificate for use of CFC and HCFC
   refrigerants.

1.4 QUALITY ASSURANCE

A. Qualifications: Refrigerant piping shall be installed by a refrigeration contractor
   licensed by State and by technicians certified in use of CFC and HCFC refrigerants.

PART 2 - PRODUCTS

2.1 COMPONENTS

A. Refrigerant Piping:
   1. Meet requirements of ASTM B 280, hard drawn straight lengths.  Soft copper
      tubing not permitted.
   2. Do not use pre-charged refrigerant lines.

B. Refrigerant Fittings:
   1. Wrought copper with long radius elbows.
   2. Approved Manufacturers.
      a. Mueller Streamline.
      b. Nibco Inc.
      c. Grinnell.
      d. Elkhart.

C. Suction Line Traps:
   1. Manufactured standard one-piece traps.
   2. Approved Manufacturers.
a. Mueller Streamline.
b. Nibco Inc.
c. Grinnell.
d. Elkhart.

D. Connection Material:

1. Brazing Rods in accordance with ANSI / AWS A5.8:
   a. Copper to Copper Connections:
      1) Classification BCuP-4 Copper Phosphorus (6 percent silver).
      2) Classification BCuP-5 Copper Phosphorus (15 percent silver).
   b. Copper to Brass or Copper to Steel Connections: Classification BAg-5 Silver (45 percent silver).
   c. Do not use rods containing Cadmium.

2. Flux:
   a. Type Two Acceptable Products:
      1) Stay-Silv White Brazing Flux by J W Harris.
      2) High quality silver solder flux by Handy & Harmon.
      3) Equal as approved by Architect before use.

E. Valves:

1. Expansion Valves:
   a. For pressure type distributors, externally equalized with stainless steel diaphragm, and same refrigerant in thermostatic elements as in system.
   b. Size valves to provide full rated capacity of cooling coil served. Coordinate selection with evaporator coil and condensing unit.
   c. Approved Manufacturers.
      1) Alco.
      2) Henry.
      3) Mueller.
      4) Parker.
      5) Sporlan.

2. Manual Refrigerant Shut-Off Valves:
   a. Ball valves designed for refrigeration service and full line size.
   b. Valve shall have cap seals.
   c. Valves with hand wheels are not acceptable.
   d. Provide service valve on each liquid and suction line at compressor.
   e. If service valves come as integral part of condensing unit, additional service valves shall not be required.
   f. Approved Manufacturers.
      1) Henry.
2) Mueller.
3) Superior.
4) Virginia.

F. Filter-Drier:
   1. On lines 3/4 inch outside diameter and larger, filter-drier shall be replaceable core type with Schraeder type valve.
   2. On lines smaller than 3/4 inch outside diameter, filter-drier shall be sealed type using flared copper fittings.
   3. Size shall be full line size.
   4. Approved Manufacturers.
      a. Alco.
      b. Mueller.
      c. Parker.
      d. Sporlan.
      e. Virginia.

G. Sight Glass:
   1. Combination moisture and liquid indicator with protection cap.
   2. Sight glass shall be full line size.
   3. Sight glass connections and sight glass body shall be solid copper or brass, no copper-coated steel sight glasses allowed.
   4. Approved Product.
      a. Alco AMI.

H. Flexible Connectors:
   1. Designed for refrigerant service with bronze seamless corrugated hose and bronze braiding.
   2. Approved Products.
      a. Vibration Absorber Model VAF by Packless Industries.
      b. Vibration Absorbers by Virginia KMP Corp.
      c. Anaconda 'Vibration Eliminators' by Universal Metal Hose.
      d. Style 'BF' Spring-flex freon connectors by Vibration Mountings.

2.2 MATERIALS

A. Refrigerant Piping Supports:
   1. Base, Angles, And Uprights: Steel meeting requirements of ASTM A 36.
   2. Securing Channels:
      a. At Free-Standing Pipe Support:
         1) Type Two Acceptable Products:
            a) P-1000 channels by Unistrut.
            b) HS-158-12 channels by Hilti.
c) Equal as approved by Architect before installation.

b. At Wall Support:
   1) Type Two Acceptable Products:
      a) P-3300 channels by Unistrut.
      b) HS-1316-12 channels by Hilti.
      c) Equal as approved by Architect before installation.

c. At Suspended Support:
   1) Type Two Acceptable Products:
      a) P-1001 channels by Unistrut.
      b) MS-41 channels by Hilti.
      c) Equal as approved by Architect before installation.

3. Angle Fittings:
   a. Type Two Acceptable Products:
      1) P-2626 90 degree angle by Unistrut.
      2) MW2 angle by Hilti.
      3) Equal as approved by Architect before installation.

4. Pipe Clamps:
   a. Type Two Acceptable Manufacturers:
      1) Hydra-Zorb.
      2) ZSI Cush-A-Clamp.
      4) Equal as approved by Architect before installation.

5. Protective Cover: 18 ga steel, hot-dipped galvanized.

2.3 MANUFACTURERS

A. Contact Information:

13. Parker Hannifin Corp, Cleveland, OH  www.parker.com/cig/.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refrigerant Lines:

1. Install as high in upper mechanical areas as possible. Do not install underground or in tunnels.
2. Slope suction lines down toward compressor one inch/10 feet. Locate traps at vertical rises against flow in suction lines.

B. Connections:

1. Refrigeration system connections shall be copper-to-copper, copper-to-brass, or copper-to-steel type properly cleaned and brazed with specified rods. Use flux only where necessary. No soft solder (tin, lead, antimony) connections will be allowed in system.
2. Braze manual refrigerant shut-off valve, sight glass, and flexible connections.
3. Circulate dry nitrogen through tubes being brazed to eliminate formation of copper oxide during brazing operation.

C. Specialties:

1. Install valves and specialties in accessible locations. Install refrigeration distributors and suction outlet at same end of coil.
2. Install thermostatic bulb as close to cooling coil as possible. Do not install on vertical lines.
3. Install equalizing line in straight section of suction line, downstream of and reasonably close to thermostatic bulb. Do not install on vertical lines.
4. Provide flexible connectors in each liquid line and suction line at both condensing unit and evaporator on systems larger than five tons. Anchor pipe near each flexible connector.

D. Refrigerant Supports:

1. Support Spacing:
   a. Piping 1-1/4 inch And Larger: 8 feet on center maximum.
   b. Piping 1-1/8 inch And Smaller: 6 feet on center maximum.
   c. Support each elbow.
2. Isolate pipe from supports and clamps with Hydrozorb or Cush-A-Clamp systems.
3. Run protective cover continuous from condensing units to risers or penetrations at building wall.

3.2 FIELD QUALITY CONTROL

A. Make evacuation and leak tests in presence of Architect's Engineer after completing refrigeration piping systems. Positive pressure test will not suffice for procedure outlined below.

1. Draw vacuum on each entire system with two stage vacuum pump. Draw vacuum to 300 microns using micron vacuum gauge capable of reading from atmosphere to 10 microns. Do not use cooling compressor to evacuate system nor operate it while system is under high vacuum.
2. Break vacuum with nitrogen and re-establish vacuum test. Vacuum shall hold for 30 minutes at 300 microns without vacuum pump running.
3. Conduct tests at 70 deg F ambient temperature minimum.
4. Do not run systems until above tests have been made and systems started up as specified. Inform Owner's Representative of status of systems at time of final inspection and schedule start-up and testing if prevented by outdoor conditions before this time.
5. After testing, fully charge system with refrigerant and conduct test with Halide Leak Detector.
6. Recover all refrigerant in accordance with applicable codes. Do not allow any refrigerant to escape to atmosphere.

B. If it is observed that refrigerant lines are being or have been brazed without proper circulation of nitrogen through lines, all refrigerant lines installed up to that point in time shall be removed and replaced at no additional cost to Owner.

END OF SECTION
SECTION 233001 - COMMON DUCT REQUIREMENTS

PART 1 - PRODUCTS

1.1 SUMMARY

A. Includes But Not Limited To:
   1. General procedures and requirements for ductwork.
   2. Repair leaks in ductwork, as identified by smoke test, at no additional cost to Owner.
   3. Soundproofing procedures for duct penetrations of walls, ceilings, and floors in mechanical equipment rooms.

B. Related Sections:
   1. Division 07: Quality of Acoustic Sealant.
   2. Section 230500: Common Work Results for HVAC
   3. Section 230593: Testing Adjusting and Balancing for HVAC.

1.2 SUBMITTALS

A. Samples: Sealer and gauze proposed for sealing ductwork.

B. Quality Assurance / Control:
   1. Manufacturer’s installation manuals providing detailed instructions on assembly, joint sealing, and system pressure testing for leaks.
   2. Specification data on sealer and gauze proposed for sealing ductwork.

1.3 QUALITY ASSURANCE

A. Requirements: Construction details not specifically called out in Contract Documents shall conform to applicable requirements of SMACNA HVAC Duct Construction Standards.

B. Pre-Installation Conference: Schedule conference immediately before installation of ductwork.
PART 2 - PRODUCTS

2.1 Finishes, Where Applicable: Colors as selected by Architect.

2.2 Duct Hangers:
   A. One inch by 18 ga galvanized steel straps or steel rods as shown on Drawings, and spaced not more than 96 inches apart. Do not use wire hangers.
      1. Attaching screws at trusses shall be 2 inch No. 10 round head wood screws. Nails not allowed.
      2. Attach threaded rod to steel joist with Grinnell Steel washer plate Fig. 60 - ph-1. Double nut connection.

2.3 Penetration Soundproofing Materials:
   A. Insulation for Packing: Fiberglass.
   B. Calking: Polysulphide.
   C. Escutcheon Frame: 22 ga galvanized iron 2 inches wide.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. During installation, protect open ends of ducts by covering with plastic sheet tied in place to prevent entrance of debris and dirt.
   B. Make necessary allowances and provisions in installation of sheet metal ducts for structural conditions of building. Revisions in layout and configuration may be allowed, with prior written approval of Architect. Maintain required airflows in suggesting revisions.
   C. Hangers And Supports:
      1. Install pair of hangers close to each transverse joint and elsewhere as required by spacing indicated in table on Drawings.
      2. Install upper ends of hanger securely to floor or roof construction above by method shown on Drawings.
      3. Attach strap hangers to ducts with cadmium-plated screws. Use of pop rivets or other means will not be accepted.
      4. Where hangers are secured to forms before concrete slabs are poured, cut off flush all nails, strap ends, and other projections after forms are removed.
      5. Secure vertical ducts passing through floors by extending bracing angles to rest firmly on floors without loose blocking or shimming. Support vertical ducts, which do not pass through floors, by using bands bolted to walls, columns, etc. Size, spacing, and method of attachment to vertical ducts shall be same as specified for hanger bands on horizontal ducts.
D. Penetration Soundproofing

1. Pack space between ducts and structure full of fiberglass insulation of sufficient thickness to be wedged tight, allowing space for application of calking.
2. Provide calking at least 2 inches thick between duct and structure on both ends of opening through structure.
3. Provide metal escutcheon on Equipment Room side. Secure escutcheon to wall.

3.2 CLEANING

A. Clean interior of duct systems before final completion.

END OF SECTION
SECTION 233113 - METAL DUCTS

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. Single-wall rectangular ducts and fittings.
   2. Single-wall round ducts and fittings.
   4. Duct liner.
   5. Sealants and gaskets.
   6. Hangers and supports.

B. Related Sections:
   1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
   2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
   3. Section 230713 "Duct Insulation" for duct insulation and fire wrap.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Seismic Performance: Duct hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 230548 "Vibration and Seismic Controls for HVAC."

   1. For equipment with a seismic importance factor of 1.0 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."

   2. For equipment with a seismic importance factor of 1.5 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."

C. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"

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

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.
13. Duct fabrication shall not begin until shop drawings have been submitted and reviewed by the mechanical engineer.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations for selecting hangers and supports.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including, but not limited to the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.
   f. Perimeter moldings.

B. Field quality-control reports.

1.6 QUALITY ASSURANCE


B. Welding Qualifications: Qualify procedures and personnel according to the following:

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements,
materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Duct dimensions shown on drawings are inside clear dimensions.

E. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. Duct dimensions shown on drawings are inside clear dimensions.

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

D. Longitudinal Seams: Not allowed.

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
B. Galvanized Sheet Steel: Comply with ASTM A 653.
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. CertainTeed Corporation; Insulation Group.
      b. Johns Manville.
      c. Knauf Insulation.
      d. Owens Corning.
   2. Maximum Thermal Conductivity:
      a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
      b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
   3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
   4. Water-Based Liner Adhesive:
      a. Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
      b. 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).

B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of 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.
   a. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Insulation Pins and Washers:
   1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
      a. 0.135-inch-diameter shank.
   2. Insulation-Retaining Washers: With beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
      a. Self-locking washers formed from 0.016-inch-thick aluminum.

D. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
   1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
   2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
   3. Butt transverse joints without gaps, and coat joint with adhesive.
   4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
   5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
   6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
   7. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
      a. Fan discharges.
      b. Intervals of lined duct preceding unlined duct.
   8. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
2.5 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 4 inches.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
7. Mold and mildew resistant.
8. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.
10. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
11. Service: Indoor or outdoor.
12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C 920.
   2. Type: S.
   3. Grade: NS.
   5. Use: O.
   6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:
   1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
   2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
   3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.6 HANGERS AND SUPPORTS

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

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:
   3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 2 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class A.
4. Outdoor, Return-Air Ducts: Seal Class A.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class A.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class A.
8. Unconditioned Space, Return-Air Ducts: Seal Class A.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class A.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
11. Conditioned Space, Exhaust Ducts: Seal Class A.
12. Conditioned Space, Return-Air Ducts: Seal Class A.
3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inchesthick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inchesthick.
   5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 SEISMIC-RERAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with the requirements specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.
3.7 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

2. Test the following systems:
   a. Supply Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
   b. Return Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
   c. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
   d. Outdoor Air Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days’ advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Any liner showing evidence that is has been wet at any time shall be removed and replaced with new liner.
   a. Disinfect affected sheet metal, and pins.
   b. Install new liner per specifications
   c. Seal friable edges and seams of repaired liner.
D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.9 DUCT CLEANING

A. Clean new duct system before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.
   1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
   2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
   3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:
   1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
   2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:
   1. Air outlets and inlets (registers, grilles, and diffusers).
   2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
   3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
   5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
   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 fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.

5. 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 drainage and cleanup for wash-down procedures.

7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.10 START UP

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

3.11 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel.

B. Ductwork running in areas where there are no ceilings or when noted on the drawings shall be doubled wall duct and shall meet the requirements indicated below.

C. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
   a. Pressure Class: Positive 2-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 16.
   d. SMACNA Leakage Class for Round: 8.

2. Ducts Connected to Constant-Volume Air-Handling Units:
   a. Pressure Class: Positive 3-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 8.
   d. SMACNA Leakage Class for Round: 4.

3. Ducts Connected to Variable-Air-Volume Air-Handling Units:
   a. Pressure Class: Positive 6-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 4.
   d. SMACNA Leakage Class for Round: 2.

4. Ducts Connected to Equipment Not Listed Above:
   a. Pressure Class: Positive 4-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 4.
d. SMACNA Leakage Class for Round: 2.

D. Return Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 16.
   d. SMACNA Leakage Class for Round: 8.

2. Ducts Connected to Air-Handling Units:
   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 16.
   d. SMACNA Leakage Class for Round: 8

3. Ducts Connected to Equipment Not Listed Above:
   a. Pressure Class: Positive or negative 3-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 8.
   d. SMACNA Leakage Class for Round: 4.

E. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
   a. Pressure Class: Negative 2-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 16.
   d. SMACNA Leakage Class for Round: 4.

2. Ducts Connected to Air-Handling Units:
   a. Pressure Class: Positive or negative 3-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 8.
   d. SMACNA Leakage Class for Round: 4.

3. Ducts Connected to Variable-Air-Volume Air-Handling Units:
   a. Pressure Class: Positive 6-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 4.
   d. SMACNA Leakage Class for Round: 2.

4. Ducts Connected to Equipment Not Listed Above:
   a. Pressure Class: Positive or negative 4-inch wg.
   b. Minimum SMACNA Seal Class: A.
F. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 16.
   d. SMACNA Leakage Class for Round and Flat Oval: 4.

2. Ducts Connected to Air-Handling Units:
   a. Pressure Class: Positive or negative 3-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 8.
   d. SMACNA Leakage Class for Round: 4.

3. Ducts Connected to Equipment Not Listed Above:
   a. Pressure Class: Positive or negative 3-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 8.
   d. SMACNA Leakage Class for Round: 4.

G. Intermediate Reinforcement:


H. Duct Liner Restrictions:

1. Duct Liner exposed to air movement shall not be used on medium pressure ductwork (2000 to 4000 FPM velocity). See section 230713 “Duct Insulation” for insulation requirements.

2. Duct Liner exposed to air movement shall not be used on high pressure ductwork (Greater than 4000 FPM velocity). See section 230713 “Duct Insulation” for insulation requirements.

3. All duct liner shall meet all of the requirements found in 2012 IECC

I. Liner: (Ductwork located Interior to building Insulated Envelope)

1. Low Pressure Supply Air Ducts (Less than 2000 FPM velocity): Fibrous glass, Type I, 1 inch thick with a minimum R value of 4.0 for ducts in unconditioned spaces.

2. Supply Air Ducts: Fibrous glass, Type I or flexible elastomeric, 1 inch thick for ducts in conditioned spaces.
3. Return Air Ducts: Fibrous glass, Type I, 1 inch thick with a minimum R value of 4.0 for ducts in unconditioned spaces.

4. Return Air Ducts: Fibrous glass, Type I or flexible elastomeric, 1 inch thick for ducts in conditioned spaces.

5. Exhaust Air Ducts: Fibrous glass, Type I or flexible elastomeric, 1 inch thick.

6. Supply Fan Plenums: Fibrous glass, Type I, 1 inch thick with a minimum R value of 4.0.

7. Return- and Exhaust-Fan Plenums: Fibrous glass, Type II, 1 inch thick with a minimum R value of 4.0.

8. Transfer Ducts: Fibrous glass, Type I or flexible elastomeric, 1 inch thick

J. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
   a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
   b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
   c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      1) Velocity 1000 fpm or Lower: 1.0 radius-to-diameter ratio and three segments for 90-degree elbow.
      2) Velocity 1000 to 1500 fpm: 1.5 radius-to-diameter ratio and four segments for 90-degree elbow.
      3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
      4) Radius-to-Diameter Ratio: 1.5.
   b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
   c. Round Elbows, 14 Inches and Larger in Diameter: Welded.

K. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
1. Rectangular:
   a. Rectangular Main to Rectangular Branch: 45-degree entry high efficiency take-off.
   b. Rectangular Main to Round Branch: 45-degree entry high efficiency take-off.

2. Round:
   a. Comply with SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
   b. Velocity 1000 to 1500 fpm: 45-degree entry high efficiency tap.
   c. Velocity 1500 fpm or Higher: 45-degree lateral.

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 dampers.
   3. Barometric relief dampers.
   5. Control dampers.
   6. Fire dampers.
   7. Smoke dampers.
   8. Combination fire and smoke dampers.
   10. Turning vanes.
   11. Remote damper operators.
   12. Duct-mounted access doors.
   13. Flexible connectors.
   14. Flexible ducts.
   15. Duct accessory hardware.

B. Related Requirements:
   1. Division 23 "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
   2. Division 23 "Diffusers, Registers and Grilles".

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
   a. Special fittings.
   c. Control-damper installations.
   d. Fire-damper, smoke-damper, combination fire- and smoke-damper, pressure relief-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
   e. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. 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.

B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

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

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

B. Comply with SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653.
   1. Galvanized Coating Designation: G60.
   2. Exposed-Surface Finish: Mill phosphatized.

B. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

C. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Warming and Ventilating; a division of Mestek, Inc.
   2. Greenheck Fan Corporation.
   3. Nailor Industries Inc.
   4. Potterff.
   5. Ruskin Company.
   6. United Enertech

B. Function:
   1. Designed to allow airflow in one direction and prevent reverse airflow.
   2. Keeps outside air out of the space by sensing and closing against mass flow.

C. Description:
   1. Gravity balanced.

D. Maximum Air Velocity:
   1. 1000 fpm

E. Maximum System Pressure:
   1. 4-inch wg.
F. Frame: Hat-shaped, with welded corners or mechanically attached and mounting flange:
   1. 16GA 0.063-inch-thick extruded aluminum.

G. Blades: Multiple single-piece blades, maximum 6-inch width noncombustible, tear-resistant, neoprene-coated fiberglass with sealed edges:
   1. Center pivoted: 16GA 0.050-inch-thick aluminum sheet.

H. Blade Action: Parallel.

I. Blade Seals: Mechanically locked.
   1. Neoprene.

J. Blade Axles: 0.20 inch diameter:
   1. Material: Nonferrous metal.

K. Tie Bars and Brackets:
   1. Aluminum.

L. Return Spring: Adjustable tension.

M. Bearings:
   1. Synthetic pivot bushings.

N. Accessories.
   1. Adjustment device to permit setting for varying differential static pressure.
   2. Counterweights and spring-assist kits for vertical airflow installations.
      a. Sleeve Thickness: 20 gage minimum.
      b. Sleeve Length: 6 inches minimum.
   4. Screen Mounting: Rear mounted.
   5. Screen Material:
      a. Aluminum.
   6. Screen Type:
      a. Bird
   7. 90-degree stops.

2.4 PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Warming and Ventilating; a division of Mestek, Inc.
   2. Greenheck Fan Corporation.
   3. Nailor Industries Inc.
   4. Potterff.
   5. Ruskin Company.
B. Function:
1. Provide component designed to protect HVAC systems by relieving air pressure from within a space that is beyond a pre-determined limit.
2. To automatically begin to open at a pre-set pressure difference above maximum system pressure.
3. Internally self-controlled with system pressure utilizing adjustable arms and weights.
4. Self-actuated with system pressure utilizing adjustable arms and weights.
5. Employs blade counterbalancing.
6. Automatically closes and re-sets when pressures return to normal conditions.

C. Air Velocity:
1. 3900 fpm.

D. Maximum System Pressure (MSP):
1. 5-inch wg.

E. Differential Pressure Preset above MSP:
1. 1-inch wg.

F. Maximum Damper Pressure Limit:
1. 5.0-inch wg.

G. Frame Material: Flanged Channel:
1. 14GA 0.079-inch- thick galvanized steel.

H. Frame Depth: 8-inch- minimum.

I. Blades:
1. Material:
   a. 16GA 0.063-inch- formed galvanized steel.
2. Type:
   a. Formed Sheetmetal.
3. Blade-stop:
   a. With stop.

J. Blade Action: Parallel.

K. Blade Seals:

L. Blade Axles:
1. Material:
   a. Plated steel.
2. Diameter: 0.375 inch.

M. Linkage:
1. External heavy duty type with galvanized steel clevis arms and plated steel tie bars & pivot pins with nylon pivot bearings.

N. Bearings:
2.5 BAROMETRIC RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Warming and Ventilating; a division of Mestek, Inc.
   2. Greenheck Fan Corporation.
   3. Nailor Industries Inc.
   4. Pottorff.
   5. Ruskin Company.

B. Function:
   1. Senses and compares outdoor ambient and indoor pressures.
   2. Allows any higher pressure indoor air to escape.

C. Description: Suitable for horizontal or vertical mounting.

D. Maximum Air Velocity:
   1. 1000 fpm

E. Maximum System Pressure:
   1. 3-inch wg.

F. Frame: Hat-shaped, with welded corners or mechanically attached and mounting flange.
   1. 13GA 0.094-inch thick, galvanized sheet steel.

G. Blades: Multiple:
   1. 16GA 0.050-inch thick aluminum sheet.
   3. Action: Parallel.
   5. Pivot:
      a. Eccentric.

H. Blade Seals:
   1. Neoprene

I. Blade Axles:
   1. Galvanized steel.

J. Tie Bars and Brackets: Rattle free with 90-degree stop.
   1. Material:
      a. Galvanized steel.

K. Return Spring: Adjustable tension.

L. Bearings:
   1. Synthetic
2.6 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Warming and Ventilating; a division of Mestek, Inc.
   b. McGill AirFlow LLC.
   c. Nailor Industries Inc.
   d. Potterff.
   e. Ruskin Company.
   f. United Enertech

2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.

   a. 16GA 0.064-inch thick, galvanized sheet steel.

5. Blades:
   a. Multiple or single blade. Parallel- or opposed-blade design. Stiffened damper blades for stability.
   b. Material:
      1) Galvanized steel, 16GA 0.064 inch thick.

6. Blade Axles:
   a. Nonferrous metal
   b. Shall extend full length of damper blades in ducts with pressure classes of 3-inch wg or more.

7. Bearings:
   a. Material:
      1) Molded synthetic.
   b. Bearings at both ends of damper operating shafts in ducts with pressure classes of 3-inch wg or more.

8. Tie Bars and Brackets: Galvanized steel.

B. Low-Leakage, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Warming and Ventilating; a division of Mestek, Inc.
   b. McGill AirFlow LLC.
   c. Nailor Industries Inc.
   d. Potterff.
   e. Ruskin Company.
   f. United Enertech
2. Comply with AMCA 500-D testing for damper rating.
3. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
4. Suitable for horizontal or vertical applications.
5. Frames:
   a. Frame: Hat-shaped,
      1) 16GA 0.064-inch thick, galvanized sheet steel.
   b. Mitered and welded corners.
   c. Flanges for attaching to walls and flangeless frames for installing in ducts.
6. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Material:
      1) Galvanized, roll-formed steel, 16GA 0.064 inch thick.
7. Blade Axles:
   a. Nonferrous metal.
8. Bearings:
   a. Molded synthetic.
   b. Dampers in ducts with pressure classes of 3-inch wg or more shall have axles full length of damper blades and bearings at both ends of operating shaft.
9. Blade Seals:
   a. Neoprene.
10. Jamb Seals: Cambered Stainless steel or aluminum.
11. Tie Bars and Brackets: Galvanized steel or aluminum.
12. Accessories:
   a. Include locking device to hold single-blade dampers in a fixed position without vibration.
C. Jackshaft:
   1. Size:
      a. 1-inch diameter.
   2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
   3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.
D. Damper Hardware:
   2. Include center hole to suit damper operating-rod size.
   3. Include elevated platform for insulated duct mounting.
2.7 CONTROL DAMPERS

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

2. Pottorff.
3. Ruskin Company.
4. Young Regulator Company.
5. United Enertech

B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Frames:

1. Section:
   a. Hat shaped.
2. Material:
   a. 20 GA 0.40-inch- thick galvanized steel.
3. Corners:

D. Blades: Multiple.

1. Maximum blade width:
   a. 6 inches.
2. Opposed -blade design.
3. Material:
   a. Galvanized-steel.
4. Thickness:
   a. 20 GA 0.40-inch- thick galvanized steel
5. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
   a. Closed-cell neoprene

E. Blade Axles:

1. Section:
   a. 3/8-inch-square
2. Material:
   a. Galvanized steel.
3. Blade-linkage hardware:
   a. Zinc-plated steel and brass.
   b. Ends sealed against blade bearings:
4. Operating Temperature Range: From minus 40 to plus 200 deg F.

F. Bearings:

1. Type:
   a. Molded synthetic.
2. Axles: Dampers in ducts with pressure classes of 3-inch wg or more shall have axles full length of damper blades.
3. Bearings: Thrust bearings at each end of every blade. Bearings at both ends of each operating shaft.

2.8 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Arrow United Industries; a division of Mestek, Inc.
   2. Greenheck Fan Corporation.
   3. Nailor Industries Inc.
   4. Pottorff.
   5. Ruskin Company.
   6. United Enertech

B. Type:
   1. Dynamic.

C. Standard: Rated and labeled according to UL 555 by an NRTL.

D. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

E. Fire Rating:
   1. 1-1/2 hours.

F. Frame:
   1. Curtain type with blades outside airstream.
   2. Material:
      a. Fabricated with roll-formed galvanized steel; with mitered and interlocking corners.
      b. Thickness:
         1) 20GA-0.040-inch-

G. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel. Length to suit application.
   1. Minimum Thickness:
      a. 18GA-0.05 inch, as indicated.
   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.

H. Mounting Orientation: Vertical or horizontal as indicated.

I. Blades: Roll-formed, interlocking, galvanized sheet steel.
   1. Thickness:
      a. 24GA-0.024-inch-
2. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

J. Horizontal Dampers: Include blade lock and Type 301 constant force stainless-steel closure spring.

K. Heat-Responsive Device: Replaceable, 212 deg F rated, fusible links.

2.9 SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Nailor Industries Inc.
   3. Pottorff.
   4. Ruskin Company.
   5. United Enertech

B. General Requirements: Label according to UL 555S by an NRTL.

C. Smoke Detector: Integral, factory wired for single-point connection.
   1. Type: Photoelectric.

D. Frame: Galvanized sheet steel. With or without mounting flange as required.
   1. Thickness:
      a. Hat-shaped, 16GA-0.064-inch.
   2. Corners:
      a. Welded.

E. Blades: Horizontal, galvanized sheet steel.
   1. Section:
      a. Roll-formed.
   2. Fit:
      a. Interlocking.
   3. Thickness:
      a. 14GA-0.079-inch.

F. Leakage:
   1. Class II.

G. Seals:
   1. Blade: Inflatable silicone fiberglass material to maintain smoke leakage rating to a minimum of 450 deg F.

H. Rated pressure and velocity to exceed design airflow conditions.

I. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.
   1. Minimum 17-inches long.
2. Thickness:
   a. 0.05-inch-

J. Damper Motors:
   1. Action:
      a. Two-position
   2. Mode: Fail close.

K. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   1. Electrical Connection: 115 V, single phase, 60 Hz.

L. Accessories:
   1. Auxiliary switches for signaling:
      a. Position indication.
      b. [Fan control].
   2. Test Switch type:
      a. Momentary test switch.
      b. [Test and reset switches].
   3. Test Switch Mounting:
      a. Damper.
      b. [Remote].

2.10 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Nailor Industries Inc.
   3. Potterff.
   4. Ruskin Company.
   5. 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 static pressure class and minimum velocity of:
   1. 4000-fpm

D. Fire Rating:
   1. 1-1/2 hours.

E. Frame: Hat shaped, galvanized sheet steel. With or without mounting flange as required.
   1. Thickness:
      a. 16GA-0.064-inch
   2. Corners:
      a. Welded.
F. Heat-Responsive Device: Replaceable, 212 deg F rated, fusible links.

G. Blades: Horizontal, galvanized sheet steel.
   1. Type:
      a. Air-foil.
   2. Fit:
      a. Interlocking.
   3. Thickness:
      a. 0.063-inch-.

H. Leakage:
   1. Class I.

I. Rated pressure and velocity to exceed design airflow conditions.

J. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.
   1. Thickness:
      a. 18GA 0.05-inch-.

K. Master control panel for use in dynamic smoke-management systems.

L. Damper Motors:
   1. Locate outside air stream unless otherwise indicated,
   2. Action:
      a. Two-position.
   3. Voltage: to match fire alarm system (coordinate).
   4. Listed: UL, as part of damper assembly.
   5. Outdoor Motors and Motors in Outside-Air Intakes:
      a. Gaskets: O-ring gaskets designed to make motors weatherproof.
      b. Internal heaters: Equip to permit normal operation at minus 40 deg F.

M. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   1. Electrical Connection: 115 V, single phase, 60 Hz.

N. Accessories:
   1. Auxiliary switches:
      a. Signaling.
      b. Position indication.
   2. Test Switch type:
      a. Momentary test switch.
   3. Test Switch Mounting:
      a. Damper.

2.11 DUCT SILENCERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Industrial Acoustics Company.
2. Ruskin Company.
3. SEMCO Incorporated.

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.

C. Shape:

1. Rectangular straight with splitters or baffles.
2. Round straight with center bodies or pods.
3. Rectangular elbow with splitters or baffles.
4. Round elbow with center bodies or pods.
5. Rectangular transitional with splitters or baffles.

D. Rectangular Silencer Outer Casing: Galvanized sheet steel.
1. ASTM A 653:
   a. G60.
2. Thickness:
   a. 22GA-0.034 inch.

E. Round Silencer Outer Casing: Galvanized sheet steel.
1. ASTM A 653:
   a. G60.
2. Sheet Metal Thickness for Units up to 24 Inches in Diameter: 22GA-0.034 inch thick.
3. Sheet Metal Thickness for Units 26 through 40 Inches in Diameter: 20GA-0.040 inch thick.
4. Sheet Metal Thickness for Units 42 through 52 Inches in Diameter: 18GA-0.05 inch thick.
5. Sheet Metal Thickness for Units 54 through 60 Inches in Diameter: 16GA-0.064 inch thick.

F. Inner Casing and Baffles: Galvanized sheet metal with 1/8-inch- diameter perforations.
1. ASTM A 653:
   a. G60.
2. Thickness:
   a. 22GA-0.034 inch.

G. Special Construction:

1. Suitable for outdoor use.
2. High transmission loss to achieve STC 45.
H. Connection Sizes: Match connecting ductwork unless otherwise indicated.

I. Principal Sound-Absorbing Mechanism:
   1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
   2. Dissipative or Film-lined type with fill material:
      a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 15 percent compression
      b. Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.
      c. Prohibited: Mineral wool will not be permitted as a substitute for glass fiber.
   3. Lining:
      a. Material: Tedlar
      b. Prohibited: Mesh, screen or corrugated perforated liner will not be acceptable as a substitute for the specified spacer.

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. Joints:
      a. Lock formed and sealed.
   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.
   4. Structural Criteria: The silencers shall not fail structurally when subjected to a differential air pressure of 8 inches water gage.
   5. Spot Welds: All spot welds shall be painted.

K. Accessories:
   1. Integral [1-1/2] [3]-hour fire damper with access door. Access door to be high transmission loss to match silencer.
   2. Factory-installed end caps to prevent contamination during shipping.
   3. Removable splitters.

2.12 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. METALAIRE, Inc.
   2. SEMCO Incorporated.
B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
   1. Fabricate single blade vanes to comply with SMACNA’s “HVAC Duct Construction Standards-Metal and Flexible.”

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

E. Vane Construction:
   1. Single wall

F. Vane Spacing:
   1. 1-1/2” spacing between turning vanes
   2. 3-1/4” spacing not allowed.

G. Vane Construction: Single wall for ducts up to 36 inches wide and additional bracing for larger dimensions.

2.13 REMOTE DAMPER OPERATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Pottorff.
   2. Ruskin Company; Tomkins PLC.
   3. Young Regulator Company.

B. Cable Type:
   1. Description: Cable system designed for remote manual damper adjustment.
   2. Tubing/Sheathing: Galvinsed, Brass, Copper or Aluminum.
   3. Cable: Stainless steel or Steel.
   4. Wall-Box Mounting: Coordinate with Architect.
   5. Wall-Box Cover-Plate Material: Coordinate with Architect.

C. Activated Electric Type:
   1. Description: Electrically activated zone control damper for remote adjustment. When an adjustment is needed the system is powered up.
   3. Portable 9 volt system. No field power requirement.
   4. Mounting: Recessed Wall Box or Diffuser or Hand Held.
   5. Wall-Box Cover Finish: Coordinate with Architect.
6. Wall-Box Porting: 1 to 6 ports or more.

2.14 DUCT-MOUNTED ACCESS DOORS

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

2. McGill AirFlow LLC.
3. Pottorff.
5. Ruskin Company


1. Door:
   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c. Vision panel.
   d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
   e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
   a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches Square:
      1) Hinges:
         a) Two hinges and two sash locks.
   c. Access Doors up to 24 by 48 Inches, provide outside and inside handles:
      1) Hinges:
         a) Three hinges and two compression latches.
   d. Access Doors Larger Than 24 by 48 Inches, provide outside and inside handles:
      1) Hinges:
         a) Continuous and two compression latches with outside and inside handles.

2.15 FLEXIBLE CONNECTORS

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

1. Ductmate Industries, Inc.
2. Ventfabs, 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 wide fabric strip attached to two narrower metal strips. Provide strips of metal compatible with connected ducts.
   1. Wide Strip:
      a. 3-1/2 inches.
   2. Narrow Strips:
      a. 0.028-inch-thick, galvanized sheet steel.

   1. Minimum Weight: 26 oz./sq. yd..
   2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
   3. Service Temperature: Minus 40 to plus 200 deg F.

   1. Minimum Weight: 24 oz./sq. yd..
   2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
   3. Service Temperature: Minus 50 to plus 250 deg F.

2.16 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. Themaflex

B. Ducts shall conform to the requirements for Class I connectors when tested in accordance with "Standard for Factory Made Air Ducts Materials and Air Duct Connectors" (UL 181).

C. Ducts shall also pass the 15 minute U.L. flame penetration test as specified in the UL 181 Standard.

D. Insulated, Flexible Duct: Two-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.
   1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
   3. Temperature Range: Minus 10 to plus 160 deg F.
   4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.
E.  Flexible Duct Connectors:
   1.  Clamps:  in sizes 3 through 18 inches, to suit duct size.
       a.  Material:  Stainless-steel band with cadmium-plated hex screw to tighten
           band with a worm-gear action.

2.17  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.

C.  Splitter Damper Accessories:  Zinc-plated damper blade bracket; 1/4-inch, zinc-plated
    operating rod; and a duct-mounted, ball-joint bracket with flat rubber gasket and
    square-head set screw.

D.  Flexible Duct Clamps:  Stainless-steel band with cadmium-plated hex screw to tighten
    band with a worm-gear action, in sizes 3 to 18 inches to suit duct size.

2.22  HIGH EFFICIENCY TAKE-OFFS

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

    1.  Air-Rite
    2.  Hercules Industries
    3.  Sheet Metal Connectors, Inc.
    4.  Spiral Manufacturing Co. Inc.
    5.  Ferguson

B.  Materials:

    1.  24 gauge galvanized sheet metal meeting ASTM A653 and A924

C.  Take-off shall meet SMACNA third edition Section 4.8 figure 4.6 - 45 degree entry.

D.  Rectangular opening with flanged sides on all sides.  Complete with closed cell
    neoprene gasket
    to provide a tight seal.

E.  Zeros VOC's
PART 3 - EXECUTION

3.1 INSTALLATION

General

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. Use the Remote Damper Operator when they are called out on the drawings or when the damper cannot be easily accessed.

D. Install high efficiency take-off on all branch duct take-offs. Provide take-off with balancing damper as shown on drawings. Spin-in fittings are not allowed.

Flexible Ducts / Flexible Duct Connectors

E. Install flexible connectors to connect ducts to equipment.

F. Flexible duct connections from the main trunk ducts to diffuser boots shall be furnished and installed as shown on the drawings. Flexible ductwork shall only be used as indicated on the drawings.

G. Where flexible duct is indicated, use insulated flexible duct for supply air return and exhaust air.

H. Flexible ductwork shall be run in straight lengths.

I. Provide support in flexible duct every three feet.

J. Flexible ducts shall have compression fittings on both ends.

K. Flexible ductwork is not allowed to bend 90 degrees. If a bend is needed use sheet-metal hard elbows. Hard turns, offsets, or kinks will not be allowed.

L. Flexible ducts shall connect to trunk duct with high efficiency takeoffs.

M. Connect flexible ducts to metal ducts with draw bands.

N. Connect ducts to duct silencers:
   1. With flexible duct connectors.

O. Connect terminal units to supply ducts:
   1. With maximum 12-inch lengths of flexible duct.

P. Do not use flexible ducts to change directions.
Q. Connect diffusers or light troffer boots to ducts:
   1. With maximum 60-inch lengths of flexible duct clamped or strapped in place.

Backdraft/Control/Pressure Relief Dampers

R. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

S. Install pressure relief damper immediately upstream of main fire damper.

Volume Damper

T. 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.

U. Set dampers to fully open position before testing, adjusting, and balancing. Exception: Pressure relief damper.

V. A balance damper with locking quadrant will be provided downstream of take-off from trunk duct.

Fans And Test Holes

W. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

X. 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 movement during start and stop of fans.

Y. Install duct test holes where required for testing and balancing purposes.

Z. Install test holes at fan inlets and outlets and elsewhere as indicated.

FIRE, SMOKE AND FIRE-SMOKE DAMPERS

AA. Install fire and smoke dampers according to UL listing.
   1. Install fusible links in fire dampers.

BB. For round ductwork 24-inch and smaller a true round fire damper with the same rating may be used.

Access Doors

CC. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
AIR DUCT ACCESSORIES

1. On upstream side of duct coils.
2. Upstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be standard access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum 50-foot spacing.
8. Upstream from turning vanes.
9. Upstream or downstream from duct silencers.
10. Control devices requiring inspection.
11. Elsewhere as indicated.

DD. Install access doors with swing against duct static pressure.

EE. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.

FF. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

3.3 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire and smoke dampers for proper action.
C. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

END OF SECTION
SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section includes ceiling- and wall-mounted diffusers, registers, and grilles.

B. Related Sections:
   1. Section 233714 "Fixed Louvers" for fixed and louvered wall vents, whether or not they are connected to ducts.
   2. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include the following:
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
   1. Ceiling suspension assembly members.
   2. Method of attaching hangers to building structure.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
   5. Duct access panels.
B. Source quality-control reports.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings and schedules indicate specific requirements of diffusers, registers, and grilles and are based on the specific requirements of the systems indicated.


PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Air Factors
2. Carnes.
4. METALAIRE, Inc.
5. Nailor Industries Inc.
7. Titus.
8. Tuttle & Bailey.

2.2 REGISTERS, GRILLES, & DIFFUSERS

A. General: The frames for all registers, grilles, and diffusers shall match type of ceiling where they are to be installed. Special frames shall be provided for narrow T-bar ceilings. Refer to reflected ceiling plan and other specification divisions for ceiling type. See drawings AND schedules for additional information.

2.3 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, according to manufacturer's written instructions, coordination drawings, original design, and referenced standards.

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 Architect 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, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

3.4 CLEANING

A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

END OF SECTION
SECTION 236200 - PACKAGED COMPRESSOR AND CONDENSER UNITS

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 packaged, refrigerant compressor and condenser units.

1.3 PERFORMANCE REQUIREMENTS
   A. Seismic Performance: Compressor and condenser units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and with the requirements specified in Section 230548 "Vibration and Seismic Controls for HVAC."

1.4 ACTION SUBMITTALS
   A. Product Data: For each compressor and condenser unit. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.
   B. Shop Drawings: For compressor and condenser units. Include plans, elevations, sections, details, and attachments to other work.
      1. Wiring Diagrams: For power, signal, and control wiring.
   C. Delegated-Design Submittal: For compressor and condenser units indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
      1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
      2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
      3. Seismic calculations and detailed analysis: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices. Project specific design documentation and calculations shall be prepared and stamped by a registered engineer.

PACKAGED COMPRESSOR AND CONDENSER UNITS 236200 - 1
1.5 INFORMATIONAL SUBMITTALS

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

1. Structural members to which compressor and condenser units will be attached.
2. Liquid and vapor pipe sizes.
3. Refrigerant specialties.
4. Piping including connections, oil traps, and double risers.
5. Compressors.

B. Seismic Qualification Certification: For compressor and condenser units, accessories, and components, 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.

C. Field quality-control reports.

D. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For compressor and condenser units to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of condensing units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Standard for Refrigeration Systems."

D. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6, "Heating, Ventilating, and Air-Conditioning."
E. ASME Compliance: Fabricate and label water-cooled compressor and condenser units to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-In-Place Concrete" and Section 033053 "Miscellaneous Cast-In-Place Concrete."

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

C. Coordinate location of piping and electrical rough-ins.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of compressor and condenser units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Compressor failure.
   b. Condenser coil leak.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 COMPRESSOR AND CONDENSER UNITS, AIR COOLED, 1 TO 5 TONS

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

   1. Carrier Corporation; Commercial HVAC Systems.
   2. Lennox International Inc.
   3. Trane; a business of American Standard Companies.
   4. YORK; a Johnson Controls company.

B. Description: Factory assembled and tested; consisting of compressor, condenser coil, fan, motors, refrigerant reservoir, and operating controls.

C. Compressor: Scroll, hermetically sealed, with rubber vibration isolators.

   1. Motor: Single speed, and includes thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

D. Refrigerant: **R-407C** or **R-410A**.
E. Condenser Coil: Seamless copper-tube, aluminum-fin coil; circuited for integral liquid subcooler, with removable drain pan and brass service valves with service ports.

F. Condenser Fan: Direct-drive, aluminum propeller fan; with permanently lubricated, totally enclosed fan motor with thermal-overload protection.

G. Accessories:
1. Crankcase heater.
2. Cycle Protector: Automatic-reset timer to prevent rapid compressor cycling.
3. **Electronic programmable thermostat** to control compressor and condenser unit and evaporator fan.
4. Evaporator Freeze Thermostat: Temperature-actuated switch that stops unit when evaporator reaches freezing temperature.
5. Filter-dryer.
6. High-Pressure Switch: Automatic-reset switch cycles compressor off on high refrigerant pressure.
7. Liquid-line solenoid.
8. Low-Ambient Controller: Cycles condenser fan to permit operation down to **0 deg F**.
11. Thermostatic expansion valve.
12. Time-Delay Relay: Continues operation of evaporator fan after compressor shuts off.

H. Unit Casing: Galvanized steel, finished with baked enamel; with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Mount service valves, fittings, and gage ports on exterior of casing.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "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.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate compressor and condenser units according to **ANSI/AHRI 210/240 or ANSI/AHRI 340/360**.


C. Test and inspect shell and tube condensers according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
D. Testing Requirements: Factory test sound-power-level ratings according to ANSI/AHRI 270 or ANSI/AHRI 370.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of compressor and condenser units.

B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where compressor and condenser units will be installed.

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

3.2 INSTALLATION

A. Install units level and plumb, firmly anchored in locations indicated.

B. Equipment Mounting:

1. Install compressor and condenser units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 CONNECTIONS

A. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

B. Connect refrigerant piping to air-cooled compressor and condenser units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Section 232300 "Refrigerant Piping."
3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
   2. Leak Test: After installation, charge system with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor operation and unit operation, product capability, and compliance with requirements.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   5. Verify proper airflow over coils.

C. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

D. Compressor and condenser units will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
      a. Inspect for physical damage to unit casing.
      b. Verify that access doors move freely and are weathertight.
      c. Clean units and inspect for construction debris.
      d. Verify that all bolts and screws are tight.
      e. Adjust vibration isolation and flexible connections.
      f. Verify that controls are connected and operational.

B. Lubricate bearings on fan motors if not sealed.

C. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.

D. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.
E. Measure and record airflow and air temperature rise over coils.

F. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

G. After startup and performance test, lubricate bearings.

3.6 DEMONSTRATION

A. Training: **Engage a factory-authorized service representative to train** Owner's maintenance personnel to adjust, operate, and maintain compressor and condenser units.

END OF SECTION 236200
SECTION 237200 - AIR-TO-AIR ENERGY RECOVERY 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. Fixed-plate total heat exchangers.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For air-to-air energy recovery equipment. 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. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For air-to-air energy recovery equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of air-to-air energy recovery equipment.

2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
3. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

A. 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. Suspended ceiling components.
2. Structural members to which equipment or suspension systems will be attached.

B. Seismic Qualification Certificates: For air-to-air energy recovery equipment, accessories, and components, 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.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-to-air energy recovery equipment to include in 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.

1. Filters: One set of each type of filter specified.
2. Fan Belts: One set of belts for each belt-driven fan in energy recovery units.
3. Wheel Belts: One set(s) of belts for each heat wheel.

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. ARI Compliance:


C. ASHRAE Compliance:
1. Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."

D. NRCA Compliance: Roof curbs for roof-mounted equipment shall be constructed according to recommendations of NRCA.

E. UL Compliance:
1. Packaged heat recovery ventilators shall comply with requirements in UL 1812, "Ducted Heat Recovery Ventilators"; or UL 1815, "Nonducted Heat Recovery Ventilators."
2. Electric coils shall comply with requirements in UL 1995, "Heating and Cooling Equipment."

1.9 COORDINATION
A. Coordinate layout and installation of air-to-air energy recovery equipment and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.10 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of air-to-air energy recovery equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Packaged Energy Recovery Units: Two years.

PART 2 - PRODUCTS

2.1 FIXED-PLATE TOTAL HEAT EXCHANGERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Mitsubishi Electric Sales Canada Inc.
2. RenewAire LLC.

B. Casing: Galvanized steel.
C. Plates: Evenly spaced and sealed and arranged for counter airflow.
   1. Plate Material: Chemically treated paper with selective hydroscopicity and moisture permeability, and gas barrier properties.

D. Bypass Plenum: Within casing, with gasketed face-and-bypass dampers having operating rods extended outside casing.

E. Disposable Panel Filters:
   1. Comply with NFPA 90A.
   2. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
   3. Factory-fabricated, viscous-coated, flat-panel type.
   4. Thickness: 2 inches.
   5. Minimum Arrestance: 80, according to ASHRAE 52.1.
   6. Minimum Merv: 13, according to ASHRAE 52.2.
   8. Frame: Galvanized steel with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.

2.2 CONTROLS

A. Time Clock:
   1. Solid-state, programmable, microprocessor-based unit for:
      a. Wall mounting.
   2. Up to eight on/off cycles per day and battery backup protection of program settings against power failure to energize unit.

B. 24 VAC Voltage.

C. Refrigerant-Cooling-Coils Controls:
   1. Sensor with sensor adjustment located in control panel:
      a. Remote-mounted sensor for field installation in supply-air duct.
   2. Control panel to control remote condensing unit to maintain temperature.
   3. Wall-mounted, space-temperature sensor with:
      a. Temperature adjustment (type):
         1) Standard.
      b. Modulation of temperature by means of a factory-mounted or a factory furnished coil-control valve.

D. Electric-Coils Controls:
   1. Sensor with sensor adjustment located in control panel to control electric coil to maintain temperature:
      a. Remote-mounted for field installation in supply-air duct.
2. Wall-mounted, space-temperature sensor with **temperature adjustment** to control electric coil to maintain temperature.

3. Coil Controls (type):
   a. On/off.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-to-air energy recovery equipment installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for electrical services to verify actual locations of connections before installation.

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

#### 3.2 INSTALLATION

A. Install heat wheels so supply and exhaust airstreams flow in opposite directions and rotation is away from exhaust side to purge section to supply side.

   1. Install access doors in both supply and exhaust ducts, both upstream and downstream, for access to wheel surfaces, drive motor, and seals.
   2. Install removable panels or access doors between supply and exhaust ducts on building side for bypass during startup.
   3. Access doors and panels are specified in Section 233300 "Air Duct Accessories."

B. Install heat-pipe heat exchangers so supply and exhaust airstreams flow in opposite directions. Install flexible connectors on ducts to enable tilt control; make connections airtight and with slack to compensate for full tilt.

   1. Install heat exchanger with clearance space for heat-pipe coil removal.
   2. Install duct access doors in both supply and exhaust ducts, both upstream and downstream, for access to both sides of heat-pipe coil. Access doors and panels are specified in Section 233300 "Air Duct Accessories."
   3. Install tilt-control components, including electronic controller, electric actuator and linkage, thermostats, and sensors.

C. Install fixed-plate heat exchangers so supply and exhaust airstreams flow in opposite directions.

   1. Install duct access doors in both supply and exhaust ducts, both upstream and downstream, for access to heat exchanger. Access doors and panels are specified in Section 233300 "Air Duct Accessories."
D. Install gas-fired furnaces according to NFPA 54, "National Fuel Gas Code."

E. Equipment Mounting:
   1. Install air-to-air energy recovery equipment on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Division 03.

F. Roof Curb: Install on roof structure or concrete base, level and secure, according to:
   2. Install air-to-air energy recovery equipment on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories." Secure air-to-air energy recovery equipment to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

G. Unit Support:
   1. Install unit level on structural curbs.
   2. Coordinate wall penetrations and flashing with wall construction.
   3. Secure air-to-air energy recovery equipment to structural support with anchor bolts.

H. Install wind and seismic restraints according to manufacturers' written instructions. Wind and seismically restrained vibration isolation roof-curb rails are specified in Section 230548 "Vibration and Seismic Controls for HVAC."

I. Install units with clearances for service and maintenance.

J. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

K. Pipe drains from drain pans to nearest floor drain; use ASTM B 88, Type L, drawn-temper copper water tubing with soldered joints, same size as condensate drain connection.

L. Pipe drains from drain pans to nearest floor drain; use ASTM D 1785, Schedule 40 PVC pipe and solvent-welded fittings, same size as condensate drain connection.

   1. Requirements for Low-Emitting Materials:
      a. 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).
      b. 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. Requirements for Low-Emitting Materials: Solvent cement and 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."
3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to unit to allow service and maintenance.

C. Connect piping to units mounted on vibration isolators with flexible connectors.

D. Connect cooling condensate drain pans with air seal trap at connection to drain pan and install cleanouts at changes in pipe direction.

E. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping."

F. Comply with requirements for ductwork specified in Section 233113 "Metal Ducts."

G. Indirect-Fired Furnace Vent Connections: Comply with Section 235100 "Breechings, Chimneys, and Stacks."

H. Install electrical devices furnished with units but not factory mounted.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

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. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Adjust seals and purge.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Set initial temperature and humidity set points.
5. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

D. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.

E. 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 air-to-air energy recovery units.

END OF SECTION 237200
TABLE OF CONTENTS

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SECTION 260500 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARYs

A. Section Includes:
   1. Sleeves for raceways and cables.
   2. Sleeve seals.
   4. Common electrical installation requirements.

1.2 SUBMITTALS

A. Product Data: For sleeve seals.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water stop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

   1. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
      b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
3. Pressure Plates: Stainless steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.
B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
E. Cut sleeves to length for mounting flush with both surfaces of walls.
F. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 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 07 Section "Penetration 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 pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 260500
SECTION 260519 - 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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:
   1. Section 260513 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 2001 to 35,000 V.
   2. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2 and 3 control cables.
   3. Section 271500 "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.3 DEFINITIONS

A. VFC: Variable frequency controller.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

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. Alpha Wire Company;
2. American Insulated Wire Corp.;
3. Belden Inc;
4. Cerro Wire LLC;
5. Encore Wire Corporation;
6. General Cable Technologies Corporation;
7. General Cable: General Cable Corporation;
8. Senator Wire & Cable Company;
9. Southwire Company;

B. Aluminum and Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658

D. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 with ground wire.

E. VFC Cable:

1. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable.
2. Type TC-ER with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire and sunlight- and oil-resistant outer PVC jacket.

2.2 CONNECTORS AND SPLICES

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. 3M;
2. AFC Cable Systems, Inc;
3. Gardner Bender;
4. Hubbell Power Systems, Inc.;
5. Ideal Industries, Inc.;
6. ILSCO;
7. NSi Industries LLC;
8. O-Z/Gedney; an EGS Electrical Group brand; an Emerson Industrial Automation business;
9. Tyco Electronics Corp.;

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
2.3 SYSTEM DESCRIPTION

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. Comply with NFPA 70.

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, except VFC cable, which shall be extra flexible stranded.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN/THWN-2, single conductors in raceway

B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway

E. Feeders in Cable Tray: Type THHN/THWN-2, single conductors in raceway

F. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway

G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway

H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway

I. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

J. VFC Output Circuits: Type XHHW-2 in metal conduit

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. 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.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

G. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

3.4 CONNECTIONS

A. tightened 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-486B.

B. Make splices, terminations, and taps that are compatible with conductor material

1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least [6 inches (150 mm)] [12 inches (300 mm)] of slack.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

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 test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.


3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

   a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.

   b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

   c. 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.

D. Test and Inspection Reports: Prepare a written report to record the following:

   1. Procedures used.
   2. Results that comply with requirements.
   3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

E. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 260519
SECTION 260526 - GROUNDING AND BONDING 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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes grounding and bonding systems and equipment, plus the following special applications:
   1. Underground distribution grounding.
   2. Ground bonding common with lightning protection system.
   3. Foundation steel electrodes.

1.3 ACTION SUBMITTALS

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

1.4 QUALITY ASSURANCE

A. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Burndy; Part of Hubbell Electrical Systems.
   2. Dossert; AFL Telecommunications LLC.
   3. ERICO International Corporation.
   4. Fushi Copperweld Inc.
   5. Galvan Industries, Inc.; Electrical Products Division, LLC.
   6. Harger Lightning & Grounding.
   7. ILSCO.
   8. O-Z/Gedney; an EGS Electrical Group brand; an Emerson Industrial Automation business.
   9. Robbins Lightning, Inc.
   10. Siemens Power Transmission & Distribution, Inc.
2.2 SYSTEM DESCRIPTION

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. Comply with UL 467 for grounding and bonding materials and equipment.

2.3 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:

4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

A. Listed and labeled by an NRTL 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.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad 3/4 inch by 10 feet (19 mm by 3 m)

B. Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts
1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches (1200 mm) long.
2. Backfill Material: Electrode manufacturer's recommended material.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.
   1. Bury at least 24 inches (600 mm) below grade.
   2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Install bus horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.

E. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
   3. Connections to Ground Rods at Test Wells: Bolted connectors.

3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.
3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

3.5 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
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.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

G. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

H. Metallic Fences: Comply with requirements of IEEE C2.
   1. Grounding Conductor: Bare, tinned copper, not less than No. 8 AWG.
   2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
   3. Barbed Wire: Strands shall be bonded to the grounding conductor.

3.6 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 Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.
   1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
   2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches (300 mm) deep, with cover.
   1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.
1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
2. Bury ground ring not less than 24 inches (600 mm) from building's foundation.

I. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 feet (6.0 m) long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.

3.7 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. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. 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. Make tests at ground rods before any conductors are connected.

   a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

   b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526
SECTION 260529 - HANGERS AND SUPPORTS 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 01 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.
B. Related Sections include the following:
   1. Section 260548.16 "Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS
A. EMT: Electrical metallic tubing.
B. IMC: Intermediate metal conduit.
C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS
A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of [five] times the applied force.
1.5 ACTION SUBMITTALS

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. ERICO International Corporation.
   d. GS Metals Corp.
   e. Metal Ties Innovation.
   f. Thomas & Betts Corporation, A Member of the ABB Group.
   g. Unistrut; an Atkore International company.
   h. Wesanco, Inc.

2. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

3. Channel Dimensions: Selected for applicable load criteria.

B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. Fabco Plastics Wholesale Limited.
   d. Seasafe, Inc.; AMICO, a Gibraltar Industries Company.
2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
3. Fitting and Accessory Materials: Same as channels and angles.
4. Rated Strength: Selected to suit applicable load criteria.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Hilti, Inc.
      2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
      3) MKT Fastening, LLC
      4) Simpson Strong-Tie Co., Inc.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti, Inc.
      4) ITW Ramset/Red Head; 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.
2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted 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 two-bolt conduit clamps

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

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 (90 kg).

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 Existing Concrete: Expansion anchor fasteners.
5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69
6. To Light Steel: Sheet metal screws.
7. 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 Section 055000 "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 (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
B. Use 3000-psi (20.7-MPa) 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "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: 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. Touchup: Comply with requirements in Section 099113 "Exterior Painting", Section 099123 "Interior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529
SECTION 260533 - RACEWAYS AND BOXES 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 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Metal conduits, tubing, and fittings.
   2. Nonmetal conduits, tubing, and fittings.
   3. Metal wireways and auxiliary gutters.
   4. Nonmetal wireways and auxiliary gutters.
   5. Surface raceways.
   7. Handholes and boxes for exterior underground cabling.
B. Related Requirements:
   1. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
   2. Section 270528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.

1.3 DEFINITIONS
A. ARC: Aluminum rigid conduit.
B. GRC: Galvanized rigid steel conduit.
C. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS
A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.
1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
   1. Structural members in paths of conduit groups with common supports.
   2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

C. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, 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.
   4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   3. Anamet Electrical, Inc.
   4. Electri-Flex Company.
   5. FSR Inc.
   6. O-Z/Gedney; an EGS Electrical Group brand; an Emerson Industrial Automation business.
   7. Patriot Aluminum Products, LLC.
   8. Picoma Industries.
   10. Robroy Industries.
   12. Thomas & Betts Corporation, A Member of the ABB Group.
   13. Western Tube and Conduit Corporation.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. GRC: Comply with ANSI C80.1 and UL 6.
D. ARC: Comply with ANSI C80.5 and UL 6A.

E. IMC: Comply with ANSI C80.6 and UL 1242.

F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit
   1. Comply with NEMA RN 1.
   2. Coating Thickness: 0.040 inch (1 mm), minimum.

G. EMT: Comply with ANSI C80.3 and UL 797.

H. FMC: Comply with UL 1; zinc-coated steel

I. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

J. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
   1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
   2. Fittings for EMT:
      a. Material: Steel
      b. Type: compression
   3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
   4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

K. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Anamet Electrical, Inc.
   3. Arnco Corporation.
   4. CANTEX INC.
   5. CertainTeed Corporation.
   7. Electri-Flex Company.
   8. Kraloy.
   10. Niedax-Kleinhuis USA, Inc.
   11. RACO; Hubbell.
   12. Thomas & Betts Corporation, A Member of the ABB Group.

B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. ENT: Comply with NEMA TC 13 and UL 1653.

D. RNC: Type EPC-40-PVC complying with NEMA TC 2 and UL 651 unless otherwise indicated.

E. LFNC: Comply with UL 1660.

F. Rigid HDPE: Comply with UL 651A.

G. Continuous HDPE: Comply with UL 651B.

H. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.

I. RTRC: Comply with UL 1684A and NEMA TC 14.

J. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

K. Fittings for LFNC: Comply with UL 514B.

L. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

M. Solvent cements and adhesive primers 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."

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper B-Line, Inc.; a division of Cooper Industries.
   2. Hoffman; a brand of Pentair Equipment Protection.
   3. MonoSystems, Inc.
   4. Square D.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
   1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.
2.4 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Tele-Power Poles:
   1. Material: Galvanized steel with ivory baked-enamel finish
   2. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Adalet.
   2. Cooper Technologies Company.
   3. EGS/Appleton Electric.
   5. FSR Inc.
   8. Kraloy.
   10. MonoSystems, Inc.
   11. Oldcastle Enclosure Solutions.
   13. RACO; Hubbell.
   15. Spring City Electrical Manufacturing Company.
   17. Thomas & Betts Corporation, A Member of the ABB Group.
   18. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy Type FD, with gasketed cover.

E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

F. Metal Floor Boxes:
   1. Material: Cast metal
   2. Type: Semi-adjustable.
3. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.

H. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb (32 kg).

1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

I. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

J. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

K. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

L. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep)

M. Gangable boxes are prohibited.

N. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

O. Cabinets:

1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of reinforced concrete.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armorcast Products Company.
   b. Carson Industries LLC.
   c. NewBasis.
   d. Nordic Fiberglass, Inc.
   e. Oldcastle Precast, Inc.
   g. Synertech Moulded Products.

2. Standard: Comply with SCTE 77.
3. Color of Frame and Cover: Green.
4. Configuration: Designed for flush burial with closed bottom unless otherwise indicated.
5. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
6. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
7. Cover Legend: Molded lettering, "ELECTRIC."
8. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
9. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.7 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
   1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
   2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed Conduit: IMC
   2. Concealed Conduit, Aboveground: IMC
   3. Underground Conduit: RNC, Type EPC-40-PVC
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFNC.
   5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R

B. Indoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT
2. Exposed and Subject to Physical Damage: IMC. Raceway locations include the following:
   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical rooms.
   d. Gymnasiums.
   e. Equipment room
3. Concealed in Ceilings and Interior Walls and Partitions: EMT to be used for homeruns. MC cable with ground is allowed to be used from homerun to devises.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
5. Damp or Wet Locations: IMC.
6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
   3. EMT: Use setscrew steel fittings. Comply with NEMA FB 2.10.
   4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface raceways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C)

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches (300 mm) of enclosures to which attached.

I. Raceways Embedded in Slabs:
   1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m) intervals.
   2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
   3. Arrange raceways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions.
   4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
   5. Change from ENT to IMC before rising above floor.

J. Stub-ups to Above Recessed Ceilings:
   1. Use EMT, IMC, or RMC for raceways.
   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

K. 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.

L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cuts straight and perpendicular to the length.
R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

S. Surface Raceways:
1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer’s written instructions. Tape and glue are not acceptable support methods.

T. Install raceway sealing fittings at accessible locations according to NFPA 70 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 according to NFPA 70.

U. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by NFPA 70.

V. Comply with manufacturer’s written instructions for solvent welding RNC and fittings.

W. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
   c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
   d. Attics: 135 deg F (75 deg C) temperature change.
3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer’s written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

Y. 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. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

Z. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

AA. Locate boxes so that cover or plate will not span different building finishes.

BB. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

CC. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

DD. Set metal floor boxes level and flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.

2. Install backfill as specified in Section 312000 "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 (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."

4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.

   b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Install handholes with bottom below frost line, 30" Minimum 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 enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.
SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND 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. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
   2. Sleeve-seal systems.
   5. Silicone sealants.

B. Related Requirements:
   1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:
   2. 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 Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:
   2. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
      b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS

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 Company (The).
      d. Pipeline Seal and Insulator, Inc.
      e. Proco Products, Inc.
   2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Stainless steel.
   4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. HOLDRITE.
2.4 GROUT

A. Description: Non-shrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.


C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

   a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."

   b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
   1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
   2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install 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.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544
SECTION 260548 - SEISMIC CONTROLS 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 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Restraint channel bracings.
   2. Restraint cables.
   4. Mechanical anchor bolts.
   5. Adhesive anchor bolts.

B. Related Requirements:
   1. Section 260529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
      a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES and OSHPD
      b. Annotate to indicate application of each product submitted and compliance with requirements.
   2. Seismic[- and Wind]-Restraint Details:
      a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
      b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
      c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
d. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES and OSHPD showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.

B. Qualification Data: For professional engineer

C. Welding certificates.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis. They shall bear anchorage preapproval from OSHPD in addition to preapproval, showing maximum seismic-restraint ratings, by ICC-ES or another agency acceptable to authorities having jurisdiction. 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) that support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

E. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Basic Wind Speed: 100.
2. Building Classification Category: III
3. Minimum 10 lb/sq. ft. (48.8 kg/sq. m) multiplied by maximum area of HVAC component projected on vertical plane normal to wind direction and 45 degrees either side of normal.

B. Seismic-Restraint Loading:
1. Site Class as Defined in the IBC: As identified on architectural document
2. Assigned Seismic Use Group or Building Category as Defined in the IBC: As identified on architectural document
   a. Component Importance Factor: 1.5
   b. Component Response Modification Factor: 2.5
   c. Component Amplification Factor: 2.5
3. Design Spectral Response Acceleration at Short Periods (0.2 Second): As identified on architectural document.
4. Design Spectral Response Acceleration at 1.0-Second Period: As identified on architectural document

2.2 RESTRAINT CHANNEL BRACINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper B-Line, Inc.; a division of Cooper Industries.
   2. Hilti, Inc.
   3. Mason Industries, Inc.
   4. Unistrut; an Atkore International company.

B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end, with other matching components, and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.3 RESTRAINT CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Kinetics Noise Control, Inc.
   2. Loos & Co., Inc.
   3. Vibration Mountings & Controls, Inc.

B. Restraint Cables: ASTM A 492 stainless-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.4 SEISMIC-RESTRAINT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper B-Line, Inc.; a division of Cooper Industries.
   2. Kinetics Noise Control, Inc.
   3. Mason Industries, Inc.
   4. TOLCO; a brand of NiBCO INC.
B.  Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

C.  Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

D.  Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.

E.  Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

F.  Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.5 MECHANICAL ANCHOR BOLTS

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

1.  Cooper B-Line, Inc.; a division of Cooper Industries.
2.  Hilti, Inc.
4.  Mason Industries, Inc.

B.  Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.6 ADHESIVE ANCHOR BOLTS

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

1.  Hilti, Inc.
2.  Kinetics Noise Control, Inc.
3.  Mason Industries, Inc.

B.  Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for 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 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an evaluation service member of ICC-ES and OSHPD

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where required to prevent buckling of hanger rods caused by seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork

B. Equipment and Hanger Restraints:

   1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
   2. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES and OSHPD providing required submittals for component.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

E. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

F. Drilled-in Anchors:

   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are...
encountered during drilling. Locate and avoid prestressed 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. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

5. Set anchors to manufacturer’s recommended torque using a torque wrench.

6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days’ advance notice.


4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.

5. Test to 90 percent of rated proof load of device.

B. Seismic controls will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 260548
SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Identification for raceways.
   2. Identification of power and control cables.
   3. Identification for conductors.
   5. Warning labels and signs.
   6. Instruction signs.
   7. Equipment identification labels.
   8. Miscellaneous identification products.

1.2 ACTION SUBMITTALS

A. Product Data: For each electrical identification product indicated.

1.3 QUALITY ASSURANCE

A. Comply with ANSI A13.1.
B. Comply with NFPA 70.
D. Comply with ANSI Z535.4 for safety signs and labels.
E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

PART 2 - PRODUCTS

2.1 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
B. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
   1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2.2 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

B. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
   1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.3 FLOOR MARKING TAPE

A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.4 UNDERGROUND-LINE WARNING TAPE

A. Tape:
   1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical utility lines.
   2. Printing on tape shall be permanent and shall not be damaged by burial operations.
   3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:
   1. Comply with ANSI Z535.1 through ANSI Z535.5.
   2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE,
   3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE, >.

C. Tag:
   1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, compounded for direct-burial service.
   2. Overall Thickness: 5 mils (0.125 mm).
   3. Foil Core Thickness: 0.35 mil (0.00889 mm).
   4. Weight: 28 lb/1000 sq. ft. (13.7 kg/100 sq. m).
   5. 3-Inch (75-mm) Tensile According to ASTM D 882: 70 lbf (311.3 N), and 4600 psi (31.7 MPa).

2.5 WARNING LABELS AND SIGNS


B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
C.  Warning label and sign shall include, but are not limited to, the following legends:

1.  Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2.  Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.6 EQUIPMENT IDENTIFICATION LABELS

A.  Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

B.  Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

C.  Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A.  Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B.  Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A.  Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

B.  Apply identification devices to surfaces that require finish after completing finish work.

C.  Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

D.  Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

E.  System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

G. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

2. Power.
3. UPS.

B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
   a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
   b. Colors for 208/120-V Circuits:
      1) Phase A: Black.
      2) Phase B: Red.
      3) Phase C: Blue.
   c. Colors for 480/277-V Circuits:
      1) Phase A: Brown.
      2) Phase B: Orange.
      3) Phase C: Yellow.
   d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

C. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

D. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.


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.


F. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Limit use of underground-line warning tape to direct-buried cables.
2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

G. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

H. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels

2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
   a. Power transfer switches.
   b. Controls with external control power connections.

I. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch (10-mm) 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 the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:
   a. Indoor Equipment: Adhesive film label Unless otherwise indicated, provide a single line of text with 1/2-inch (13-mm) high letters on 1-1/2-inch (38-mm) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
   b. Outdoor Equipment: Engraved, laminated acrylic or melamine label
   c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
   d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
END OF SECTION 260553
SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Receptacles, receptacles with integral GFCI, and associated device plates.
   2. Weather-resistant receptacles.
   3. Snap switches and wall-box dimmers.
   4. Solid-state fan speed controls.
   5. Wall-switch and exterior occupancy sensors.
   6. Communications outlets.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
2. Hubbell Incorporated; Wiring Device-Kellems.
3. Leviton Manufacturing Co., Inc.

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

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. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2.4 GFCI RECEPTACLES

A. General Description:

1. Straight blade, non-feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

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

   a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
2.5 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

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

   a. Single Pole:
      1) Cooper; AH1221.
      2) Hubbell; HBL1221.
      3) Leviton; 1221-2.
      4) Pass & Seymour; CSB20AC1.

   b. Two Pole:
      1) Cooper; AH1222.
      2) Hubbell; HBL1222.
      3) Leviton; 1222-2.
      4) Pass & Seymour; CSB20AC2.

   c. Three Way:
      1) Cooper; AH1223.
      2) Hubbell; HBL1223.
      3) Leviton; 1223-2.
      4) Pass & Seymour; CSB20AC3.

   d. Four Way:
      1) Cooper; AH1224.
      2) Hubbell; HBL1224.
      3) Leviton; 1224-2.
      4) Pass & Seymour; CSB20AC4.

C. Pilot-Light Switches, 20 A:

1. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."

D. Key-Operated Switches, 120/277 V, 20 A:

1. Description: Single pole, with factory-supplied key in lieu of switch handle.

2.6 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.

1. 0-10volt dimmers shall have pre-set on-off and be low profile and be rated for the load.
B. Control: Continuously adjustable slider with single-pole or three-way switching. Comply with UL 1472.
   1. 600 W; dimmers shall require no derating when ganged with other devices. Illuminated when "off." Dimmers shall be rated for type of load it is controlling.

2.7 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.
   1. Provide stainless steel cover plate for all the devices in public area.
   2. Plate-Securing Screws: Metal with head color to match plate finish.
   5. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.8 FINISHES

A. 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.

B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:
   1. Protect installed devices and their boxes. 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 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 right 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.
   4. Existing Conductors:
      a. Cut back and pigtail, or replace all damaged conductors.
      b. Straighten conductors that remain and remove corrosion and foreign matter.
      c. Pigtailling existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:
   1. Replace devices that have been in temporary use during construction and that 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 (152 mm) in length.
   5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
   6. Use a torque screwdriver when a torque is recommended or required by 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. Receptacle Orientation:
   1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the left.

F. 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.

G. 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.

3.2 GFCI RECEPTACLES
   A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.
3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display 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 unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.

C. Wiring device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 262726
SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600 V ac and less for use in the following:
   a. Control circuits.
   b. Motor-control centers.
   c. Panelboards.
   d. Switchboards.
   e. Enclosed controllers.
   f. Enclosed switches.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cooper Bussmann; a division of Cooper Industries.
2. Edison; a brand of Cooper Bussmann; a division of Cooper Industries.
3. Littelfuse, Inc.
4. Mersen USA.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

1. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
2. Type RK-5: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, time delay.
4. Type CD: 600-V, 31- to 60-A rating, 200 kAIC time delay.
5. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
6. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.
7. Type T: 600-V, zero- to 800-A rating, 200 kAIC, time delay.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s) in location as indicated in the field by Owner.

3.2 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813